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Taxation on robots? Challenges for tax policy in the era of automation

¿Impuesto sobre los robots? Desafíos para la política tributaria en la era de la automatización

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ABSTRACT The aim of this article is to discuss about the main issues related to the proposal of a robot tax. For this purpose, the first part briefly shows the current automation context in the world. The second part debates on how the tax could be justified, ranging from the threats of unemployment and inequality up to how governments could help displaced workers via universal basic income. The third part analyses in detail the issues of a robot tax. Finally, the last part tries to answer the question whether the tax is a good idea or not.

KEYWORDS Robot tax, automation, tax policy, unemployment, universal basic income.

RESUMEN El objetivo de este artículo es discutir acerca de los principales problemas relacionados con la propuesta de un impuesto sobre los robots. Para este propósito, la primera parte muestra brevemente el contexto actual de la automatización en el mundo. La segunda parte debate cómo se podría justificar el impuesto, abarcando desde las amenazas de desempleo y desigualdad hasta cómo los gobiernos podrían ayudar a los trabajadores desplazados vía un ingreso universal básico. La tercera parte analiza en detalle los problemas de un impuesto sobre los robots. Finalmente, la última parte trata de responder a la pregunta si el impuesto es una buena idea o no.

PALABRAS CLAVE Impuesto sobre los robots, automatización, política tributaria, desempleo, ingreso universal básico.

Introduction

It is commonly said that we are facing a new technological revolution[1]. Rapid advances in automation technologies, including artificial intelligence, robotics, machine learning, big data, blockchain, and other advances in computer technology have begun to fundamentally transform our economy, society, and world (Mazur, 2018: 3). We may not notice it directly, but if we look closely around us, it is already possible to see how certain tasks that a few years were developed by humans are now being developed by machines, *e.g.* self-propelled subway carriages, self-service checkouts, warehousing robots, and even more complex tasks, such as automated customer service or review of legal documentation.

Even though new technological developments are often related to efficiency and catalogued as beneficial for nation's progress, policymakers and experts in some countries fear the consequences that these rapid technological changes may have in employment and inequality. They generally say that the current transformation is not like any other we have had before, and that we should pay attention and act quickly to avoid any harm to society, because with automation not only low-skill repetitive tasks are endangered (although they are more exposed, as we will discuss later), but all kinds of jobs overall.

Following this idea, a Member of the European Parliament, Mady Delvaux, tried to introduce a recommendation of a robot tax in a Committee on Legal Affairs Report in 2017. She argued that the current development of robotics and artificial intelligence (AI) might result in a large part of the work now done by humans being taken over by robots. Therefore, there are real concerns about the future of employment, the viability of social welfare and security systems and the continued lag in pension contributions if the current basis of taxation is maintained, creating the potential for increased inequality in the distribution of wealth and influence. Due to the foregoing, the report suggest that the possibility of levying with a tax the work performed by a robot or a fee for using and maintaining a robot, should be examined in the context of funding the support and retraining of unemployed workers whose jobs have been reduced or eliminated (Delvaux, 2016: 4). Ultimately, however, the resolution adopted by the European Parliament included only non-tax recommendations, namely, civil law rules (hereinafter, the "Resolution").

Bill Gates, the co-founder of Microsoft, used a similar reasoning in 2017 when in an interview —just a day after the final Resolution of the European Parliament— proposed the idea that governments should introduce a tax on robots due to their effect on employment. Gates thinks that when a machine replaces a human worker, for

1. Also referred as 'The Fourth Industrial Revolution', 'The Digital Era', 'The Age of Artificial Intelligence' or the 'Age of Automation'.

example, it should pay the same income and social security taxes that the displaced human did. Therefore, governments will be able to finance social programs such as jobs taking care of elderly people or working with kids in schools.[2]

Although some people supported Gates and Delvaux ideas, *e.g.* Nobel Prize winner, economist Paul Krugman, others rejected it saying that, even though it is true that many jobs are being currently automated, there is not enough evidence to prove that there will be a mass unemployment or other harmful effect on society any time soon. Another usual argument in favour of robots is that with automation, many other jobs will be created and they should absorb the ones lost, as it has happened before in history.

Despite divergent opinions, one thing seems to be certain: development of new technologies and the current path of automation pose major challenges to law, and particularly, to tax law. Usually, changes to tax legislation come much later than those produced in society, which, in turn, frustrates the achievement of its objectives. An example of the above is the digital economy with services provided by Uber, Netflix, Airbnb, Spotify, Amazon, among others. Even with BEPS Plan[3] and some other recommendations from the OECD, it is still unclear how to tax some of these services.[4]

Based on the premise that we are experiencing a major cultural change due to technology and that this change may have a direct impact in taxation, this article aims to discuss from a theoretical standpoint of view, and as way of introduction to the problematic, which tax policy issues should be addressed before a robot tax is effectively implemented. For these purposes, the first section will briefly review the current automation context in the world. Then, the second part debates on how a robot tax could be justified, with special attention on future employment prospects and inequality, considered the two greatest threats from robots. In addition, it discusses the idea of establishing a Universal Basic Income. The third part analyses in detail the issues of a robot tax, including definitions, impact on economy and competitiveness, options for taxation, and administrative issues, among others. Finally, the last part tries to answer the question whether the robot tax is a good idea or not.

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2. Kevin J. Delaney, "The robot that takes your job should pay taxes, says Bill Gates", *Quartz*, February 17, 2017, available at https://bit.ly/2lr9eYJ.

3. 'Base Erosion and Profit Shifting' or 'BEPS' is referred by the OECD to tax planning strategies of some multinational corporations that artificially shift profits from higher-tax jurisdictions to lower-tax jurisdictions or tax havens. On July 2013, the OECD presented a Plan with 15 Actions recommended in order to address the problem of tax avoidance.

4. Although it is a subject still under discussion, for online streaming services, for example, most countries chose to introduce a withholding indirect tax —similar to VAT/GST— payable at source. Tax rates start from 3% (Italy) up to 25% (Norway). In the case of Chile, the tax reform approved in February this year established that digital services provided by non-residents will be subject to 19% VAT starting in June 2020.

Context of automation

The concern over technological unemployment is hardly a recent phenomenon. Throughout history, the process of creative destruction, following technological inventions, has created enormous wealth, but also undesired disruptions (Frey and Osbourne, 2013: 5). One of these examples is the process known as the industrial revolution.

The industrial revolution of the XVIII century shaped the face of new industrial and economically successful societies by modifying their social and economic structures. By the introduction of new high-impact inventions of production, societies indeed witnessed an explosion of various manufactured goods such as textile items and metal products (Van Neuss, 2015: 2). Under this social context and due to the rapid loss of traditional jobs, englishman Ned Ludd encouraged his followers —so-called Luddites— to destroy textile machines (Atkinson and Miller, 2013: 3). The British government however took an increasingly stern view on those groups attempting to halt technological progress and deployed 12,000 men against the rioters (Frey and Osbourne, 2013: 7), dissolving them violently.

It has been several decades since then, but some people think that we could be facing a similar historical context. In opinion of Klaus Schwab (2016), founder of the World Economic Forum, we are currently facing the fourth industrial revolution. The first one used water and steam power to mechanize production. The second used electric power to create mass production. The third used electronics and information technology to automate production. Now a fourth industrial revolution is building on the third, the digital revolution that has been occurring since the middle of the last century. It is characterized by a fusion of technologies with 'intelligence' that is blurring the lines between the physical, digital, and biological spheres, and, consequently, the activities that can be performed by machines.

There are many examples that illustrate this idea and they seem to be particularly evident in transportation. In 2004, Professors Frank Levy from MIT and Richard Murnane from Harvard published a list of professions that were more likely to experience automation. The example of truck drivers was given as a job that could not possibly be automated in the near future. Only ten years later, Google and Tesla proved them wrong (Harari, 2016: 353). Since 2014, some Tesla cars are being sold with partial automatic pilot, but it is expected that in just a few years they will be completely autonomous. Notwithstanding, a hundred percent driverless cars already exist and tests have been carried out successfully; however, regulation and some safety issues are still underway in order to make their use accepted as the general rule.

In this regard, the U.S. Society of Automotive Engineers (SAE), proposed in 2014 a technical standard to classify assistive driving technologies from level 0, where no on-board computer controls anything, to level 5, where no human control is required.

For example, in level 2, the car can control speed and direction. An example is the Mercedes-Benz E-Class, which since 2016 has an assistant Drive Pilot, which is able to prevent the exit from the road. From level 3 onwards, vehicles can run autonomously in controlled environments such as highways, but their driver must be able to regain control at any time. This would be the case of Tesla's Autopilot in Model S. It is expected that level 5 —no human intervention needed while driving— will be reached by the year 2025.[5]

There are more examples. In the last Portugal Cup final match in 2017, a man surfing drone delivered the ball to the referee. Uber is planning to launch a flying taxi by 2023.[6] Amazon has already started to deliver some orders using only drones.[7]

However, these changes do not only involve the transport industry. Recent years have seen the emergence of machines that can diagnose cancers, detect fraudulent financial transactions in a matter of milliseconds, produce coherent news stories for media outlets, shuttle goods and pallets within complex distribution warehouses, trade stocks and shares in financial markets, and perform case research for the legal industry (Dellot and Wallace-Stephens, 2017: 4). For instance, Ross Intelligence, a company that uses IBM's Watson AI technology, created a software that can out-perform humans in the field of legal research. The difference with other search engines is that Ross uses artificial intelligence to obtain better results allowing it to 'learn' and adapt in the process, making it the perfect lawyer's assistant when doing research such as legal precedents.

Asia has also been leading the automation process. Haidilao International, a Chinese based company, in association with Panasonic, opened in October 2018 in Beijing the world first fully automated restaurant; robots take orders, prepare and deliver raw meat and fresh vegetables to customers without human interference. Another firm, linked to the Chinese multinational Alibaba, established China's biggest robot warehouse in 2018.[8] More than 700 robots locate and organize products faster than humans, allowing the company to be more efficient and to make less mistakes.

In Latin America, the case of Chile is particularly interesting. Falabella Group, engaged in the retail business, opened in 2018 in Santiago the most modern distribution centre of the region. It has 264 robots that circulate at 10 km/hour; they store and extract products, pass them through conveyor belts, categorize them, and finally

5. Moisés Barrio, "El coche autónomo acelera", *El País*, April 25, 2019, available at https://bit.ly/2IVlUm1.

6. Alba Asenjo and Ruqayyah Moynihan, "An Uber boss insists its flying taxis will be fully functional by 2023, and says the company is talking with NASA to find a way to manage air traffic", *The Verge*, October 24, 2019, available at https://bit.ly/2zoWwCA.

7. Luke Johnson, "9 things you need to know about the Amazon Prime Air drone delivery service", *Digital Spy*, February 7, 2017, available at https://bit.ly/2lp2SWr.

8. Arjun Kharpal, "Firm linked to Alibaba opens China's biggest robot warehouse to help deal with Singles Day demand", *CNBC*, October 29, 2018, available at https://cnb.cx/2P47S17.

dispatch them.[9] In the same line, early this year Walmart Chile inaugurated the first 100% self-service checkout store in Latin America, including the United States.[10]

Whether it is driverless cars or surgical robot assistants, banking 'chatbots' or self-service checkouts, it is now common to hear of how new machines are stepping in for humans at work (Dellot and Wallace-Stephens, 2017; 10). Robots are expanding in magnitude around the world. Between 2010 and 2014, the average increase in sales of robots stood at 17% per year and, in 2014, sales rose by 29%, the highest year-on-year increase ever, with automotive parts suppliers and the electrical/electronics industry being the main drivers of the growth. In addition, annual patent filings for robotics technology have tripled over the last decade (Delvaux, 2017: 4). In terms of units, in 2013 there were an estimated 1.2 million robots in use and it was projected to increase to about 1.9 million in 2017 (West, 2015: 2).

Investment in robots is also growing. The amount of venture capital funding going into robotics doubled between 2011 and 2015 to US$587 million, while the number of mergers and acquisitions of AI start-ups went from 11 in 2012 to 78 in 2016. The global market for robotics and AI-based systems is expected to grow to US$153 billion by 2020 (Dellot and Wallace-Stephens, 2017; 10). Not long ago, robots and automated services cost more than it could cost to pay an employee for the same job but this is no longer the case. Robots are set to become less costly, smaller, more intelligent, autonomous, and agile in the future (OECD, 2016: 7).

Under this scenario, it is reasonable for people to have fears. Changes in our cities and our daily life are happening fast. Due to the technological revolution that we have described, as well as the disastrous consequences that some people say it could have on people's lives, a tax on robots has been proposed as a solution for such scenario. The discussion of this proposal is addressed in the next paragraphs. The following chapter will focus on the discussion of how the application of the tax might be justified in order to, later, in the third chapter, analyse some of the main technical issues that policymakers will have to address if they wish to apply the tax.

Justifying a robot tax

Before any technical matter, policymakers will have to deal with the problem of how to justify the introduction of the tax. From our perspective, that justification could be divided into two preliminary questions that must be satisfactorily answered: the '*why*' and the '*what for*' of the tax.

9. Patricia Marchetti, "Gigante del retail chileno inaugura el centro de distribución más moderno de Latinoamérica con presencia de Piñera", *Emol*, November 29, 2018, available at https://bit.ly/2Q1VjZA.

10. Rodrigo Olivares, "Walmart instala en Chile primera tienda 100% autoservicio de Latinoamérica y Estados Unidos", *Diario Financiero*, December 31, 2018, available at https://bit.ly/2CGDA1t.

The '*why*' issue relates to the possible consequences of automation, namely, high rates of unemployment and increasing inequality. On the other hand, the '*what for*' relates to the objective, and it could be explained as a way to obtain public revenue to finance social programs for those displaced by machines. Taxation on robots, then, would help via distribution of resources to finance aid for those displaced, in the first place, and to reduce inequality, in the second place. Notwithstanding, traditional redistribution mechanisms are not the only alternative. Some people like Elon Musk, Bill Gates, Richard Branson and Mark Zuckerberg, for example, have proposed the idea of moving towards a Universal Basic Income.[11] We discuss these ideas below.

The '*why*' of a robot tax

Mass unemployment?

The effect of technological change is drawing increased attention from academics, policymakers and the public (OECD, 2016: 7). In general, there are two approaches related to the future of employment: (i) optimists for one side, who say that automation will bring benefits, and; (ii) pessimists on the other side, who are particularly worried about the consequences on employment. In this second group, for example, we can find Nobel-prize winner, economist Paul Krugman:

> Today a much darker picture of the effects of technology on labour is emerging. In this picture, highly educated workers are as likely as less educated workers to find themselves displaced and devalued, and pushing for more education may create as many problems as it solves.[12]

But where does this fear come from? Probably from the fact that for many years humans adapted well to technological changes: jobs were destroyed but new jobs were created reasonably faster. Nevertheless, this time it could be different. The main argument for this approach is based on an analysis suggesting that progression in digital technologies and artificial intelligence is exponential and stable. This is usually referred to as Moore's law (*e.g.* Brynjolfsson and McAfee). Faced with such exponentially, it is harder to foresee the dynamics of the new demand for labour and harder for workers to adjust by education. For this reason, part of workforce will face a situation often called nowhere left to run (Pulkka, 2017: 297).

As noted by Richard Posner, if technological advance is very rapid, causing in turn a large and very rapid drop in demand in a large labour market, the economy may not

11. Catherine Clifford, "What billionaires and business titans say about cash handouts in 2017 (Hint: lots!)", *CNBC*, December 28, 2017, available at https://cnb.cx/2ClzfkY.

12. Paul Krugman, "Sympathy for the Luddites", *New York Times*, June 13, 2013, available at https://nyti.ms/2r7RHq0.

Table 1. Market capitalization and total employees for top firms, 1962 and 2017

Company	Market cap in US$	Year	Number of employees
AT&T	20 billion	1962	564,000
General Motors	12 billion	1962	605,000
Apple	800 billion	2017	116,000
Alphabet (Google)	679 billion	2017	73,000
Microsoft	540 billion	2017	114,000
Facebook	441 billion	2017	18,770

Source: West (2018: 65).

be able to absorb the sudden surplus of labour in a short period of time. The result will be soaring unemployment that will retard normal market processes by reducing incomes and in turn production and therefore in the demand for workers.[13]

Automation and the implementation of technology such as robots with artificial intelligence into production processes has modified the way companies operate. People are slowly —but consistently— being replaced at work. Some numbers can illustrate this idea. **Table 1** compares the market capitalizations and workforces of the largest firms in 1962 and 2017, while Table 2 shows the number of employees and purchase value that selected companies had when acquired by top technological firms.

As we can see, there is a downward trend in the number of employees that big companies have today compared to big companies of the past. Also, thanks to technology it is easier for software companies to reach a high market capitalization with only a few human employees. This is why several studies predict how machines will displace human workers over the next years.

In 2013, Oxford professors Carl B. Frey and Michael A. Osbourne published 'The Future of Employment'. They estimated that around 47 percent of total US employment is in the high-risk category, *i.e.* jobs that could be automated relatively soon, perhaps over the next decade or two. Another report by McKinsey Global Institute in 2017 estimated that between 400 million and 800 million individuals around the world could be displaced by automation and will need to find new jobs by 2030. In addition, the study predicted that for advanced economies, the share of the workforce that may need to learn new skills and find work in new occupations is much higher: up to one-third of the 2030 workforce in the United States and Germany, and nearly half in Japan. In the case of Chile, up to 3.2 million people could be replaced by automated systems over the next two decades, 49% of the current workforce.

13. Richard Posner, "Automation and Employment", *The Becker-Posner Blog*, March 17, 2013, available at https://bit.ly/2DOofd6.

Table 2. Number of employees that selected companies had when acquired by top technological firms

Company	Purchase value in US$	Year	Number of employees
YouTube	1,65 billion	2006	65
Instagram	1 billion	2012	13
WhatsApp	19 billion	2015	55

Source: Pulkka (2017: 297).

In the same line, the OECD released a report in 2018, prepared by Ljubica Nedelkoska and Glenda Quintini (2018), which concludes that across the 32 member countries, close to one in two jobs are likely to be significantly affected by automation, based on the tasks they involve. However, their conclusions vary from one country to another. For example, 33% of all jobs in Slovakia are highly automatable, while this is only the case with 6% of the jobs in Norway. More generally, jobs in Anglo-Saxon, Nordic countries and the Netherlands are less automatable than jobs in Eastern European countries, South European countries, Germany, Chile and Japan.

Similarly, the World Economic Forum (WEF) published in 2018 'The Future of Jobs', a report indicating that by 2025, more than half of all current workplace tasks will be performed by machines as opposed to 29% today. RSA/YouGov survey found that business leaders in UK on average believe 15 percent of jobs in their organization have the potential to be fully automated within 10 years (Dellot and Wallace-Stephens, 2017: 32). Any Haldane, the chief economist of the Bank of England, told the Trades Union Congress on 12 November 2016 that on the basis of probabilities of automation, up to 15 million jobs could be at risk in the UK, and up to 80 million jobs in the US (Mitha, 2017: 5)

As we can see, most studies predict that a great percentage of jobs have the risk to be automated soon, being this the main argument for 'pessimists' in order to be concerned about the future of employment. However, on the other hand, there is still space for optimism. The same study conducted by the WEF in 2018 determined that even with jobs losses, in terms of overall numbers, the outlook is positive with 133 million new jobs expected to be created by 2022 compared to 75 million that will be displaced.

McKinsey Global Institute (2017: 12) arrived to a similar conclusion indicating that with sufficient economic growth, innovation, and investment, there can be enough new job creation to offset the impact of automation. Moreover, economists predict that automation is more likely to complement the task that humans do, rather than substitute the human workers, which would further minimize any massive unemployment (Mazur, 2018: 8).

This positive scenario, unlike those who fear technological changes, suggests technological unemployment only in the short or medium term but most importantly, more convenient jobs for the majority. Wages are also expected to rise due to growing productivity. The key policy recommendation among this school is to invest in education (Pulkka, 2017: 299) rather than hinder technology development. Robots are already driving productivity. Some studies have found that investment in robots contributed to 10 percent of GDP growth per capita in OECD countries from 1993 to 2016. There is also a 0.42 percent correlation between a country's wage-adjusted manufacturing robot adoption and growth in productivity between 2010 and 2017 (Atkinson, 2019: 3).

In conclusion, there is not straight answer to the question whether automation will cause a mass unemployment in a near future. At least, recent evidence suggests the opposite. However, this statement assumes that the speed of changes will remain constant. Therefore, actually there is no certainty whether it will remain this way in 15 or 20 years, especially considering the advances in artificial intelligence and other technologies that could occur during this time. In this regard, although it is not possible to say exactly whether there will be a high unemployment rate anytime soon, there are jobs that are at great risk of disappearing in the short-term, as we will see below.

Inequality?

The second common threat related to the rise of the robots is increased inequality. This fear stems from the belief that the growing automation of tasks previously performed by workers will contribute to lower wages for workers and greater profits for those who own the robots (Mazur, 2018: 10). This could be particularly critical in countries with a high Gini coefficient,[14] like Chile, Mexico, India, Brazil, or the United States. If the trend continues, the small group that owns capital in those countries could see their profits increase even more, while the majority would see their income reduced by the impossibility of competing against the machines. Gavin Mueller's 'The Rise of the Machines' argues that in the short term, the new machines benefit capitalists, who can lay off their expensive, unnecessary workers to fend for themselves in the labour market (Atkinson and Miller, 2013: 6).

Even if robots do not eliminate routine and lower-skill jobs, workers in these occupations are nevertheless likely to see a decline in wages. To compete with robots who are more productive, do not take sick days, make less errors, and are often less

14. The 'Gini coefficient' is a measure of statistical dispersion intended to represent the income or wealth distribution of a nation's residents. This measure is represented by values from 0 to 1. A Gini coefficient of zero expresses perfect equality, while a Gini coefficient of 1 expresses maximal inequality.

costly, workers in these positions will have to accept lower wages to keep their jobs (Mazur, 2018: 11).

Those who do not pay much attention to jobs losses (because new ones are created), base their beliefs in standard models of economic growth, implicitly assuming that economic growth —that is boosted by automation— benefits all residents of a country. However, just as Nobel Prize-winning, economist Paul Samuelson showed, outsourcing and offshoring do not necessarily increase the welfare of all workers, as it is also true that technological progress is not a rising tide that automatically raises all incomes. Even as overall wealth increases, there can be, and usually will be, winners and losers. In short, the losers are not necessarily some small segment of the labour force like buggy whip manufacturers. In principle, they can be a majority or even 90% or more of the population (Brynjolfsson and McAfee, 2011: 27).

Furthermore, 'capital versus labour' could not be the only element that increases inequality; also, among workers, there is place for disparity. Most studies reveal a technological bias against low-skilled and low-paid workers. The OECD calculates that 44 percent of workers with less than a high-school degree hold jobs made up of many highly automated tasks, compared with 1 percent for the college-educated. Similarly, Deloitte estimates that UK jobs paying less than £30,000 are five times more vulnerable to displacement than jobs paying £100,000 or more (Dellot and Wallace-Stephens, 2017: 32). This means that the risk of automation is not distributed equally among workers.

Automation is found to affect mainly 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. The occupations with the highest estimated automatability typically only require basic to low level of education. At the other end of the spectrum, the least automatable occupations almost all require professional training and/or tertiary education (OECD, 2018: 8). For example, insurance agents, sports referees, cashiers, chefs, bakers, travel guides, and waiters, are jobs that have a probability of more than 90% of being automated by the year 2033, while recreational therapists, healthcare social workers, sales engineers, psychologists, elementary school teachers, athletic trainers and mechanical engineers have a probability of less than 1% (Frey and Osbourne, 2013).

The consensus of most experts and studies is that low-skilled jobs have a greater risk of disappearing soon. This could lead to an increasing inequality, as those people displaced may face an even greater challenge in a world that they are not prepared for. Is it reasonable to require a 50-year-old truck driver to reinvent himself because an autonomous truck replaced him? How will people react to these changes? Policymakers should consider these variables when proposing regulation.

The fate of high-skilled jobs, however, is currently more controversial. Some argue that technology provides opportunities to create new jobs, increase productivity, and deliver effective public services (World Bank, 2019: 2). By contrast, exists the fear that in the longer view, automation may raise the spectre of a world without work, or one with a lot less of it, where there is not much for human workers to do (Atkinson and Miller, 2013: 6). For instance, the development of blockchain software, which links groups of computers, will remove the need for many accountants, bankers, lawyers and other staff involved in the financial industry (Mitha, 2017: 5), all considered as high-skilled jobs. If changes are too disruptive, even jobs reserved for high-skilled humans could be endangered, further increasing inequality, leaving room only for specific jobs of a small elite engaged in the technology business.

In recent decades, countries have gone through a revolution as industrial jobs disappear and the service sector expands. In 2010, only 2 percent of Americans worked in agriculture; 20 percent worked in industry; and 78 percent worked as teachers, doctors, designers, lawyers, etc. (Harari, 2016: 349). Then, what will happen when robots start to replace humans in those jobs as well? Where do all those workers who shifted from the agricultural and industrial sector to the service sector will move when this sector is highly automated too? Will there be enough opportunities for everyone? Policymakers should begin to ask these questions.

The '*what for*' of a robot tax

Universal Basic Income

If changes in job market are too disruptive, then millions of people may lack employment and they may not be able to find one. In 1920, a farm worker could find employment in a tractor factory. In 1980, a factory worker could work as a cashier in a supermarket. These changes were possible because changing from farm to factory and from factory to supermarket required only a few skills. However, it might be difficult in 2050, when a cashier losses his job due to a robot, to start working as a cancer researcher, as a drone operator or as part of an AI-banking team (Harari, 2018: 50).

The starting point is evident. Millions of workers around the world will be replaced in their jobs by robotic systems and artificial intelligence over the next years and will not be able to relocate to the new jobs being created by the so-called digital revolution (Segura, 2018: 177). In addition, there is the problem of growing inequality. Due to the foregoing, ideas like a universal basic income (UBI) have gained strength in recent years.

A universal basic income could be defined as a regular fixed cash transfer payment provided by the government —or another institution in the public sphere— to every citizen or resident, regardless of whether he or she is rich or poor and/or wishing to be engaged in paid employment (Zheng, Guerriero and Lopez, 2017: 3). The characteristics of the UBI are that its payment is: (i) universal; (ii) without any condition, and; (iii) on an individual basis.

Although the idea of a basic income started gaining greater attention recently, it has a long history. Many different proposals were produced over the years, backed by advocates of the welfare state, such as John Kenneth Galbraith and Anthony Atkinson, as well as numerous free-market and libertarian economists, including F. A. Hayek and Milton Friedman (Tanner, 2015: 2). All of them understood that without a minimum income guaranteed for everyone, no equality or freedom is possible. The former, because this minimum makes social justice possible, and the latter because it allows individuals not to have specific claims on the members of the particular small group into which they were born.

But has the UBI ever been applied? Can it work in reality? Would people work less or more? Would it have any benefit? Some experiments have attempted to answer these questions; the most iconic of them is from Finland. In 2017, Kela, Finland's social insurance institution, conducted a two-year experiment that ended in December 2018. Finland paid 2,000 unemployment benefit recipients €560 a month without requiring them to go through the bureaucracy involved in applying for the traditional benefits and regardless of whether they landed a job. Recipients didn't have to give up other social benefits such as social assistance and housing and sickness allowances. They could even continue to apply for unemployment benefits if the amount due to them was higher than the basic income, a frequent situation for families with children.[15]

The preliminary results of the first year of the experiment (2017) have just been released. The conclusions are mixed. On one hand, according to the analysis of the register data, basic income recipients were no better or worse at finding employment than those in the control group during the first year of the experiment, and in this respect, there are no statistically significant differences between the groups. The recipients of basic income had half a day more of employment in the open labour market than the control group. Having earnings from the open or subsidized labour market was more frequent among the basic income recipients than in the control group by one percentage point. Then again, the earnings and income from self-employment were on average 21 euros lower in the test group than in the control group (Kela, 2019: 29).

However, on the hand, the results also showed that the wellbeing of the basic income recipients was clearly better than that of the control group. Those in the test group experienced significantly fewer problems related to health, stress and ability to concentrate than those in the control group. According to the results, those in the test group were also considerably more confident in their own future and their ability to influence societal issues than the control group. In particular, compared to the control group, monthly payment recipients reported a 37% reduction in depression

15. Leonid Bershidsky, "Is there a case for universal basic income?", *Bangkok Post*, February 11, 2019, available at https://bit.ly/2GyGGqx.

levels, a 22% improvement in confidence for their futures, and an 11% bump in faith in politicians (Kela, 2019: 30).

Some think that the experiment damaged the cause of UBI, as it would show that people do not necessarily work more when receiving a basic income. In addition, the group that were given the money could still access to other common subsidies from the government, therefore, the UBI would be pointless as it just imply more expenses from the government without proving a direct positive impact on employment. However, if we assess the experiment in terms of the effect of well-being in people, then the experiment clearly shows a positive outcome in their daily life. More importantly, it would contradict a widespread myth in the detractors of the UBI, as it would show that by receiving an unconditioned periodic payment, people don't spend all day sitting on the couch watching TV; on the contrary, they continue to seek jobs and to work.

Notwithstanding, these preliminary results need to be assessed with caution. First, only the first year of the experiment has been released yet. The full report will be available by 2020 according to Kela. Second, there are elements that would make the experiment very particular and from which general conclusions could not be drawn clearly. For example, the payment was given only to unemployed, not universally. In addition, the beneficiaries only received an amount of €560 monthly, which is not a large amount of money for Finland's standard of living. Third, the knowledge that the experiment had a duration of 2 years could have influenced people's behaviour.

Despite the difficulties, the Finnish experiment is a good start to assess the future desirability of establishing regular and unconditional payments. Similar initiatives are currently being planned. For example, the technology incubator 'Y Combinator' will give unconditional cash transfers to 3,000 participants in two cities of the US, beginning in mid-2019.

In conclusion, while a UBI may be an alternative, more studies are needed to overcome the difficulties involved. At the end, all experiments should answer some basic questions: Would people work less or more? Would they be happier? There will be more time to enjoy with their families or to study what they really love? Would it be too expensive in order to be sustainable by time? Which is the right amount for the UBI? Is it necessary to give the payment to everyone, even the rich? It is too soon to know.

Challenges of a robot tax

A first major problem, as we have seen, is to justify the introduction of the tax. So far, there is no conclusive empirical evidence on the future of the labour market. There are as many reports that indicate a loss of jobs, as there are those that indicate that this loss would be compensated by new jobs. However, the truth is that the nature of work is changing rapidly. Digitalisation and artificial intelligence are going to change the way we live in society. By virtue of this, it is at least worth to consider the possibility of a tax on robots.

While in the final chapter we will try to answer the question of whether a tax like the one proposed is a good idea or not, in this chapter we will assume that policymakers have decided to move in that direction. In other words, they have decided to introduce a tax on robots because they have been able to justify it in an appropriate way (*i.e.* answering the 'why' and 'what for' questions of the previous chapter in a satisfactorily way). However, now they will be faced with a series of challenges related to the design of the tax; problems that we seek to uncover from a theoretical perspective in this section.

Economy

Although we have slightly referred to possible economic consequences of taxing robots, it is time to develop the idea a little further. First, we must bear in mind that all government's regulations have an effect on the market from an economic perspective. According to the traditional neoclassical theory, in a perfect competitive market both suppliers and demanders will reach the equilibrium price, one at which each producer can sell all he wants to produce and each consumer can buy all he demands. Thus, society as a whole will have reached the social optimum point.

However, taxes raise the price paid by consumers and lower the price received by sellers, giving buyers an incentive to consume less and sellers an incentive to produce less. As buyers and sellers respond to these incentives, the size of the market is reduced and less than optimal. Therefore, as taxes distort the decisions of households and firms, they cause markets to allocate resources inefficiently (Mankiw, 2002: 165).

This assumption may be true in some cases, but not all. As literature has proved, markets are not always perfectly competitive because there are market failures, and when that happens, the allocation of resources is not efficient. One example of a market failure are negative externalities. There are markets where harmful or prejudicial effects on citizens are generated by the excessive consumption or production of certain goods and services. These effects are not measured or reflected by the demand or supply functions of the market. Therefore, the market cannot generate an allocation of resources that is socially efficient or that maximizes the social welfare of the community (Yáñez, 2016: 198).

One solution to the problems mentioned above are taxes. A 'pigouvian tax', named after the economist Arthur Cecil Pigou, consists in a tax on any market activity that generates negative externalities. Some classic examples are cigars, alcohol, sugar, and in general, those industries that pollute the environment. All in these cases, the market does not generate the social optimal, as the consumption or production of such goods generate harmful effects on society; therefore, a tax —that raises their price— would make people consume less and/or companies produce less, achieving the equilibrium.

Under this approach, a tax on robots could be justified as a pigouvian tax, as way to emend the lack of human employment produced by the introduction of robots in the labour market. The tax —irrespective of how it is constructed— would have the function of slowing down the replacement of humans at work, de-encouraging companies to acquire or to use machines instead of people, because they will be more expensive.

Notwithstanding, the application of pigouvian taxes has long been controversial. The design of any such corrective tax would pose a significant challenge for any legislator. In the case of a specific robot tax, a trade-off needs to be made between the positive social welfare effects —including positive externalities *e.g.* in the field of R&D— that can be attained by using intelligent robots, on the one hand, and the negative effects on the labour market and society as a whole, on the other hand. To strike a right balance will require close monitoring and empirical evaluation of the effects of the tax, and the political willingness to enact subsequent amendments reflecting better insights (Englisch, 2018: 15), something not always easy.

On one vision, redundant workers would bear the incalculable cost of the loss of potential, self-worth, family and marital breakdown, ill health, homelessness and despair that unemployment sometimes creates. The government would be justified in correcting the market failure by directly or indirectly with the robot tax. This would enable it to compensate those who suffered the negative externalities created by automation that are not reflected in the price of robots (Mitha, 2017: 10). In opposition, new technology is often a major driver for economic growth and progress. Advancements in robotics, automation and artificial intelligence are likely to do the same as this technology dramatically increases productivity and improves the quality of goods and services produced (Mazur, 2018: 22).

A report made by the firm PwC in 2017, concluded that artificial intelligence has a potential contribution of US$15.7 trillion to the global economy by the year 2030. It shows that 45% of total economic gains by 2030 will come from product enhancements, stimulating consumer demand. This is because AI will drive greater product variety, with increased personalisation, attractiveness, and affordability over time. Another study by Accenture in 2018 determined that AI could double the economic growth and increase up to 35% labour productivity in some OECD countries by the year 2035.[16] In general, some experts agree that new technologies combined with artificial intelligence could boost production and benefit economic growth. This is why a robot tax generates a great resistance.

16. Accenture, "Artificial Intelligence Is The Future Of Growth", *Accenture*, December 20, 2018, available at https://accntu.re/2MboBfI.

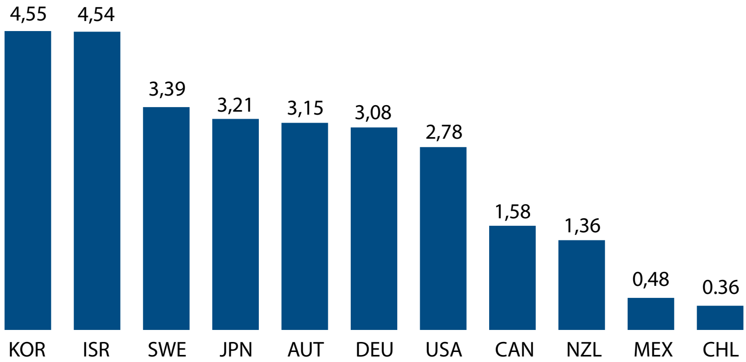

Figure 1. Human and financial resources devoted to R&D in selected OECD countries, 2017 (OECD, 2019).

Innovation and competitiveness

One of the ways in which countries achieve sustained economic growth over time is through innovation. Innovation, in general, implies discovering new ways of doing things, new ways of thinking. When companies innovate, they conceive new products, services, or processes, which makes them more efficient. If they are efficient and more competitive, business grows and so does the country. It is a virtuous circle.

Due to the aforementioned, countries usually foster innovation through research and development (R&D) policies. For instance, according to the OECD, as shown in the figure below, in the year 2017 South Korea and Israel lead the gross domestic expenditure on R&D as a percentage of GDP, with 4.55% and 4.54%, respectively. The next in the list were Sweden (3.39%), Japan (3.21%), Austria (3.15%), Germany (3.08%), and the United States (2.78%). In the middle we can find Canada (1,58%) and New Zealand (1,36%), and finally at the bottom, Mexico (0.48%) and Chile (0.36%).

In turn, a great percentage of this R&D expense is directed to the technological industry. This has allowed countries to embrace new technologies, to discover the benefits of artificial intelligence, blockchain, machine learning, and the digital economy, among others. Consequently, the tax as the one proposed is likely to hinder innovation. A robot tax would increase the cost of robots, therefore reducing the incentive for companies to innovate, penalizing technological progress (Mazur, 2018: 21).

In addition, each year states provide millions of dollars in grants that are used precisely for research in these areas. Therefore, if a robot tax was introduced, on one hand, governments will be promoting research into new technologies (*e.g.* FinTech companies, robots or artificial intelligence),[17] but on the other hand they will be

17. For example, the 36 OECD member countries and a few other non-members signed on May 21, 2019 a joint declaration —Recommendation of the Council on Artificial Intelligence— in which they call for the promotion and implementation of a set of principles in relation to artificial intelligence. Some of

charging companies for using them instead of humans. This contradiction could be complex from a public policy standpoint if it is not addressed properly.

Another problem comes from competitiveness. Globalization and free trade policies of recent decades have led countries to compete with each other in order to attract foreign capital and investment. Some argue that a robot tax might not be a feasible option in modern open economies, at least not regarding robots used in industrial production processes. Imposing additional tax burdens on the use of robots will likely lead to reduced competitiveness of the respective jurisdiction and make it significantly less attractive as an investment location (Englisch, 2018: 12). What would happen if a country introduces the tax, but the neighbouring country, which has similar characteristics as the first, does not? The answer is that, probably, the investment in capital assets such as robots would be allocated in the latter.[18] Therefore, even though we need to address the negative implications of automation, it is essential to do so in a manner that does not impede on innovation, but rather harnesses the benefits of automation (Mazur, 2018: 22).

A possible solution to these problems could be limiting the definition of what is understood by a robot tax in the first place. Notwithstanding, even in that scenario, a single or isolated effort of a country could not be enough, as the problem of competitiveness would still be present. For that reason, addressing the problem from a multilateral perspective through organisations such as the UN, EU or the OECD, could be a more effective approach.

Defining robot

The first image that usually comes to people's mind when they think of a robot is a sort of machine with humanoid shape, like those from popular movies such as 'I, Robot' or the Terminator; or, more recently in the real world, the machines developed by Boston Dynamics. However, to be subject to tax, a robot must be clearly determinable from a legal point of view. The concept is still not sufficiently delimited today to be adequately defined legally. This task is rather difficult. After all, machines are part of technological development and are a follow-up of AI (Oberson, 2017: 249).

The term 'robot' was first conceived in the play R.U.R. (*Rossumovi Univerzální Roboti*) by the Czech writer Karel Čapek in 1920. The word comes from the translation of *roboti*, which literally means 'forced labour' in Czech (García-Prieto, 2018:

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these principles are inclusive growth, sustainable development, human-centred values and fairness. The call for 'investing in AI research and development' and 'fostering a digital ecosystem for AI' is especially noteworthy. More information could be found in the following link: https://bit.ly/2VMUCRW.

18. Of course, taxes are not the only element when assessing an investment in a given country. In addition, political stability, property rights protection, level of development and infrastructure, among others, are also important.

31). Since then, literature and science fiction have shaped the modern conception of robots.[19]

But what is a robot for tax law purposes? Is any type of machine that replaces a human job? Does it include a bot, a robot programmed to perform tasks online? Does it have to be physical or can it be something intangible, such as software or algorithms that allows a computer to work as a doctor, lawyer or architect? (Mazur, 2018: 20). Should we only consider those immersed in a productive process? What about the devices in our homes —intelligent vacuum cleaner— or in our offices —intelligent air-conditioning system—? (Segura, 2018: 174). What is the role of artificial intelligence in all this?

One tool that may be useful in designing the definition is to differentiate between 'simple robots' and 'smart robots'. This were in part the recommendations suggested by the European Parliament in their Resolution of 2017 (although not specifically for tax but legal purposes). The document proposed a common legal definition of cyber physical systems, autonomous systems, smart autonomous robots and their subcategories, by taking into consideration the following characteristics of a 'smart robot':

- The acquisition of autonomy through sensors and/or by exchanging data with its environment (inter-connectivity) and the trading and analysing of those data;
- Self-learning from experience and by interaction (optional criterion);
- At least a minor physical support;
- The adaptation of its behaviour and actions to the environment;
- Absence of life in the biological sense (European Parliament, 2017: 6).

Under this approach, a vending machine, for example, could be labelled as a simple robot. The way it operates is that a customer comes and selects an option, pays, the choice is dispensed and the change is returned. Perhaps, the intelligent aspect of a vending machine is the process of identifying money, calculating and giving back the change (Marwala, 2018: 2), but does it mean we should tax —with a specific robot tax— the vending machine? Can we consider this 'robot' smart enough in order to make it subject to the tax? Although vending machines put some shopkeepers out of the work, according to the definition proposed by the European Parliament the answer is no, because its 'intelligence' is very limited.

19. For instance, the three laws of robotics of the writer Isaac Asimov introduced in his 1942 short story 'Runaround'. First Law: A robot may not injure a human being or, through inaction, allow a human being to come to harm. Second Law: A robot must obey the orders given it by human beings except where such orders would conflict with the First Law. Third Law: A robot must protect its own existence as long as such protection does not conflict with the First or Second Laws.

On the other hand, examples of smart robots could be those immersed in production processes. Amazon is planning to fully automate shipping warehouses in maximum 10 years[20]. Robots are still not very smart —or smarter than humans— at detecting a package, moving towards it and shipping it while interacting 100% independently with its environment, but soon they will be. Once that happens, the 125,000 employees working at Amazon's U.S. factories could see their jobs threatened. These warehouse robots will have autonomy of movement, self-learning experiences, physical presence and they will adapt its behaviour to a complex environment, fitting almost perfectly with the definition of the proposal above.

A critic that can be made to the definition proposed by the EU Parliament, however, is that the Resolution uses examples that might not fit perfectly with it. For instance, surgical robots (referred to in paragraph 17 of the proposal) can be assimilated to robots in general; they cannot enter in the category of autonomous and intelligent robots. Indeed, surgical robots most often work on a master-slave model, *i.e.* by simple teleoperation by the practitioner, like the Da Vinci surgical robot. As man remains in the decision loop, it may then be more difficult to talk about robot autonomy. Another example are drones (referred to in the proposal in paragraph 19), which are most often remotely operated by their operator, and only with difficulty meet the condition of autonomy and of intelligence (Nevejans, 2016: 10).

Other organisations have developed standards and definitions in the field of robots and robotics, an example of which is the ISO 8373:2012 standard on robots and robotic devices. This international standard specifies vocabulary used in relation to robots and robotic devices operating in both industrial and non-industrial environments. In general, a robot is an 'actuated mechanism programmable in two or more axes with a degree of autonomy, moving within its environment, to perform intended tasks'. The standard further specifies that a robot includes the control system and interface of the control system. The International Federation of Robotics (IFR) uses the same definition as the ISO standard (Oberson, 2017: 250).

Another proposal by Nathalie Nevejans (2016: 81) suggests that the definition of 'robot' should include the following elements:

- A physical machine;
- Has a capacity to act in the real world;
- Is alimented by energy;
- Can analyse the environment;
- Can render decisions;

20. Nick Statt, "Amazon says fully automated shipping warehouses are at least a decade away", *The Verge*, May 1, 2019, available at https://bit.ly/2ZOeJCl.

- Can learn.

Although in general terms it is good policy to have a single definition not only for legal purposes, but also for economic, technological and constitutional approaches (Mitha: 2017: 12), it has to be noted that all the above definitions have not been developed with a tax perspective in mind, but more from an ethics and civil liability perspective. From a tax perspective, a rather 'form neutral' definition of robots would tend to be favoured for tax purposes (Oberson, 2017: 250).

A definition of robots for tax purposes, as opposed to a general legal definition, should also include the objectives of the tax. For example, if designed as a compensatory tax for the reduction in wage and payroll taxes, the physical support element is less relevant than in the context of a Pigouvian tax that aims to slow down the pace of transition from human to machine labour in the field of services that require a local physical presence (Englisch, 2018: 19). In the first case, software or algorithms would be included in the scope of the tax, while in the second case they would not.

In my opinion, the definition of 'robot' for tax purposes should include more or less all of the elements indicated above: autonomy, self-learning, adaptation to the environment and a physical support. This last requirement is essential. We are aware that the digital economy involves not only the development of robots in the sense indicated above, but also new ways of doing business *e.g.* via streaming platforms or via softwares mixed with artificial intelligence. Although in these cases there could be the replacement of humans by an algorithm —or other non-physical artificially intelligent agents—, taxing these intangibles with a robot tax could hinder excessively the development of new technologies and innovation. Not only in business, but also in other more crucial aspects like health, science or education. In this regard, it may be more convenient to further limit the hypothetical tax on robots to a physical machine at this early stage.[21]

In addition, countries should be cautious on banning intelligent robots that instead of completely replacing people complement their work. How do we differentiate it? How can we tell that a robot is complementing a human task rather that eliminating it? This is not always easy. Even a valid question could be: how do we know that a smart robot is creating jobs instead of taking them away? We are not only talking about the work that consists of designing, building and maintaining a

21. An exception to this could be the financial market or the role played by speculative companies, because it is not clear that their activities are productive and not merely extractive, as Mariana Mazzucato argues in her book 'The Value of Everything: making and taking in the global economy' (2018). Many financial companies now use artificial intelligence software, which tells them when to buy/sell, even automatically. Consequently, for the specific case of these companies, a tax on non-physical artificial intelligence agents could be plausible.

robot, but also those robots that will allow other humans to find jobs. For example, in Japan, a pop-up restaurant has run a trial employing disabled people to work as remote operators of waiter robots. A team of 10 people, with a range of conditions including amyotrophic lateral sclerosis (ALS), controlled the robots. Even a man that could only move his eyes could still operate them.[22] In this case, there is no doubt that robots fulfil a noble purpose and that such actions should be fostered. However, if there are no exceptions in the concept of robots exists the danger that initiatives like the one described could be discouraged.

In this regard, a solution could be to limit the scope of the tax to certain activities, *e.g.* industrial companies or companies involved in specific production processes; or also to limit the tax to certain types of companies, *e.g.* big companies. This, rather than limiting the definition of robot —something not advisable, as we have seen— would limit the application of the tax *per se*.

Options for taxation

Once policymakers have decided what 'robot' means for tax purposes, it is now time to decide *what* and *whom* to tax. There are many options.

A tax directly on robots

A first —and why not, radical— proposal is to tax the robots 'themselves', as if they were individuals or corporations, and to make them liable of paying taxes. In practice, this would mean to levy the income generated by the activities carried out by the robots, giving them some sort of tax capacity to pay taxes. In words of Bill Gates:

> Right now, the human worker who does, say, $50,000 worth of work in a factory, that income is taxed and you get income tax, social security tax, all those things. If a robot comes in to do the same thing, you'd think that we'd tax the robot at a similar level (…). But you can't just give up that income tax, because that's part of how you've been funding that level of human workers.[23]

This approach has been defended in part by professor Xavier Oberson in a 2017 article titled *Taxing Robots? From the Emergence of an Electronic Ability to Pay to a Tax on Robots or the Use of Robots*. Under his view, a tax on robots would be the consequence of recognizing a specific tax personality of robots.

22. Harry Petit, "Tokyo cafe to use robot waiters controlled from home by people with severe disabilities to allow them to work remotely", *Daily Mail*, September 25, 2018, available at https://dailym.ai/2HQ4rt5.

23. Kevin J. Delaney, "The robot that takes your job should pay taxes, says Bill Gates", *Quartz*, February 17, 2017, available at https://bit.ly/2lr9eYJ.

The above argument consists in the following reasoning: (i) the development of smart machines, endowed with autonomy and learning experiences, have led them to constantly replace humans in some activities; (ii) in the past, the recognition of companies as separate tax subjects was a follow-up to legal personality, and consequently, they were granted with a capacity to pay different from their shareholders (*i.e.* corporate tax); (iii) the same argument could be applied to robots; their autonomy and their activities could justify to treat them as separate legal entities with their own legal personality, leading to a new electronic ability to pay, derived from the activities they perform (work, transfer of goods and services, etc.).

As a consequence of the foregoing, it could be argued that tax law should grant a legal capacity to robots, introducing a new type of legal personality into tax law (Oberson, 2017: 250). Notwithstanding, the author acknowledges that at an early stage, even though there may be a specific legal personality for robots (*i.e.* civil capacity), if tax on an imputed income generated by robots' activities is contemplated, it is usually not the robot that should be subject to tax but the use of them[24]. As a second stage, however, an ability to pay robots should be considered when technology allows for a payment capacity to be allocated to them (Oberson, 2017: 261).

In the same line, Filipe Maia argues in favour of granting a separate legal status for 'artificially intelligent agents', and to consider them as autonomous *electronic persons*. However, at this stage of development, he finds no justification for the specific attribution of property rights to such agents, or more importantly, for making them taxpayers, although in the future —when self-awareness of machines is achieved, if that ever happen— it could be advisable. The author, nonetheless, present some options for taxation apparently leaning towards applying the tax to the owner of the robots, *i.e.* similar to a tax for the use of robots (Maia, 2017: 36).

The problem with the approach of granting legal capacity to robots is that, in first place, at this stage of development it is doubtful that the robots can exercise patrimonial rights or to pay taxes by themselves, even if they have some sort of capacity. Prior to a singularity event, it is unlikely that robots will 'hold' asset of their own, making imposition of liabilities illusionary (Caytas, 2017: 5). This, of course, does not mean that there should not be a special statute and organic regulations for robots. Nevertheless, it is unlikely that this regulation should include the full exercise of patrimonial rights just like a human being.

From a common sense perspective, the argument of Bill Gates in order to tax the income generated by robots is it reasonable, but there is a technical difference between the income generated by the human and the hypothetical income of the robot. In the case of humans, they are directly subject to the tax (because they have legal capacity), and in general companies act as mere withholders of that tax that is

24. We will analyse this alternative later.

attributable the worker and pay it on their behalf. Therefore, if robots cannot have legal capacity for tax purposes, they cannot be tax subjects.

However, from Bill Gates' argument it is also possible to deprive a second option: a tax for the use of robots. In this type of tax robots would be *objects* of the tax rather than *subjects*. The subject, most likely, would be the the owner of the robot rather than the machine 'itself'.[25]

A tax for the use of robots

Robots are not machines that walk through life autonomously and independently, fulfilling their own goals or with particular objectives. At least not yet. Today, robots are used by companies or people who see in them a more efficient way to make profits for their businesses. For instance, many supermarket chains and fast food restaurants are automating purchases through self-service checkouts. A machine is replacing old human cashiers. Why? Because now it is more profitable for companies to have self-service machines than to pay wages, pay social securities, pay labour taxes; deal with unions, diseases and work shifts, among others. Therefore, it is logical that if a tax on robots is established, those companies who benefit from their use should be held responsible for the payment of the tax by their own (not as mere withholders).

But what type of tax? Or rather, how do we calculate it? A first option would be to tax companies on the imputed notional income of their robots. It, theoretically, would be possible to impute a notional salary to robots that displaced human workers, equivalent to the wages that were or would have been paid to the workers they displace (Mitha, 2017: 14). This proposal, although easy to say, it is extremely complicated in practice. It ignores how technology is incorporated into companies (García, 2018: 2). Robots often take over tasks before taking over an entire job, which makes finding a link between the robot and the displaced worker difficult (Mazur, 2018: 23). Sometimes, the substitution is by production sectors made by other related companies.

Then, how do we measure precisely this displacement? For example, when a company replaces 10 human workers with a robot, it could be relatively easy to say that the aggregate salary of the displaced should be the amount of the tax. The wages of the displaced workers would be used as a reference point for assessing the company's liability to this tax. Nevertheless, this approach does not take into consideration factors such as productivity, company growth, efficiency or the evolution of salaries over

25. This opinion slightly differs from authors such as Oberson (2017), who apparently considers that in the case of a tax on the use of robots, the subject could still be the robot. In my opinion, it does not make sense to consider the robot as a subject, but simply as the object; that is to say, using/owning robots would be the fact (object) that would trigger the obligation of the owner (subject) to pay the tax.

time. How would the number be adjusted over time? How do we measure the amount of the tax in cases where there have been no previously displaced workers? For example, a new company or a subsidiary is just getting started and it 'employs' mostly robots instead of humans, how would the tax be measured? Should the tax also apply in these cases? How could the law put itself in all *ex ante* cases? These are big issues.

A second option would be to impose the robot tax on the amount of income generated by the use of automation. This, again, raises the question: how do we measure the profits or value created by the robot or automation program? Robots and human workers often work together to complete a job and jointly contribute to the value produced. To allocate the income between the different labour and robot components would create significant compliance challenges. Similarly, multiple capital assets, not all of which are "robots," often work together to contribute to the value produced, but there is no clear-cut method to assign profits to the robot components (Mazur, 2018:24). A solution, perhaps, could be to impose a greater tax on companies with high profits compared to their workforce. A high 'profit:people' ratio would indicate companies that are highly automated.[26]

However, in all these cases, as pointed out by professor Oberson, a problem of double economic taxation could arise. This, because the income, or at least part of it, could be taxed twice: first at the robot level, on the imputed salary or income arising from the use of the robots, and second at the corporation level (Oberson, 2017: 265). The author, nonetheless, shows two potential solutions. First, the imputed salary could be deductible at corporate level as any 'salary'. Second, robots could still be regarded as depreciable assets for tax purposes, as any fixed asset.

In my view, the deduction at corporate level of the 'imputed salary' should not proceed, as robots would be *objects* of the tax and no double taxation may occur. Robots will not be paid in reality at this stage of development. Their notional imputed salary or the income generated by automation will only be used to calculate the amount of the tax that the owner would have to pay. In other words, there will be no economic sacrifice by the employer because he will not actually pay wages. On the other hand, the tax deduction via amortization needs more discussion, as we will see later.

Increase of the corporate tax rate

An increase in the corporate tax rate has also been given as alternative when thinking a robot tax. However, this proposal would not reduce the incentive for firms to replace workers with robots; it would hurt labour-intensive businesses and firms using robots alike, and discourage domestic and international investment (Mitha, 2017:

26. Anita Monteith, "How do you tax a robot?", *Icaew*, November 25, 2019, available at https://bit.ly/3fvchsa.

14). In addition, a policy of simple increasing the corporate tax rate could encourage companies to invest more in robots and automation, because as we have seen, they tend to be cheaper than humans are.

Nonetheless, if it were designed in such a way that companies using robots (something previously defined in the law) would pay a corporate tax surcharge, it could be a viable option. For instance, if in general the corporation tax rate is set at 25%, then those corporations that use robots (and meet certain requirements, *i.e.* high 'profit:people' ratio) must pay 25% tax rate plus a 2% surcharge, thus increasing their final corporate tax rate up to 27%. Even a progressive surcharge could be thought of as the number of robots used increases significantly.

Lump-sum tax

A simpler approach —yet not necessarily fairer— could be establishing a lump-sum tax. In general, a lump-sum tax consists in tax in which the taxpayer is assessed the same amount regardless of their particular circumstances. For example, all the companies that use robots would have to pay US$5,000 annually (or another amount) for each robot they employ.

These are the only kind of taxes that don't create distortions in the economy. Therefore, they would not impede automation because they are payable at the same level by everyone (Mitha, 2017: 14), being this a positive argument for its application. The downside, of course, is that it does not take into consideration the particular economic situation of the taxpayer, making it unfair and unpopular.

A tax on high skilled workers

Another option would be to focus the tax with a redistributive method from 'non-routine' workers, or high skilled, to 'routine workers' or low skilled. This would imply levying with personal taxes the income of those favoured by automation, with progressive rates. If it were simply to increase personal tax rates, it would be doubtful to call such a tax a robot tax. Now, if it were a special and specific personal tax, with a certain tax base, then it might make sense to call it a tax on robots.

This approach can find its justification in the fact that those future high skilled workers (*e.g.* programmers, engineers, technological employees) could be the new elite, something that is already happening in places like Silicon Valley and other technological hubs[27]. Therefore, these technological elite should pay different personal taxes than the general ones, considering its advantageous position in this new society.

27. Tekla S. Perry, "Tech Salaries: Silicon Valley Still Tops but Other Regions Come on Strong", *Spectrum*, July 1, 2019, available at https://bit.ly/339JamT.

Disallowance of tax deductions

Finally, a suggestion for taxing robots is not necessarily a sophisticated new tax. Authors like Professors Ryan Abbott and Bret Bogenschneider have recommended, among other proposals, that tax deductions at corporate level related to the acquisition or use of robots should be overhauled.

In 2017, South Korea, known for being one of the most robotized countries in the world, announced what was called the first 'robot tax'. In reality, however, the legal modification was far more modest: the country planned to limit tax incentives and benefits for investments in automated machines. That is precisely the point of Abbott and Bogenschneider. In a 2017 paper titled '*Should Robots Pay Taxes? Tax Policy in the Age of Automation*', the authors argued that current tax policies favour automation, even when sometimes it's not the most efficient choice.

Most tax systems are not 'neutral' as between work performed by robots versus people. Automation provides several major tax advantages. These include avoidance of employee and employer wage taxes, benefits from claiming accelerated tax depreciation on capital costs for automated workers, and indirect incentives for machine or automated workers (Abbott and Bogenschneider, 2017: 22). In other words, if robots and humans cost the same amount, tax policies make robots cheaper to employ. They pay no payroll tax, businesses can accelerate deductions for capital expenses like robots, and there may not be indirect taxes on robots[28].

Tax depreciation refers here to the deduction (a reduction in the tax base) claimed by the firm in respect to capital outlay for automated workers. Deductions for capital outlays for robotic equipment will allow the firm to reduce its tax base over time, which reduces the amount of tax that is payable. Of course, wages paid to individuals are also tax deductible, but the timing of the deduction works differently for robot and human workers, and this may have a significant effect on a firm's tax burden (Abbott and Bogenschneider, 2017: 23). Moreover, if we consider the options existing for accelerated tax deductions. This is why the replacement of human workers for robots makes sense from a business perspective.

Overall, the authors deliver some alternatives. For example, to disallow the respective corporate income tax deductions for capital investment that give rise to the automation tax benefit; and in case of indirect taxation, to forbid VAT exemptions or to claim credits. Another option could be to offset preferences for human workers by designing an accelerated deduction for future wage compensation expense (*i.e.*, the

28. Tom Davenport, "Advancing the Debate on Taxing Robots", *Forbes*, June 13, 2019, available at https://bit.ly/2rcg88V. In the case of indirect taxation, capital assets may be in some cases exempt from indirect taxation, or in the Chilean case, while it could be levied by complying some requirements, taxpayers can use the VAT payed as a credit.

firm would get an accelerated tax deduction) to match the accelerated depreciation for automated workers. These measures could help in order to narrow the gap between different tax treatments.

Administrative and compliance issues

Finding a simple and efficient way to administer the tax will be an extremely difficult task. On the one hand, taxpayers must be certain about questions such as who pays the tax and how it should be calculated. We must remember that modern tax systems are self-reporting. Therefore, the tax must be understandable and 'reasonable' so that taxpayers can voluntarily pay it.

On the other hand, tax administrations must also understand how the tax would operate. More important, effective mechanisms to combat tax evasion and avoidance should be implemented when designing the tax. Public records or the obligation to report robot purchases are some of the measures that could be implemented. Notwithstanding, these measures would require to be addressed by a multilateral organisation.

Overall, there is the danger that these proposals may involve a substantial element of arbitrariness and complexity to implement, each of which is likely to increase the compliance and administrative burden on companies and tax authorities (Mazur, 2018: 25).

Is the robot tax a good idea?

We have seen that a robot tax, as proposed in most cases, would entail a number of challenges that are quite difficult to overcome. Even more. This article attempted to approach the issue from a theoretical point of view, and yet the tax resulted in a number of complexities. Assuming that each of these problems can be addressed properly, there would still be more practical and specific problems. For instance, what exactly would the taxable event be? How would be the tax base calculated and by whom? What would be the tax rate? How much would the tax collect? How to audit its application? Not to mention all the problems in the field of international taxation.

Despite the foregoing, in my opinion, and to the answer the question of this chapter, the idea of a limited robot tax could be addressed at this preliminary stage of development if it meets some requirements. For example, a tax that: (i) is paid by certain taxpayers that use robots (*i.e.* large companies); (ii) is related to certain activities (*i.e.* some industrial and/or financial activities); (iii) has a limited definition for robots (*i.e.* physical smart machines or non-physical intelligent software's in case of financial or other unproductive activities), and; (iv) has a low tax rate. Under these conditions, a tax on robots could be viable. However, countries should assess the pertinence of applying it. A tax on robots in countries that are already industrialized is not the same as a tax on developing countries that hope to prosper their manufacturing companies, just to mention one point. The tax, then, must be approached from a comprehensive perspective.

If we go further, however, in a long-term perspective the problems that automation brings will hardly be solved with a specific tax on robots. Perhaps, reviewing the form in which capital is currently taxed would be a more effective approach. Why capital? The answer at this point may be obvious, but it is worth referring to it briefly.

If the phenomenon of automation continues to accelerate as it has been doing in recent years, then there could be a future in which only the owners of capital —and therefore the owners of robots— see their profits increase, to the detriment of the rest of the population. Most people, even in the most industrialized countries, live only on their work and wages, which prevents them from reinvesting in capital or obtaining other types of passive income as business owners do. This leads to an unequal distribution of capital. And if they lack of jobs in the future, then they will be left helpless.

Consequently, there are at least four reasons why we should focus on taxing capital. First, the growing use of automation is likely to result in a decrease in labour income for a period of time. Second, automation is likely to occur regardless of whether or not capital income is subject to taxation. Market forces already encourage taxpayers to invest in robotics. Tax incentive to purchase capital assets are likely to result in an overinvestment in automation. Third, these automation technologies potentially further minimize the distinction between capital and labour income, which combined with the distinction between capital and labour is likely to present additional tax gaming opportunities. Finally, automation exacerbates the tax system's effect on economic inequality. The current tax system already benefits capital owners at the expense of workers by under-taking capital income (Mazur, 2018: 38).

In taxation, the principle of equity is usually associated with the principle of ability to pay, which in turn derives into the principles of horizontal and vertical equity. Briefly, this means that people with the same ability to pay, pay the same, and people with greater ability to pay, pay more, generally, regardless of the nature of their income (capital or labour). In the first case, reference is made to horizontal equity and in the second to vertical equity (Musgrave and Musgrave, 1992: 272). However, as we have seen, in the vast majority of countries capital income has a more favourable tax treatment. For example, reduced dividend tax rates; exemptions or preferential treatment in the disposal of shares, bonds or other financial instruments; accelerated tax depreciation; deferral of personal taxes; the possibility of reducing business expenses, among others. Therefore, the principle of equity is not always satisfied.

It is even possible to question whether the way in which the principle of tax equity is currently understood, is still satisfactory in a world with robots and artificial intelligence. Should income from labour and capital have perfect tax neutrality? We know that in practice, this does not happen, however, the majority of the current economists and experts think it should. However, we could go further. In the near future, when the differences between labour and capital increase in an almost irreversible way,[29] would not be more logical to tax capital in a different way than labour, making this type of income contribute more?

Conclusions

The current development of new technologies such as robots and artificial intelligence are deeply transforming our lives. Autonomous and independent machines, which in some cases are smarter and more efficient than humans at performing certain tasks, are slowly but consistently replacing us at work. Several reports indicate that many jobs in the near future are potentially automatable. Consequently, there is a fear that this rapid development will have devastating consequences for society, the main ones being unemployment and increasing income inequality. With this scenario in mind, a tax on robots has emerged as a possible solution. This would aim to slow down the replacement of humans in the workplace, and would allow governments to obtain resources that can be used in initiatives such as universal basic income.

However, if this is the path that policymakers decide to take, a number of complexities arise when thinking about the design of the tax. We saw that questions that in principle may seem as basic as what a robot is, have big implications for the design. In a first stage, to think of a definition that includes a physical component of the machine, in addition to other characteristics such as autonomy, self-learning and the ability to solve complex problems, would be advisable. But not only that. They must also take into consideration some economic aspects (how will it affect economic growth? how will it affect innovation?), as well as the difficulties related to taxpayers compliance, on one side, and the audit that the tax administrations may carry out, on the other.

Nevertheless, perhaps the greatest challenge would be to establish the elements of the tax, such as the taxable event, the tax base, who is the person subject to pay, what is the tax rate, among others. A logical solution, we saw, is to tax the companies that use robots, because they are the ones who benefit from them. In consequence, these companies would be in charge of paying the respective tax. Ideally, the tax should be calculated in relation to those workers who were substituted or would have been employed if robots had not been used, but this is it not something easy to estimate.

29. According to Thomas Piketty's 'Capital in the 21st Century', in recent decades the rate of return on capital (r) has been greater than economic growth (g), and since labour income depends on the latter, if $r > g$, inequality tends to increase and to be perpetuated in time.

Additional requirements like only certain companies or industries (*i.e.* large companies) are affected, would be advisable. Thus, a tax on robots could be viable.

A different approach emphasizes more in the way capital is currently treated rather than a specific robot tax. In most countries, capital income is more favourably taxed than labour income. Therefore, from this perspective it makes more sense to narrow these differences rather than focus on a tax on robots. In my view, these positions are not necessarily exclusive.

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