

## **Jorgenson laudatio**

Magnific Rector of the University of Valencia,

Honourable authorities,

Dear professor Jorgenson,

Members of the university community,

Distinguished colleagues from other universities,

Friends, ladies and gentlemen

I want to begin by recalling something that happened half a century ago but which, by its nature, is most likely present in the dreams of many young researchers here today who shall receive their PhD from the University of Valencia. I'd like to address them in particular in the first part of my tribute to Professor Jorgenson, who shall be awarded an honorary degree from our University this morning for his outstanding merits.

The event that I want to recall, in order to stress the significance that both you and he are the protagonists of this occasion today, happened in the spring of 1963 when, at the young age of 30, Dale Jorgenson published a seminal work that would be the starting point of a long career which has received worldwide recognition. It's not unusual that the most creative stage of a researcher's career is that of their youth, and that's why I'm referring to this early publication: to emphasize that gathered in this auditorium today are the ideas taking shape in the minds of young researchers and those which are reflected in the impressive academic resume of Professor Jorgenson. Thanks to the driving force of these connections which shape dreams and intellectual results, knowledge advances. And it is through this knowledge that a great deal of the progress enjoyed by modern society is achieved.

Therefore, it's worth drawing attention to the fact that gathered here on this occasion are those who have made universities what they are, and those who depend on what these institutions will become. To those who

are starting out, it's important to keep in mind that pushing the boundaries of knowledge and informing society of these developments requires a great deal of effort and a clear vocation of service. You need inspiration, but also a lot of sweat and hard work. And this is shown in the career devoted to study and teaching of Professor Jorgenson, whose academic life reflects such intelligence and such effort that it should be set as an example.

I would like to thank my colleagues for giving me the opportunity to address you all at this ceremony; to my colleagues at the Faculty of Economics and the Department of Economic Analysis, who unanimously supported the proposal for this investiture and to the Rector Esteban Morcillo who endorsed it; and particularly to Professor Matilde Mas and Professor Javier Quesada, with whom I have shared this initiative, as well as a long collaboration with Professor Jorgenson, which began with his first visit to Valencia over two decades in 1994.

Dale Jorgenson received his PhD from Harvard University in 1959 when he was 26 years old and was immediately hired by the University of California, on the campus of Berkeley. In the two years after obtaining his PhD, he had eight articles published, some of which were in top-ranking journals such as *Econometrica* and *Review of Economic Studies*. But it was a study that appeared in May 1963, which I mentioned earlier, which proved seminal to his career and that of many other economists. It was brief, just 13 pages long, and was called "Capital Theory and Investment Behavior". It was published in one of the top journals in our field, the *American Economic Review*, and would become extremely relevant. To such an extent that half a century later in 2011, it was chosen as one of the twenty most influential articles published in the first hundred years of the journal. The article was selected on account of "its intellectual quality, its influence on the ideas and practices of economists, and its relevance and scope".

More than fifty years have passed since the publication of that work, and the extensive academic and professional career of Professor Jorgenson has so many outstanding aspects that it's easier to identify them rather than summarize them. I will try to do the second task with brevity, so I can

devote more time to discussing the scope of his main contributions to economists and everyone present here today.

After being promoted to full professor at Berkeley and being a visiting professor at the universities of Oxford, Chicago and Jerusalem, Jorgenson returned to Harvard as a full professor in 1969, aged 36. He would go on to serve as head of the Department of Economics and the Program on Technology and Economic Policy at the Kennedy School of Government. Today he is Samuel W. Morris Professor of Economics, while continuing to be linked to these two units of the university considered by many to be the best in the world. He has directed more than 70 doctoral theses (some of which were economic graduates from our university and are here with us now) and is the author of more than 300 articles on economics, mostly in high-impact journals. He has served as editor of the leading Economic journals in the world, such as *American Economic Review*, *Review of Economics and Statistics*, *Quarterly Journal of Economics*, *Bell Journal of Economics*, *Review of Economic Studies*, *Journal of American Statistical Association*. He is the author or editor of thirty-six books, mainly published by the most prestigious university presses.

Professor Jorgenson has held some of the most important positions in the scientific community, such as President of the American Economic Association; Chairman of the Board on Science, Technology and Economic Policy of the National Research Council; Chairman of Selection 54 of Economic Sciences of the National Academy of Sciences; and President of the Econometric Society. He is Honorary Member of the American Philosophical Society, the Royal Swedish Academy of Sciences, the US National Academy of Sciences and the American Academy of Arts and Sciences. He has received multiple academic recognitions, among which are eight honorary doctorates by the universities of Uppsala, Oslo, Keio, Mannheim, Rome, Stockholm, Hong Kong and Kansai, and to which today we shall add our university.

I would like to comment on one of the most outstanding recognitions, that of the John Bates Clark Medal awarded by the American Economic Association in 1971, to outline the aspects in which Professor Jorgenson most excels. This Medal is awarded every two years in recognition of great

contributions to economic thought and knowledge to researchers born or working in the United States under the age of 40. Jorgenson was awarded the prize aged 38 and the committee highlighted his outstanding contributions to pure economic theory and statistical method, stating that he was “a master of the territory between economics and statistics, where both have to be applied to the study of concrete problems. His prolonged exploration of the determinants of investment spending, whatever its ultimate lessons, will certainly long stand as one of the finest examples in the marriage of theory and practice in economics.”

And indeed it has. The article by the young Jorgenson in 1963 was already an early and magnificent example of this approach. But many other of his works reflect his conception of economics as a discipline which requires that theories be empirically tested. Hence, his continuing concern to improve the theoretical, statistical and econometric tools, so as to base economic analysis and public policies on more solid foundations. His regular presence in academic and institutional forums also reflects his commitment to transferring his research results to those who make decisions in the areas studied, to help them make better decisions.

The backdrop of many of Jorgenson’s works is a subject that generates the greatest interest in economics since its emergence as a distinct scientific field: factors which drive progress. Adam Smith called his most important work, *An inquiry into the nature and causes of the wealth of Nations*, and since the middle of the 20th century we have been talking about the study on the sources of economic growth. The contributions of Professor Jorgenson have allowed us to review in depth over the last decades the professional consensus existing on this issue until the 1970s. And thanks to his contributions, today we can better assess the channels through which knowledge contributes to economic development via the accumulation of different tangible and intangible assets, and especially understand the role that ICT has played over the last decades.

In the early stages of the analysis of the sources of growth, the physiocrats stressed that the source of wealth was land productivity, while classical economists believed it was human labour. However, the more insightful analysts, such as Ricardo and Marx, soon warned that capital should play

an important role in industrial economies; in other words, the set of sustainable means of production which are financed from savings and accumulated from investment, along with labour and nature in the production of goods and services. Classical economists examined the value that machinery added to production, convinced that its contribution was crucial to understanding a new era, where technology was making it possible for productivity to advance at a pace not witnessed before and substantially improved the living standard of the inhabitants of countries that were able to sustain continued accumulation rates.

As I will talk a lot about capital in the rest of my speech, let me clarify for those who are not economists that when I refer to this concept, I am not talking about its financial meaning, but rather its real meaning, i.e. machinery, equipment and the ships in which the investments materialize, as well as other intangible assets, which are no less productive, such as human capital assets.

In the last two centuries, economics has focused greatly on the study of capitalization processes as determinants of the advantages achieved by those companies and countries that manage to go further. It was soon understood that they did so on the basis of the investment effort made; in other words, that they were able to be more productive and enjoy higher incomes thanks to the capital accumulated in the past. As Bernard of Chartres said in the fourteenth century when referring to the accumulation of knowledge, using an expression frequently attributed to Isaac Newton, our greatest capabilities in a given moment of history derive from the fact that "we are like dwarfs perched on the shoulders of giants. We are able to see more and farther than the latter. And this is not at all because of the acuteness of our sight or the stature of our body, but because we are carried aloft and elevated by the magnitude of the giants."

But for those who had an empirical conception of the economy, the challenge was not only to be aware of the role played by capital, but also to specify to what extent the platform that it represents contributed to growth. To approach this objective reasonably, a long time elapsed before an appropriate metric was available for this purpose. It was developed in

the last half of the century, mainly from the contributions of Dale Jorgenson. There were three steps that had to be taken to formulate it: the discovery that the contribution of capital was not properly reflected in the value of accumulated capital stock, but rather in the services that capital provides; the formulation of a suitable measure of those capital services offered by the different assets, estimating them through the cost of use; and the creation of statistics with which to measure the cost of use, taking into account that the services of the different types of capital may vary.

The first of those three steps was taken with the development of the marginal productivity theory, but advances in formulating the cost of use were insufficient until the Jorgenson's paper in 1963. A few years earlier, in 1957, Solow still considered that the measurement of cost of capital was a utopia, even for the more statistically advanced economies such as the United States, which already had some estimates of capital stock. The fact that statistics and theory were limited meant that the contributions of capital to growth were measured inaccurately and a very high percentage of it (up to four-fifths) was unexplained, and was known as *the measure of our ignorance*, according to the expression coined by Abramovitz. Under these circumstances, given that the observed growth was much higher than the estimated contributions of labour and capital employed, the difference was attributed to exogenous technical progress, not incorporated into the factors, descending on the economy like a manna from heaven, which made it difficult to identify why this source of progress flowed more in some countries than in others.

With some exceptions, which Jorgenson himself noted in 2009, that was the consensus of the profession until the beginning of the 1970s, both in the theoretical and empirical literature, but the prevailing diagnosis of growth until that date has been subsequently widely exceeded. Today most of the growth is explained by the contribution of production factors, especially by improvements in the quality of labour and capital. Technological progress is no longer exogenous, but rather incorporated through investment processes in human capital as well as in different kinds of capital, both tangible and intangible. This new vision allows us to

keep track of progress, and highlights the relevance of the specific features of accumulation processes in each economy, its composition and the use of different investments in physical and human capital.

The theoretical and statistical work of Jorgenson has been crucial in changing our perspective of how we interpret growth. His seminal article completed the definition of cost of capital, adding two very important variables to interest rates and depreciation: taxes on capital performance and the effect of price variations of investment assets, both at the time of their acquisition and over their product life. Taking all these components into account helps to understand that the cost of using different assets is not the same and allows us to evaluate what the productivity should be of an investment project to cover the cost of use of each type of capital employed. In other words, Jorgenson's cost of capital formula completes and summarizes all the essential information needed when making investment decisions.

If a company is rational at the time of investment, then it would wait for its projects to be productive enough to cover the cost of capital, and would take into account that success depends on circumstances controlled by the company and others which are beyond its control. For the company or entrepreneur, getting it right is crucial for their investment to be profitable. But this is also true for countries, because if their capital productivity is not sufficient then investment costs will not be covered. In this case, despite the investment effort, the source of growth will flow more slowly and its weakening may well have lasting effects since capital is lasting.

Jorgenson's approach allows us to examine all dimensions of the problem concerning investment and warns us that without adequate information on the cost of capital use, then the evaluation of the productivity of investments and the contributions of capital growth are inaccurate. Problems due to lack of data frequently arise in economics and pose a risk for diagnoses in the orientation of policies and social welfare, as leading economists and different economic institutions have recently warned us once again. Joseph Stiglitz emphasized this in his presentation of the *Report by the Commission on the Measurement of Economic Performance*

*and Social Progress* in 2009, saying that "what we measure affects what we think and what we do".

This very same concern is why Professor Jorgenson, following his conceptual guide to improve the understanding of investment decisions, has worked tirelessly to improve the empirical basis with which to measure the cost of capital. Thanks to the progress made with his initiatives and the collaboration of other economists from different countries (some of whom are with us here today), we can assess the dynamics of investment and productivity, measure the contribution of capital to growth with greater certainty, and better anticipate the implications of economic policies which affect accumulation processes. Furthermore, in the light of these developments, we can and we should review the implications of conventional assessments of the use of installed productive capacity and the growth potential of economies underlying some predictions of secular stagnation.

Jorgenson has contributed to making important progress in the measurement of capital and labour contributions to growth by proposing methods to estimate the quality of productive factors. He has worked tirelessly for economies to have data systems and statistical methodologies which allow the quality of factors to be measured, emphasizing the need to break down the data as much as possible on different types of labour, physical assets and other investments in intangible assets.

To achieve these advances, Professor Jorgenson has led major international statistical and scientific cooperation projects, broadening the scope with which the current National Accounts Systems are structured so as to include productive capital. At the same time, he has promoted World KLEMS, an international project which generates comparable data and analysis on five continents and more than 40 countries, and involves researchers at our University and the Ivie. World KLEMS has just celebrated its fourth World Conference this week, and on this occasion it was held in Spain. I want to thank the representatives of this important project from Japan, the United Kingdom, Italy, the Netherlands, the United States and Argentina who are present here today.



This comprehensive list of contributions which bears the hallmark of Dale Jorgenson has, therefore, helped improve our way of thinking and made it possible to measure sources of growth more precisely, while explaining relevant phenomena that are connected with these sources. One particularly outstanding aspect is the role of ICT in growth over the last quarter of a century. The shift in perspective regarding the methodology has allowed us to understand why its importance is even greater than that reflected in the rapid increase in these investments. The reason that ICT is important is that it accounts for so much investment and this, in turn, is because its production cost has been reduced dramatically due to technological progress, while the flow of services that provide this capital is very intense.

The price of ICT fell dramatically on account of the exponential increase of microprocessor capacity described by Moore's law, which captures the fact that successive generations of semiconductors are faster and better. The parallel reduction in the price of semiconductors during the last twenty years has led to massive investments in ICT assets, although accelerated depreciation means that the cost of use of each euro spent on these assets is high. Despite the cost, its penetration has not slowed down because investors attribute high productivity to ICT. The question that should be asked is whether this assumption proves to be true or not. In other words, whether the productive services actually provided by ICT are the ones expected in all projects. The answer is that the outcome could depend on whether ICT assets are properly combined with other assets, especially with the most qualified human resources and other intangible capital linked with organizational improvements within companies, capable of making their full potential profitable.

The significant improvement in recent statistical data thanks to projects promoted by Jorgenson, in particular the sector breakdown of a lot of data, has improved our ability to assess this issue. We can now say that ICT penetration has gone from driving productivity improvement in the producers of hardware, software and communication sectors, to doing so in ICT user sectors in many more countries than those which actually produce ICT. These changes frequently occur through the introduction of

both product and process innovations in many industrial activities, but especially in services. For many companies engaged in tertiary activities, ICT have now become cross-cutting elements of their technology and they force companies to frequently review their organization and use more human capital to manage their complexity. For this reason, the effective use of the opportunities offered by ICT varies in different economies. Those that manage to combine it properly with the adequate human and organizational capital are more productive than those that do not. Our ability to explain these differences at company level is limited at the moment because the microeconomic databases which are used rarely allow us to know the composition of the capital used by companies.

Thanks to the work developed by researchers at the University of Valencia and the Ivie on the methodological and statistical basis promoted by Professor Jorgenson, we can better explain the origin of the shortcomings in Spain in terms of productivity, employment and per capita income. The problems are mainly due to poorly orientated investment: too biased towards unproductive assets, such as real estate, and too little towards ICT and intangible assets, such as human and organizational capital. The problems are also caused by the fact that investment effort in education is not exploited, along with inadequate productive specialization, which is barely orientated towards knowledge and generates very little value.

But in the same way as Dale Jorgenson's contributions are relevant to Spain, they can measure and interpret many very relevant questions like the causes of stagnation in Japan in recent decades; the reasons why Europe's productivity stopped approaching that of the United States twenty years ago; what the sources of accelerated growth have been in emerging economies such as China and India, allowing hundreds of millions of people to escape from extreme poverty; why development is uneven in Latin America; and if this process can be applied to the African continent. Thus, as in so many other cases, academic work has direct and indirect implications that make it extremely relevant at a social level.

If we are interested in how policies can contribute to remedying deficiencies, then Jorgenson work also provides guides for efficient design and evaluation of highly important public policies. A common feature in

his recommendations is to question how the policies proposed will affect the volume and orientation of investment. Insofar as investor behaviour can be affected positively or negatively, these will have effects on the variables upon which the current growth and the welfare of present and future generations depend. So as to provide more precise answers to the question of what type of impacts policies can have, Jorgenson proposes to construct intertemporal general equilibrium models, which allows us to assess them quantitatively by studying a wide range of behaviours and restrictions.

In recent years, Jorgenson has been especially active in three areas of public action which are of great concern to him. The first is how to achieve efficient taxation; in other words, proportional to the capacity of production factors to generate income. Or, technically, how to achieve equal marginal tax rates of labour and capital. His answer is: tax bases should be set on the foundation of a proper assessment of the services provided by each type of asset, i.e., wage and the cost of use of different capitals. The second area of Dale Jorgenson's recent concern is the economic analysis of environmental policy. His theory sheds light on the problem by warning us that while environmental regulations are designed so that they raise the cost of capital use, they will affect growth. On the other hand, if they are based on the taxation on emissions and on emission permits, the desired objectives can be achieved without hindering growth. The third area in which he has recently worked is the assessment of welfare and inequality, sharing this particular concern with other leading economists and many observers of social reality. He warns that representing the trajectories of our societies with too much focus on the evolution of GDP and its distribution is risky and misleading. His proposal is to pay more attention to the distribution of consumer spending and not only to income. That is, to include in the assessment of consumption the services provided by household capital goods (both real estate and equipment), given that at present they are very important, and also the public services provided free of charge by governments.

After this brief summary of his contributions, I must conclude with a personal note. If contemplating the academic contributions of professor

Jorgenson doesn't fail to impress, then no less impressive is his approachable personality and his simple manner. His great capacity to welcome others —reinforced by the personality, insight and intelligence of his wife, thank you Linda— is, without a doubt, directly proportional to his ability to make teams and mobilize them. Professor Jorgenson is an active, direct and enthusiastic person. He exerts leadership with great intelligence and with the utmost restraint, and this is an area where he excels in an extraordinary way. And some of us have been extremely fortunate to have benefited from his great qualities.

But I believe it is not because of this that our University distinguishes him with an honorary degree, but rather from the point of view that I mentioned at the beginning of my speech: that his career is an example of what a scholar —or in his case a *maestro*— should be, this is what defines Dale Jorgenson and what makes him great as a person, and we should never fail to remember this.

Thank you very much for your attention.