Robot Economy: Ready or Not, Here It Comes

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Abstract—Automation is not a new phenomenon, and questions about its effects have long accompanied its advances. More than a half-century ago, US President Lyndon B. Johnson established a national commission to examine the impact of technology on the economy, declaring that automation “can be the ally of our prosperity if we will just look ahead”. In this paper, our premise is that we are at a technological inflection point in which robots are developing the capacity to do the cognitive as well as the physical work of some fractions of the labor force, and thus becoming able to replace workers in many activities. An increase in automation and autonomy capacity brings the question of robots directly participating in some economic activities as autonomous agents. In this paper, a technological framework describing a robot economy is outlined and the challenges it might represent in the current socio-economic scenario are discussed.

I. INTRODUCTION

Robots are every day acquiring more “human-like” capabilities and advanced traits pertaining to sensing, dexterity, memory, trainability, and object recognition. Advances in artificial intelligence (AI) are enabling greater autonomy for robots to make decisions in open worlds and unstructured environments.

With increasing levels of autonomy and human-robot interaction, intelligent robots could soon accomplish new human-like capabilities such as engaging into social or even economic agreements (involving the exchange and consumption of goods and services) with other humans or robot counterpart (Figure 1).

A robot economy (“robonomics” [1], [2], [3], [4]) would be an economic system in which intelligent robots act as autonomous agents with the capacity to replicate some human behavior in various key economic activities.

The participation of robots in the economy has, so far, only taken place effectively for the production of goods. As a result, most of the published studies have focused on the impact of automation on economic growth, employment and income distribution [5], [6], [7], [8], [9], [10], [11], [12], [13], [14]. As noted by [15], technological innovations can affect employment in two main ways:

- By directly displacing workers from tasks they were previously trained for (displacement effect).
- By increasing the demand for labor in new industries or jobs that arise or develop as a result of technological progress (productivity effect).

Therefore, to analyze the current impact of intelligent robotics, the main question is which of the two effects, displacement or productivity, will dominate [9]. Broadly speaking, two narratives have emerged [10]:

- Technology pessimists, who consider that it would evolve towards an economy with great inequality and class conflicts [1], [7], [8], [14], [16].
- Technology optimists, who point out that income growth raises the demand for labor in sectors that produce non-automatable goods or services [12], [13], [15], [17], [18].

On the other hand, it should also be taken into account that new technologies are dependent on human capital, institutional procedures, and capital equipment. And therefore, their impact is subject to the various macroeconomic factors [19]. Thus, complex issues, such as the proliferation of new low productivity jobs and the possible arising of “zero-sum” economic activities [20], need to be contemplated. And these effects cannot be easily incorporated simple macroeconomic model.

The debate between pessimists and optimists is unsettled (Figure 2), although there seems to be a certain consensus in accepting that a robot economy will inevitably have a redistributive effect that, to a large extent, will ultimately depend on the social and policy responses.

The starting point for this paper is that we are effectively in a technological inflection point in which intelligent robots are rapidly enabling the ability of performing cognitive and physical work, and perhaps become participants in a

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whole set of new economic activities. In the following sections: First, we develop a brief description of the essential characteristics of a robot economy (section 2). Second, we analyze a framework for which a robot economy could arise (section 3). Third, we consider the foreseeable impacts of the robot economy on the current socio-economic environment (section 4). Four, these impacts are analyzed by means of simple robotic model (section 5). Finally, in section 6, we briefly discuss robot economy challenges, related to diverse aspects, such as regulatory policy, ethics or law.

II. The Robot Economy

Robot economy is a scenario in which intelligent robots would produce and provide many goods and services and also participate as autonomous agents in the exchange markets [2].

In a robot economy, intelligent robots can perform economic operations autonomously. For such activities to happen, robots must have the opportunity to create and undertake digital contracts for their services or operations, so that they can be fully integrated as autonomous agents into the human economy.

However, in a safe and human-dependent robot economy three rules [3] have been proposed that we are contemplating:

1) A robot economy has to be developed within the framework of the digital economy.
2) The economy of robots must have internal capital that can support the market and reflect the value of the participation of robots in our society.
3) Robots should not have property rights and will have to operate only on the basis of contractual responsibility, so that people control the economy.

This rules impose the condition that robots do not have ownership rights since a human economy must necessarily be geared towards obtaining an added value for the human society. As such, the above paper points that the lack of meaning if the final recipient of the production of goods and services is a robot with ownership rights. If this type of transactions or owner rights were contemplated, there would be an impermissible transfer of added value from human society to a robotic society.

In economic-financial transactions, robots can adopt both the role of the agent that originates the transaction (supplier, seller) and the role of the agent receiving the transaction (consumer, buyer).

On the supply side, robot economy is currently more developed, since industrial robots have been incorporated significantly in manufacturing in numerous sectors. Robots improve productivity when they are used for tasks they perform more efficiently and with a higher quality level than humans. It is expected that advances in artificial intelligence allow an extension of the automatable tasks, providing the robots with autonomous learning capabilities [13].

On the demand side, robot economy has not reached any remarkable degree of development yet. However, future capabilities of home robots will allow them to search, select and purchase products and services on behalf of their owners. This means that they will interfere in the consumer behavior of their owners [21]. In addition, the robots themselves, participating as autonomous agents in exchanges of goods and services with humans or other robots, could be considered consumers. Thus, from the demand perspective, the boundaries between robots and human beings as consumers also could disappear [21], [22].

Recent advances in robotics and AI make us think that the development of robot economy as has been described in this section is possible since the firsts robots participating actively in the economy could be close with the currently available technology.

III. Technological Framework for the Robot Economy

Intelligent robots should be provided with the necessary technology to make the robot economy possible. Briefly, the following requirements could be pointed out:

1) Autonomous task performance related to the economic activity and communication, through an external network, of the status and implementation of these tasks in accordance with the terms of a digital contract.
2) Real-time digital communications that allow the interaction between a human and a robot or between several robots.
3) Capacity to formalize contractual liabilities through “smart contracts”, digital agreements that can incorporate complex contractual relationships in code, and that are self-executing (zero ambiguity) and self-verifying (hard guarantees) [23]. That is, neither the will of the parties to comply with their word nor the dependence on a third party (i.e., a legal system) is required [24].
4) Ability to carry out financial transactions (payment and collection of economic operations) with digital media.

In the following subsections we describe a framework that meets these requirements with current technology and that allows, therefore, the initial development of robot economy.

A. Robot Operating System (ROS)

Intelligent robots require an adequate structure for onboard programming the tasks related to economic activity, which can be provided by the “Robot Operating System (ROS)” framework. ROS is an Linux-based open-source robotic middle-ware which is working as a publisher/subscriber model, and it is one of the most common standards in the industry. The open-source software allows the cloud support of the evolution of robotic applications in a decentralized network [25].

The operation basis of the autonomous agent is the ROS “behavioral algorithm” which allows the interaction of the robot with the environment through a interface.

The ROS system is composed of many nodes, each providing certain functionality. These nodes communicate with each other by messages, which are data structures. Messages can be passed among nodes by asynchronous (topics) or synchronous (services) mechanisms. Topics are a publish-subscribe method of inter-process (or inter-node) communication. When a node publishes a message to one topic, each node that subscribed to that topic will receive that message. On the other hand, services are a request-reply method of inter-node communication. In this case, a node requests a message to another and waits for the reply before continuing [26].

Two essential aspects of ROS are that it abstracts individual robot capabilities, allowing robots to be controlled through messages, and that also provides facilities for starting and stopping the individual ROS nodes providing these capabilities.

So that intelligent robots can communicate, ROS can provide communication protocols with an external network (Figure 3). Although there are several solutions, as an example of this functionality, “rosbridge” can be pointed out. Rosbridge offers a simple, socket-based programmatic access to robot interfaces and algorithms provided by ROS through the use of web technologies like Javascript. That is, the rosbridge protocol allows access to underlying ROS messages and services as serialized Java Script Object Notation (JSON) objects, and in addition, it provides control over ROS node execution and environment parameters [27]. Being language and platform independent, any non-ROS client from any platform that understands JSON could interact with a ROS-based robot [28].

ROS-based products are coming to market, including manufacturing robots, agricultural robots, and others. Government agencies are also looking more closely at ROS for use in their fielded systems; e.g., NASA is expected to be running ROS on the Robonaut 2 that is deployed to the International Space Station [29]. In addition, a library for ROS that is a pure Java implementation, called rosjava, allows Android applications to be developed for robots [30], and, also, Microsoft has just released an experimental version of ROS for Windows platform [31].

A recent development towards robot economy using ROS, called AIRA (Autonomous Intelligent Robot Agent) project [32], implements a standard of economic interaction human-robot and robot-robot via liability smart contracts. AIRA has developed ROS packages that provide methods for robot task/result store, delivery and interpretation [3].

To conclude, it should be noted that one of the highest values that ROS open-source middle-ware offers to robot economy is the opportunity to grow a worldwide community joining forces towards its development.

B. Cloud Robotics and Internet of Robotic Things

Complex real-life problems, requiring real-time execution, demand sophisticated data analysis and computational capabilities, are challenging for networked robots to handle. A perspective such as that adopted by “Cloud Robotics” [25] must be applied to overcome the limitations imposed by resources on board. Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, storage, applications, and services) that can be
rapidly provisioned and released with minimal management effort or service provider interaction [25].

Cloud robotics architecture mainly consists of two components: the cloud infrastructure and its bottom facility. The bottom facilities typically include different types of robots and the cloud infrastructure consists of high-performance servers and massive databases, that can support high-speed processing along with huge storage capabilities. The cloud infrastructure cannot only provide the means for a robot which needs external data to support its operation but also opens ways to interact with other robotic systems [37].

“Internet of Robotics Things” (IoRT) [34] is a new paradigm, which goes beyond networked and collaborative/cloud robotics and integrates heterogeneous intelligent devices into a distributed architecture of platforms operating both in the cloud and at the edge. In the original research, IoRT was defined as “intelligent robotic devices can monitor events, fuse sensor data from a variety of sources, use local and distributed intelligence to determine the best course of action, and then act to control or manipulate objects in the physical world, and in some cases while physically moving through that world” [34]. IoRT need arises because multiple autonomous robots must communicate, and it must be addressed their coordination, exchange of information and security. [35].

In robot economy, it is key that multiple autonomous agents can exchange information and coordinate effectively. Therefore, among the technologies that allow the development, implementation and deployment of Cloud Robotics and IoRT applications, to enable a technological framework for robot economy, the following are particularly relevant: (a) The platform architectures (that is, the intelligent layer that facilitates communication, data flow and abstract applications from the robots with the goal to enable the development of services) have to achieve several goals, like flexibility, usability and productivity; and (b) The communication infrastructure and external communication need to be able to perform time-critical communication [36].

C. Blockchain

Although the centralized cloud has many advantages, to guarantee the requirements imposed by robot economy the best option seems to be a decentralized and distributed approach. By means of a periodically updated copy, the information can be pieced back together in the event of a small-scale loss. Thus, it confers robustness to the system towards errors in the transmission or storage of data. Moreover, it also guarantees security against hackers or data thieves since the data is widely distributed and it can be continuously verified. And, finally, decentralization provides privacy given that it is not fully controlled or accessible by a third party [37]. Taking into account the advantages provided by the fully decentralized cloud, it is when public (or open) “Blockchain” technology (originated in the bitcoin field) [38] for cloud storage enters the picture.

The blockchain is a public chronological database of transactions recorded by a network of agents. The blockchain is, as its name suggests, a grouping of data sets (referred as “blocks”) forming a chain. Each block contains: (a) information about a certain number of transactions (individual transactions containing details of who sent what to whom); (b) a reference to the preceding block in the blockchain; and (c) an answer to a complex mathematical challenge known as the “proof of work”. The proof of work is used to validate the data associated with that particular block, as well as to create the creation of blocks computationally “hard”, thereby preventing attackers. After ensuring that all new transactions to be included in the block are valid (and do not invalidate previous transactions), a new block is added to the end of the blockchain by an agent (referred as a “miner”) in the network. At that moment, the information contained in the block can no longer be deleted or modified, and it is available to be certified by everyone on the network [39]. So, the blockchain can be considered as an open and distributed ledger that can record transactions between two parties in a verifiable and permanent way.

The blockchain technology allows, by combining peer-to-peer networks with cryptographic algorithms, that a group of autonomous agents can:

- Reach an agreement on a particular state of affairs.
- Record that agreement without the need for a controlling authority.

The blockchain is also a payment mechanism and makes it possible for the autonomous agents to exchange value among themselves using crypto currencies [40].

In the blockchain context, smart contracts mean transactions that go beyond simple buy-sell currency transactions, and may have more extensive instructions embedded into them. A smart contract essentially acts as an autonomous entity on the blockchain. It has its own address and account on the blockchain and it is both defined by the code and executed by the code, automatically without discretion [41]. In fact, three elements of smart contracts that make them distinct are autonomy, self-sufficiency, and decentralization [38].

A blockchain smart contract between a supplier and a buyer provides the trust that used to require elaborate control and audit processes. Not only can blockchain contracts contain the same level of detail as a physical contract, they can do something no conventional contract can: perform tasks such as negotiating prices and monitoring inventory levels [42].

A high-level scheme of a robot-to-robot interaction via smart contract is shown in Figure 4. At the first step, a smart contract in the blockchain by the customer and the corresponding instructions are sent to the service provider. Then, the service robot starts doing the required task. Once it is finished, the response is sent back to the customer, who makes then a transfer request recording it in the blockchain. A notification is sent then to the users of the blockchain, that after checking the correctness of the liability execution, the transaction is validated and the block is added permanently to the blockchain. Finally, only after the previous step, the service provider is paid [4].
Thus, with the integration of Blockchain and ROS interface of the physical system, through the technologies used for Cloud Robotics and IoRT, autonomous robotic agents can fulfill the requirements pointed out as a starting point for robot economy.

IV. IMPACT OF ROBOT ECONOMY IN THE CURRENT SOCIO-ECONOMIC SCENARIO

As a new generation of robotic technology is developed, questions start to arise: How likely is it that robots will take people’s job in large numbers? Which jobs are most vulnerable? And what is the possible economic and human impact of the rise of robots?

In the short-term, if we are not careful and do not apply the appropriate corrections, robot economy might pay a high social price. There seems to be some consensus in the published macroeconomic models that, at least in the short-run (e.g. 10 – 15 years), society could face significant technological unemployment and oversupply of human labor relative to its demand by companies and governments [8], [14], [43]. Due to increased technological productivity, the loss of many jobs due to robots might not be compensated by newly created jobs, while the unemployed may not be able to re-qualify easily to face the qualification needs of the robotized economy [2].

Occupations that share a predictable pattern of repetitive activities will probably be replaced in robot economy. Nevertheless, jobs that require a level of expertise reached after years of study or those where human interaction plays an important role are not likely to suffer a displacement effect. For low-skill workers to win the race to intelligent automation, they will have to relocate in tasks requiring more creative and social skills.

It also seems that there is a clear consensus that robot economy will produce imbalances in the current distribution of income that must be politically corrected to maintain a certain social equilibrium [7], [14], [43]. If intelligent robots are capital equipment that embodies modern technology, the distribution of income is shifted towards robots. Therefore, growth might be absorbed for those who are able to save, that is, to invest in robots, increasing the gap with those who live check-to-check [7]. So, it will be determinant to implement social measures to ensure that the returns to robotic assets are broadly spread across the population. Yet, it is not clear how this spreading of the returns might come about [44]. Perhaps, the way to do this is the one proposed by Andrew Berg [10] and Richard B. Freeman [7]: “workers need to own part of the capital stock that substitutes for them to benefit from these new robotic technologies: workers could own shares of the firm, hold stock options, or be paid in part from the profits”.

Despite the negative consequences the robot economy might bring, the positive consequences, if it is managed correctly, could tip the scales. The new wave of intelligent automation is already creating growth through a set of features unlike those of traditional automation solutions. A recent McKinsey report estimated that automation could raise productivity growth on a global basis by as much as 0.8 to 1.4 percent annually [45]. A 2018 PwC report estimated that “global GDP in 2030 could be up to 14% higher than 2016 as a result the economic impact of intelligent robotics. This impact will be driven by (a) productivity gains from businesses automating processes as well as augmenting their existing labor force with AI technologies (assisted, autonomous and augmented intelligence); and (b) increased consumer demand resulting from the availability of higher quality products and services” [46].

However, the most important fact is that in the long-term, intelligent robotics has the potential to overcome the physical limitations of capital and labor and open up new sources of value and growth. This capital question is not subject to discussion and so, for example, the European Robotics Research Agenda 2020 outlines current developments in the following way: “The robotics technology will become dominant in the coming decade. It will influence every aspect of work and home. Robotics has the potential to transform lives and work practices, raise efficiency and safety levels, provide enhanced levels of service and create jobs. Its impact will grow over time as will the interaction between robots and people” [47].

Therefore, robot economy might have an unprecedented impact in our society and our economy and it is in our hands to overcome the difficulties that it presents and make it the ally of prosperity and human well-being. As 2016 White House report “Artificial Intelligence, Automation, and the Economy” points out: “with the appropriate attention and the right policy and institutional responses, advanced automation can be compatible with productivity, high levels of employment, and shared prosperity” [48].

V. THE CLEANER ROBOT MODEL

Modeling the impact of robot economy at a large scale involves many complex social aspects that cannot be incorporated into a simple macroeconomic model. However, in a
and has to ensure the cleanliness of a 600 m² entry hall of a public building. Let us briefly look into professional cleaning with figures which are qualified estimates which are sufficient for a case study but do not claim to account for any specific application case.

The professional cleaning of 1 m² floor costs on the order of $0.10 if done manually. This includes the cost of labor and material. If the 600 m² entry hall of a public building is cleaned once a day, five days a week, 52 weeks a year, the total cost of cleaning is $15600 per year, of which approximately $1200 correspond to consumables and the rest to labor.

Then, the new state-of-the-art cleaner robot M-O goes to the market. Its functioning is based on a novel architecture that merges ROS, IoRT and Blockchain technologies. Therefore, the M-O robot has the capability to offer its services through a smart contract, working as a completely autonomous agent. As amateur robotics, Maurice decides to hire the robot to perform the cleaning, replacing the services of the manual cleaner. Maurice subscribes through the blockchain of public access a smart contract with M-O, which offers its services in the network, and defines the tasks that M-O must perform and agree on the payments that Maurice will make for the services contracted. Consequently, M-O will be in charge of the cleaning of the entry hall, and replacing the cleaning materials and the necessary work for its own maintenance.

Let us further assume that deploying and maintaining the cleaning robot requires the work of a specialist for 20 min per day and that the specialist has an hourly wage of $30. Thus, the labor for deploying and maintaining the cleaning robot accordingly costs approximately $2600 per year. Let us assume, also, that consumables and repair make up $1200 per year. Finally, assuming a depreciation period of four years and, thus, considering that the annual amortization cost of the cleaning robot is $11800 (the price for a professional cleaning robot is around $45000), the annual cost of robotic cleaning results approximately $15600.

That is, with these assumptions, the total cost for Maurice is the same, whether the cleaning is done manually or performed with a robot. In the first case more than 92% of the total expenditure budget corresponds to the cost of low-skill labor, which we can assume that, in turn, will be used by the worker in expenses of food, housing, clothing, social security, transportation, etc. However, in the second case, less than 16% of the expenditure budget is allocated to the direct remuneration of high-skill labor, while 76% of the said budget is applied to the remuneration of the capital invested in the acquisition of the cleaning robot (amortization, capital insurance, etc.) (Figure 6).

Some consequences of the potential impact of robot economy could be extracted in a qualitative way from this example: (a) First, it is evident that there has been an effective displacement of the manual cleaner (whose job consisted in a predictable and repetitive task) since it has been replaced by the robot; (b) Second, given that the manual cleaner is not immediately relocated, at least in the short term, an increase in unemployment might occur; (c) Third, although the appearance of the cleaner robot has displaced the manual cleaner, a new high-skilled activity such as the robot maintenance has appeared; (d) Fourth, the cleaner robot has changed the distribution of the budget among the different sectors and involves a transfer of labor costs towards expenses in capital retribution, shifting the income towards the capital invested in the robot; (d) Fifth, it should be noted that there is a net contribution to growth since the worker who performed the manual cleaning, that has been released, is now available to perform other tasks, increasing the potential level of production; and (e) finally, the capital invested in robotics obtains a significant part of the income, so that the question of “who owns the robots” acquires great importance in the final distribution of income.

VI. ROBOT ECONOMY CHALLENGES

Robot economy could be right around the corner. Now that humankind stands on the threshold of an era when even more sophisticated intelligent robots seem to be poised to unleash a revolution which is likely to leave no stratum of society untouched, it is vitally important to consider several and complex aspects related to the legal framework, security, ethics and the future of robotics. Legislation must consider the legal effects without stifling innovation [50]. The development of robot economy presents several regulatory challenges. First of all, a major issue arises when intelligent robots operate without the intervention of humans and, eventually, even without their awareness. Questions must be raised about the responsibility for their actions, the obligations imposed on the robots, a hypothetical attribution of rights to the robots and, above all,
the restrictions in their performance that guarantee security, privacy of data and other rights and human interests that may be threatened by their growing independence and autonomy [51]. Secondly, no government has yet authorized the use of cryptocurrencies, due to their lack of control over their monetary effects and concerns over the criminal exploitation of the decentralized peer-to-peer network. And finally, robots do not have “legal personality” to formalize contracts. In this sense, there have been some initiatives, as, i. e. [50], that have advanced the idea of creating a legal status of electronic personhood, distantly comparable to the legal personhood available for business organization, but these proposals has been very controversial, since it raises conflicts related to the requirement of responsibilities or the insurance against damages caused by robots [52], [53].

Another key concern about robot economy is security. An assisting robot will need access to historical information, as well as current information to create a dynamic worldview and adapt to the user’s changing needs and circumstances. Adapting behavior and responsiveness requires drawing on information from environmental and activity sensors instrumented into a smart home, as well as information about the user’s current physical, cognitive and emotional state through vision, audition, touch, and physiological and biometric sensing. This is sensitive information that shared inappropriately could compromise individual’s dignity and right to privacy. The operation of these technologies within the home, for instance, in seeking to sell additional services and products to users should be subject to regulation as it already applies to existing forms of online and distance selling. There may be a need for additional forms of control given the growing pervasiveness of intelligent robotics in people’s daily lives [54].

Robot economy is gaining pace, but is it running in line with our values? The ethical dilemma of intelligent robotics can be raised in a very basic principle, which is what robots cannot do the all work and “sideline” humans [55]. If this was the case, human conditions would worsen, their learning and cognitive capacities would be modified, and even conditioned to perform tasks like robots, faced with the need to compete with robots as a workforce. Then, advances in the intelligence of robots must be “driven” by human society so that robots are used to stimulate humans, increase their capabilities and make them grow as people. This perspective has been raised, for example, in a very unique way, by Carme Torras (“the risk of humans become robots”) in a recent book [56].

The progressive development of robot economy will effectively contribute to the increase of human well-being. The final economic and social objectives of the research and industrial development of production with robots must be those of contributing to the improvement of society, so that the lines of research and development that should prevail will be those that contribute to that objective. The main challenge of robotization lies in combining human and robot activities. The key aim is to find the best human-robot match. The advantages of robotics include heavy-duty jobs with precision and repeatability; the advantages of humans include creativity, decision-making, flexibility and adaptability. On the basis of co-operation of humans and robots, companies and the public sector would increase efficiency and capacity, as well as improve quality and industrial working conditions [57].

Finally, if we want to make robot economy the motor of prosperity, to increase the human well-being one main question arises above the ones presented previously in this section: “Who will own the robots?” [7], [10], [58].

VII. CONCLUSIONS

This paper describes a framework for the robot economy with the currently available technology, and reviews the challenges it faces in the current socio-economic scenario. Robot economy is described as the economic system that uses robots as production factors, instead of human labor and in which intelligent robots can perform economic operations (purchase/sale of services or goods) autonomously.

The current state of technology allows robots to incorporate an adequate structure for on-board programming the tasks related to economic activity and communication with an external network through ROS open-source middle-ware (currently the most common standard in the industry). Also, the blockchain technology, as a peer-to-peer payment system
and digital currency, allows robots to execute programs specified in the terms of intelligent contracts, creating monetary value for their work. In addition, it can be useful to register transactions and as a means of payment (cryptocurrency). Thus, with the integration of blockchain, IoT and ROS middleware, the framework for robot economy is practically developed in the current state of technology. In this paper, the essential aspects of this technological framework have been described.

The irruption of the robot economy might have an unprecedented impact on our society and economy and if we are not careful, it might lead to inequality and unemployment in the short-term. However, with the appropriate attention and the right policies the advance of automation will open the doors to new sources of value and growth.

Several complex questions regarding legislation, security, ethics and the future of robotics will arise in the context of robot economy. We must not look away. Intelligent robotics offer an unimaginable spectrum of possibilities, and it is roboticists’ responsibility to make the best of them turning them into the motor of global prosperity.

Finally, it should be remarked that we should not fear the advance of intelligent robotics. On the contrary, robotics is now more alive than ever and we should embrace its research because its unimaginable possibilities. However, as it has been discussed in this paper, several challenges will arise and we should be aware and prepared to overcome them. It is crucial to create awareness of the reality of robot economy, because ready or not, here it comes.

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