COMILLAS
UNIVERSIDAD PONTIFICIA

INVESTITURE CEREMONY AS
Doctor *Honoris Causa*

Dr. Robert F. Engle
Dr. Eduardo Schwartz

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(8 MAY 2024)

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I. Biographical sketches

Dr. Robert F. Engle

Robert Engle, Professor Emeritus of Finance at New York University Stern School of Business, was awarded the 2003 Nobel Prize in Economics for his research on the concept of autoregressive conditional heteroskedasticity (ARCH). He developed this method for statistical modeling of time-varying volatility and demonstrated that these techniques accurately capture the properties of many time series. Professor Engle shared the prize with Clive W. J. Granger of UCSD. Professor Engle is the Co-Director of the Volatility and Risk Institute at NYU Stern. In this role he has developed research tools to track risks in the global economy and make these publicly available on the V-LAB website.

Dr. Eduardo Schwartz

Dr. Schwartz is the Ryan Beedie Chair in Finance at Simon Fraser University and a Distinguish Emeritus Professor at the University of California, Los Angeles. His wide-ranging research has focused on different dimensions in asset and securities pricing. His collected works include more than one hundred articles in finance and economic journals. Topics in recent years include interest rate models, asset allocation issues, evaluating natural resource investments, pricing Internet companies, the stochastic behavior of commodity prices, valuing patent-protected R&D projects, optimal carbon abatement strategies and issues in sustainability. He has been associate editor for around twenty journals, including the Journal of Finance and the Journal of Financial Economics, and he has also been a consultant to governmental agencies, banks, investment banks and industrial corporations.

II. Ceremonial of the act

Dr. Robert F. Engle

Dr. Eduardo Schwartz

When the academic retinue enters the hall, the choir sings *"VENI CREATOR".*

Once the authorities have taken their seats, the anthem of Comillas will be played.

I. Initiation.

Magnificent Rector:

"MEMBERS OF THE FACULTY, BE SEATED PLEASE AND UNCOVER YOURSELVES. LADIES AND GENTLEMEN, BE SEATED, THE ACADEMIC CEREMONY BEGINS"

II. Reading of the designation.

Magnificent Rector:

"THE VICE RECTOR FOR INSTITUTIONAL RELATIONS AND REGISTRAR WILL READ OUT THE DESIGNATION OF DR. ROBERT F. ENGLE AND DR. EDUARDO SCHWARTZ AS DOCTORS *HONORIS CAUSA* BY THE UNIVERSIDAD PONTIFICIA COMILLAS"

The Vice Rector for Institutional Relations and Registrar reads out the designation.

III. Upon completion of the Reading, the **Magnificent Rector** will say**:**

"PROFESSOR DOCTOR ISABEL FIGUEROLA-FERRETTI GARRIGUES AND PROFESSOR DOCTOR M.ª TERESA CORZO SANTAMARÍA NOW ACCOMPANY AND BRING THE CANDIDATES TO THE HONORARY DOCTORATE DEGREE, DR. ROBERT F. ENGLE AND DR. EDUARDO SCHWARTZ, BEFORE THE PRESENCE OF ALL THE FACULTY HERE ASSEMBLED"

The Professors leave the hall.

IV. Upon the entrance of the promoters and the Doctoral candidate, the **Magnificent Rector** will say:

"PLEASE ALL RISE AND MEMBERS OF THE FACULTY COVER YOURSELVES"

The faculty members rise to receive the promoters who escort the Doctoral candidates to their right, who are wearing a gown and hood. The Doctoral candidates and their promoters will sit in the designated seats.

In this moment, choir sings *"CANTICORUM IUBILO".*

Upon completion of the choir's intervention, the **Magnificent Rector** will say:

"PLEASE BE SEATED AND MEMBERS OF THE FACULTY UNCOVER YOURSELVES"

V. Investiture of the Doctorate candidates.

Magnificent Rector:

"WE SHALL NOW PROCEED WITH THE SOLEMN INVESTITURE AS DOCTOR HONORIS CAUSA OF DR. ROBERT F. ENGLE. PROFESSOR ISABEL FIGUEROLA-FERRETTI GARRIGUES SHALL SAY A FEW WORDS PRESENTING THE CANDIDATE"

Laudatio speech in praise of the Doctoral candidate by Dr. Isabel Figuerola-Ferretti Garrigues, which shall end as follows:

"THUS, HAVING CONSIDERED AND PRESENTED THESE FACTS, DISTINGUISHED AUTHORITIES AND FACULTY MEMBERS, I HEREBY ERNESTLY REQUEST WITH ALL DUE CONSIDERATION THAT DR. ROBERT F. ENGLE, BE AWARDED AND CONFERRED THE HIGHEST DEGREE OF DOCTOR HONORIS CAUSA BY THE UNIVERSIDAD PONTIFICIA COMILLAS"

Magnificent Rector:

"WE SHALL NOW PROCEED WITH THE SOLEMN INVESTITURE AS DOCTOR HONORIS CAUSA OF DR. EDUARDO SCHWARTZ. PROFESSOR DOCTOR M.ª TERESA CORZO SANTAMARÍA SHALL SAY A FEW WORDS PRESENTING THE CANDIDATES"

Laudatio speech in praise of the Doctoral candidate by Dr. María Teresa Corzo Santamaría, which shall end as follows:

"THUS, HAVING CONSIDERED AND PRESENTED THESE FACTS, DISTINGUISHED AUTHORITIES AND FACULTY MEMBERS, I HEREBY ERNESTLY REQUEST WITH ALL DUE CONSIDERATION THAT EDUARDO SCHWARTZ, BE

AWARDED AND CONFERRED THE HIGHEST DEGREE OF DOCTOR HONORIS CAUSA BY THE UNIVERSIDAD PONTIFICIA COMILLAS"

Upon completion of the promoter's speech, the **Magnificent Rector** will say:

"PLEASE BE SEATED AND MEMBERS OF THE FACULTY UNCOVER YOURSELVES"

The promoters bring the Doctoral candidates before the Board.

While conferring the Degree, the **Magnificent Rector** will say:

"THE GOVERNING BOARD OF THE UNIVERSIDAD PONTIFICIA COMILLAS, FOLLOWING THE PROPOSAL OF THE FACULTY OF ECONOMICS AND BUSINESS ADMINISTRATION, AND IN ACKNOWLEDGEMENT OF YOUR RELEVANT MERITS, HAS NAMED YOU DOCTORS *HONORIS CAUSA*. BY VIRTUE OF THE POWERS VESTED IN ME, I HEREBY CONFER THIS DOCTORATE DEGREES AND AWARD YOU SAID DIPLOMA"

(The Magnificent Rector presents the title to the doctoral candidates).

The **Magnificent Rector** as he presents the candidates with the *Book of Science*:

"ROBERT AND EDUARDO RECEIVE THE BOOK OF WISDOM AND OF GOD'S LAW. PRESERVE IT AS A SYMBOL OF ALL THAT YOU HAVE TO LEARN AND TEACH AND AS THE TESTIMONY THAT, AS GREAT AS YOUR WISDOM MAY BE, IT HAS TO BE ALWAYS NURTURED WITH THE MEDITATION OF GOD'S WORD, THE EXAMPLE OF THE ANCIENT MASTERS AND THE CONQUESTS OF THE NEW, SO THAT THEY MAY SERVE AS THE BASIS FOR YOUR OWN DISCOVERIES, FOUNDATION FOR YOUR TEACHINGS AND A STIMULUS TO PERPETUATE THEM IN YOUR DISCIPLES"

(The Magnificent Rector presents the candidates with the *Book of Science*).

The **Magnificent Rector** as he imposes the *ring*:

"MR. ROBERT F. ENGLE AND MR. EDUARDO SCHWARTZ, I HEREBY ADMIT AND INCORPORATE YOU TO THE FACULTY OF DOCTORS OF THE UNIVERSIDAD PONTIFICIA COMILLAS WITH THE SAME RIGHTS AND OBLIGATIONS AS THE OTHER DOCTORS AT THIS UNIVERSITY"

(The Magnificent Rector imposes the ring to the doctoral candidates).

The **Magnificent Rector** as he presents the *gloves*:

"ROBERT AND EDUARDO RECEIVE THESE WHITE GLOVES, AS A SYMBOL OF THE FORTITUDE THAT YOUR HANDS MUST PRESERVE, AND ALSO AS A SIGN OF THE DIGNITY OF YOUR HIGH RANK"

(The Magnificent Rector presents the gloves to the doctoral candidates).

The **Magnificent Rector** holding the *ceremonial cap*:

"ROBERT AND EDUARDO RECEIVE THIS CAP AS A SIGN OF YOUR DIGNITY AND SYMBOL OF THE TEACHING PROFESSION TO WHICH YOU HAVE BEEN CALLED SO THAT YOUR WISDOM MAY BE OF USE TO MANY"

(The Magnificent Rector imposes the ceremonial cap to the doctoral candidates).

Mr. Robert F. Engle and Mr. Eduardo Schwartz (one after the other):

"I HEREBY ACCEPT THIS DOCTORATE DEGREE CONFERRED UPON ME AND PROMISE TO DEDICATE MY EFFORTS TO THE SERVICE OF THE TRUTH IN COMMUNION WITH THOSE OF YOU HERE WHO TEACH AND LEARN IN THE NAME OF THE CHURCH"

Magnificent Rector:

"ROBERT AND EDUARDO AS YOU HAVE JOINED THIS UNIVERSITY, RECEIVE IN THE NAME OF THE FACULTY, THIS FRATERNAL EMBRACE FROM ALL THOSE WHO FEEL HONOURED AND PLEASED TO BE YOUR COLLEAGUES"

(The Promoters embrace the Doctors *Honoris Causa*. After the subsequent round of applause, they return to their seats, the Doctors *Honoris Causa* together with their Promoters).

The choir sings *"ALLELUIA"* by Tchaikovsky.

Thereupon the **Magnificent Rector** will say:

"PLEASE BE SEATED AND MEMBERS OF THE FACULTY UNCOVER YOURSELVES"

VI. Doctoral acceptance speech.

Magnificent Rector:

"DR. ROBERT F. ENGLE HAS THE FLOOR TO READ HIS ACCEPTANCE SPEECH AS PART OF HIS INCORPORATION TO THIS UNIVERSITY'S FACULTY"

Doctoral acceptance speech pronounced from the table or lectern.

Magnificent Rector:

"DR. EDUARDO SCHWARTZ HAS THE FLOOR TO READ HIS ACCEPTANCE SPEECH AS PART OF HIS INCORPORATION TO THIS UNIVERSITY'S FACULTY"

Doctoral acceptance speech pronounced from the table or lectern.

VII. Magnificent Rector's speech.

Welcoming speech by the Magnificent Rector addressed to the new Doctor.

After the speech, the **Magnificent Rector** will say:

"PLEASE ALL RISE AND MEMBERS OF THE FACULTY COVER YOURSELVES. WE SHALL PROCEED NOW TO THE SIGNATURE IN THE BOOK OF HONOR OF THE NEW DOCTORS HONORIS CAUSE OF THE UNIVERSITY"

(With all those present standing, the signature in the Book of Honor of the University takes place. The new Doctors *Honoris Causa* therefore approaching the Table accompanied by the Promoters. They return to their seats).

Afterwards, the choir will sing "GAUDEAMUS IGITUR."

Magnificent Rector:

"THE SESSION IS ADJOURNED"

At the end of the ceremony, the board will leave the auditorium through the central aisle.

The choir sings *"GLORIA SEI DIR GESUNGEN (BACH) / REGINA COELI (AICHINGER)".*

III. Appointments

El Rector Magnífico de la Universidad Pontificia Comillas

Conforme a la propuesta formulada por la Junta de la Facultad de Ciencias Económicas y Empresariales, y en virtud del acuerdo adoptado por la Junta de Gobierno de esta Universidad, en su sesión del día 2 de octubre de 2023,

en atención a los méritos que concurren en el Profesor

Mr. Robert F. Engle

le confiere el Grado de

DOCTOR HONORIS CAUSA

por la Universidad Pontificia Comillas.

Madrid, 8 de mayo de 2024

El Rector,

Enrique Sanz Giménez-Rico

El Secretario General,

Federico de Montalvo Jääskeläinen

El Rector Magnífico de la Universidad Pontificia Comillas

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en atención a los méritos que concurren en el Profesor

D. Eduardo Schwartz

le confiere el Grado de

DOCTOR HONORIS CAUSA

por la Universidad Pontificia Comillas.

Madrid, 8 de mayo de 2024

El Rector,

Enrique Sanz Giménez-Rico

El Secretario General,

Federico de Montalvo Jääskeläinen

IV. Presentation of the doctoral candidates

Prof. Dr. Ms. Isabel Figuerola-Ferretti Garrigues

RECTOR MAGNIFICUS,
DISTINGUISHED AUTHORITIES,
PROFESSORS,
STUDENTS,
LADIES AND GENTLEMEN.

This day, this week, this month, this year, will live in our memory.

It is a great honor to take part in today's ceremony, where we bestow our university's highest recognition upon esteemed colleagues. Today, we celebrate the exceptional contributions of Professor Robert Fry Engle III and Professor Eduardo Schwartz, whose work has profoundly shaped our understanding of economics, finance and climate related risks. Let us all take inspiration from this event to advance the spirit of scientific excellence.

As a professor and researcher in Finance and Econometrics, I am deeply moved to present the nomination for Doctor *Honoris Causa* for Professor Robert Fry Engle III. Robert Engle, an Emeritus Professor of Finance at New York University Stern School of Business, received the 2003 Nobel Prize in Economic Sciences for his pioneering work on "methods of analyzing economic time series with time-varying volatility (ARCH)." These techniques have proven essential in accurately capturing the dynamics of several time series. He shared the Prize with his close friend and collaborator, Sir Clive W. J. Granger, who was recognized for his work on "methods of analyzing economic time series with common trends (cointegration)." Robert Engle was also involved in the discovery of cointegration.[1]

Engle's innovative approaches to practical problems have led him to develop groundbreaking econometric methods that have transformed empirical analysis in Economics and Finance. Throughout his career, Robert Engle has established an ex-

[1] The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 2003 was divided equally between Robert F. Engle III "for methods of analyzing economic time series with time-varying volatility (ARCH)" and Clive W.J. Granger "for methods of analyzing economic time series with common trends (cointegration)".

traordinary legacy, marked by the creation of pioneering analytical tools, as well as his co-authorship and mentorship of numerous PhD students, some of which are here today with us. His significant influence has greatly enriched their professional and personal lives. He has imparted his ideas and insights, and has nurtured a generation of leading economists across the globe.

Robert Engle graduated from Williams College with Highest Honors in Physics in 1964. His four years were full of fun, sports, music, and science. He was a standout performer in several dimensions. As a highly athletic youngster in his sophomore year, he was named in the All-American Team as a Lacrosse goalie.[2] (I played this game as a school pupil in St Andrews, Scotland, and enjoyed it a lot.) We shall see later that the amazing coordination he developed playing lacrosse contributed towards his becoming an ice-skating champion.

By that time Robert had decided to call himself "Rob" as he felt it was more masculine and mature. I will therefore call him "Rob" for the rest of this laudation! Academically, Rob studied Physics and Math at an advanced level and continued to excel as undergraduate. His brilliant performance led him to the nomination to "Phi Beta Kappa", America´s most prestigious academic´s honour society constituted with the motto "Love of Learning is the Guide to Life."[3] It was also at Williams that Rob first flirted with Economics. He had taken Introductory Economics as an elective course and loved it. This course later served as the stimulus that changed the direction of his life. He finished an MSc in Physics in 1966 at Cornell and then completed a PhD in Economics there in 1969.

Rob was simply outstanding at everything he touched. He was also string bass player at the All-State Orchestra and later played in the symphonies at Williams College, Cornel University and Massachusetts Institute of Technology (MIT).

In the subsequent sections of this laudation, I will highlight the aspects of Rob's work that have been most influential to academic careers. I will explore for this purpose his contributions in Time Series Econometrics during his time at University of California San Diego and the work in Empirical Finance developed at NYU. The transition from time series to empirical finance will be bridged by the ARCH model.

[2] I also played Lacrosse when at school in Scotland. I did not make it to goalie but enjoyed the game very much. Lacrosse is a team game similar to hockey but it uses a stick with a triangular net. It was originally played by North American Indians: the ball is thrown, carried, and caught with a long-handled stick which has a triangular frame at one end with a piece of depthless netting in the angle.

[3] Members include 17 U.S presidents 42 supreme court justices, and more than 150 Nobel Laureates.

1. The explosion of Time Series Econometrics in the University of California San Diego (UCSD)

While working as an associate professor at MIT, Rob accepted an "irresistible" offer from UCSD where he was hired as an urban economist in 1975, although he would work in broader fields. The work that he developed in San Diego with Clive Granger and others (such as Hal White) marked the start of the golden era of time series econometrics. At the time, UCSD was a world-leading, if not the world's foremost department in Time Series.

Rob was intrigued by Milton Friedman´s hypothesis (1977) that inflation unpredictability was a cause of business cycles. Rob felt that Friedman´s conjecture should be tested with a time series model with variances that could change over time. A time series model uses a sequence of data points collected over a given period. This framework would take quarterly observations of inflation over a long history and calculate the variance as a measure of dispersion from mean values. The model needed to account for changing variances. In Econometrics, we use the term "heteroskedasticity" to consider variances that are not constant over time. As you might know, "hetero" derives from the Greek word *heteros* meaning "different". "Skedastic" comes from the Greek word *skedasis* which means "dispersion". The word "Econometrics" owes *its* origins to the two Greek words *Oiknonomiia* meaning "household" and *metria* which means *"measure of"*.

In Finance, if we look at an asset, its returns are seen (in other words, are observed to be) uncorrelated. On the other hand, its squared returns exhibit correlation. This presented a problem for the models of the day, which operated under an assumption of independence; for under this assumption, both the returns themselves *and* any function of them, including their squares, should be uncorrelated. But that's not what was seen in the data. Clearly, the models had to be revised. One approach would be to model the squared returns directly. The brilliance of Rob was to see that modelling the squares could be achieved using a standard model if prediction errors exhibited a property known as conditional heteroskedasticity. This led to the ARCH model, that became a building block for financial time series. Generalizations of the model allow for better model fitting on the basis of data. What is remarkable is that Rob took this idea, grew and developed it, and enhanced it with other models and approaches, leading to the volatility and risk approach that he and other take towards financial time series that we see in universities and financial markets today.

From my own perspective, it was fascinating for me to discover while reading Rob's biography that ARCH was invented in 1979 when he went for a sabbatical to the London School of Economics (LSE). I was fortunate to study there for my Master's degree, but I was there much, much later! And in his biography, he says that it was in London in a rented flat in Hamsptead that the great EUREKA moment arrived.

"Eureka" comes from the Ancient Greek word εὕρηκα heúrēka, which means "I have found [it]". Indeed, it is the first person singular perfect indicative active of the verb εὑρίσκω heurískō, "I find"!. The term is associated with the sudden spark of inspiration of Archimedes that led him to arrive at the principle of buoyancy. In a fit of exultation, he leapt straight out of the bath and ran naked down the streets of Athens shouting "Eureka!" We will presume that the gentrified London suburb of Hampstead was not treated to such an episode, but the idea of ARCH was brilliant in its simplicity and yet encompassing in its applicability, and for the idea and pioneering contribution, Rob was awarded the 2003 Nobel Prize in Economics.

I learnt about non-constant volatility for the first time as an undergraduate in Queen Mary, University of London in 1995. Professor Christopher L. Gilbert taught the final year Time Series Econometrics course. It took me a while to pronounce the term "heteroskedasticity" but it soon became part of my orbit during my Ph.D with I took with Chris Gilbert as supervisor. It turned out Chris had completed his Ph.D in 1987 at Oxford under the supervision of Professor Sir David F. Hendry.[4] It was highly emotive for me when I discovered at last year's Climate Finance conference that David was not just a collaborator but a great friend of Rob's, and that it was he who had invented the name ARCH. Indeed, it was because of David Hendry that the first ARCH program was written. David participated here last year as a keynote speaker alongside Rob in the conference I organized with the Center for Low Carbon Hydrogen studies (ICAI-ICADE) and the Faculty of Economics and Business Administration. David F. Hendry was supposed to be here today but, unfortunately, has had to send his apologies.

Robert Engle published his ARCH model in the journal *Econometrica* in 1982. He writes in his Nobel biography "one might think that new ideas are easy to publish. At least for me they are not. It took me a bit of rewriting and persuading to finally get it accepted. In fact, I don´t think that any of my papers have had an easy time of it!" I think that we should all take note of this.

When Rob returned to UCSD, the ARCH model was well on its way and he became very interested in a concept introduced by Clive Granger that addressed low frequency (or long term) correlations, that Granger had called "co-integration". It too had its genesis in a problem with the econometric models of the day: simultaneous equations models based on economic theory were being outperformed in forecasting by atheoretical statistical models that were built on the basis of the data. Rob helped to construct an econometric approach to resolve these issues. The pioneer paper on the estimation and testing of cointegrated systems was published with Clive Granger in 1987, also in *Econometrica*.

[4] Gilbert, C. L. (1986) "Professor Hendry's Econometric Methodology", Oxford Bulletin of Economics and Statistics, 48, 3, 283-307.

2. The ARCH that bridges the transition from time series Econometrics to Finance

One aspect about Rob Engle's career – and one that distinguishes him from the majority of Nobel Laureates in Economics – is that he has a whole body of work and contribution *after* he won the Prize. Not for him to sit on his laurels! And indeed, whether by design or through a natural consequence of his move to New York, Rob's interests have leaned more heavily towards Finance. He became increasingly involved with the notion of volatility, and its association with risk. The trade-off between risk and return was a central paradigm in financial analysis and the ARCH model offered a mechanism, for addressing it. He would, however, go on to develop many other models as he integrated the perspectives of volatility and risk and their measurement more and more into his thinking, and to find real application of his methods in the financial sector.[5]

Economic and financial agents use the concept of volatility to measure risk. Quantifying uncertainty (or risk) is pivotal to the decision-making process of any individual. The advantage of knowing about risk is that we can change our practices to prevent them. However, risk cannot be fully eliminated. A zero-risk exposure would mean that humans would still live in the caves, they would not have discovered America, nor stepped on the moon. However, there are risky activities that we choose to do simply because they are worth it, meaning that the perceived underlying benefits of doing them exceed the perceived costs.[6]

When practitioners allocate their financial resources, they need to measure price variances. They usually used the square root of the mean dispersion of returns. When

[5] Rob Engle was also delighted to meet finance faculty such as Michael Brennan and Eduardo Schwartz a moment that de defines as the "peek into the new profession." In the early 1990s he started talking to financial practitioners in a series of RISK meetings and introduced the audience into ARCH models. He started consultancy projects at Salomon Brothers and the GARCH model (a generalization of ARCH) was incorporated into trading systems while became part of a steering committee of a Zurich Financial Services company that was doing path breaking work on high frequency data. He developed the Autoregresive Conditional Duration or ACD to model the speed of trading treating the time between trades as a random variable. These contributions on microstructure allowed him to approach the market microstructure main figures such as Maureen O´Hara and led him to develop a microstructure approach to optimize trades for Morgan Stanley. Engle produced additional innovative statistical methods such CAViaR and dynamic conditional correlation (DCC) models among many others.

[6] Harry M. Markowitz in 1952 and William L. Sharpe in 1964 had associated risk with portfolio returns Their contributions allowed managers to decide when a potential return is worth the risks of the investment. Markowitz and Sharpe were awarded the Nobel the prize in 1990 (along with Merton H. Miller) for their pioneering work in the theory of financial economics. Black and Scholes (1972) and Merton (1973) recognized the importance of risk in the development of their seminal work for pricing options. Option prices depended on risk and that were measured as the variance of asset returns. Their work was recognized with by a 1997 Nobel prize.

applying this volatility measure, they realized that the volatilities were changing over time.

To cut a long story short, this was the agenda that Rob has followed at NYU as founder and codirector of Stern's own Volatility Institute. His research in Financial Econometrics has produced additional innovative statistical methods and concepts such as common features, autoregressive conditional duration (ACD), Conditional Value at Risk (CAViaR) and dynamic conditional correlation (DCC) models.[7] Classic models based on the ARCH model and its generalizations, as well as the state-of-the-art advances are now featured in the Volatility Laboratory (VLAB) which provides daily estimates of volatilities and correlations for more than a thousand assets.[8]

Since Rob has just participated in our Climate Finance conference, it would be remiss of me not to mention the work he is now doing modeling termination risk and the design of portfolios that synthetically hedge climate risk exposure. The VLAB now uses the tools of modern finance and risk management, to model environmental risks.

Finally, even as we celebrate Rob's great academic achievements, we should note that his greatest attribute is the role he plays in supporting his family. It was in January of 1968 before the start of the new term in Cornell that a beautiful young woman caught Rob´s eye. She was starting graduate study in Child Development at Cornell. Her name was Marianne Eger, a distinguished clinical and sports psychologists. She became Rob´s wife in August 1969. She is his intellectual companion as well as being mother to his two children, Lindsey and Jordan. Their children and five grandsons constitute the delights of their lives. In presenting this lauration, I would like to express my gratitude to Robert Engle for his incommensurable contributions to the understanding of the world in economics finance and climate. Though now in his eighties, he is still pushing scientific frontiers for us. It is my greatest privilege of confer upon Robert Fry Engle III the highest honorary degree awarded by the Universidad Pontificia Comillas: Doctor *Honoris Causa*.

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[7] His current application of multiplicative error models (MEM) and factor spline GARCH (FSG) models combine into ever more powerful statistical tools

[8] Risk computations provided by VLAB are now used in evaluating portfolio risk, asset allocation, derivative pricing and systemic risk measures now incorporated in the NYU Stern Systemic Risk Rankings. Rob has built upon the foundation of the work on ARCH for which he was awarded the Prize to produce methods based on volatility and risk that can be taken beyond the university and into the financial world. The philosophy is simple, yet is holistic, and many financial institutions and regulators are now using his methods. If I were to try get to the core of why they have been so popular and successful, it is the effort he has made to ensure that, while his methods are effective, they are simple to apply and interpret. It's not an exaggeration to say that his methods are designed, say, to produce numbers that will tell you whether or not we're moving towards or are in financial crisis.

"THUS, HAVING CONSIDERED AND PRESENTED THESE FACTS, DISTINGUISHED AUTHORITIES AND FACULTY MEMBERS, I HEREBY ERNESTLY REQUEST WITH ALL DUE CONSIDERATION THAT PROF. ROBERT FRY ENGLE III BE AWARDED AND CONFERRED THE HIGHEST DEGREE OF DOCTOR *HONORIS CAUSA* BY THE UNIVERSIDAD PONTIFICIA COMILLAS"

Prof. Dr. Ms. M. Teresa Corzo Santamaría

Rector magnifice, dignissimae auctoritates, huius universitatis magistrorum et discipulorum amplissime ordo, amicae et amici omnes,

RECTOR MAGNIFICUS,
DISTINGUISHED AUTHORITIES,
PROFESSORS,
STUDENTS,
LADIES AND GENTLEMEN.

1. Throughout life, we encounter memorable days and happy occasions, such as today, when I have the privilege of delivering the laudation for Professor Dr. Eduardo Schwartz. This day brings joy and pride as we welcome into our university someone I consider both a mentor and friend, and a giant in the field of finance, as I will explain.

I first met Professor Eduardo Schwartz in 1997. By that time, he had already become a prominent figure in finance, known for his over 70 publications in leading journals and, indeed, in that distant year of 1997, Eduardo was presiding over the American Finance Association, publisher of The Journal of Finance, and was a professor at the Anderson School of Management at the University of California, Los Angeles (UCLA).

Although Eduardo did not begin his career as an academic, he has made significant theoretical and practical contributions to finance. One might ask, what exactly is finance? Robert Shiller, in his book "Finance and the Good Society," defines finance not as an end, but as a mechanism for exchanging goods and services for money, a tool that helps individuals and institutions achieve their goals and facilitates societal development. In this light, Professor Schwartz's contributions have been crucial for understanding key factors in complex investment environments, enhancing risk management, and often enabling decision-making under uncertainty, thereby facilitating capital allocation to development-needy areas such as natural resources, innovation, and, more recently, sustainable economic transitions.

Professor Schwartz earned his degree in industrial engineering from the University of Chile and started his career as an engineer in Chile's natural resources sector. This background later influenced his research career. Following a political change and the expropriation of his family's business, Eduardo turned adversity into opportunity

and moved to Vancouver, Canada, where he pursued an MBA and a Ph.D. in Finance at the University of British Columbia, under the guidance of another distinguished financial economist, Professor Dr. Michael Brennan.

His academic journey in Canada marked the beginning of a new life. I will divide his versatile and inspiring academic path into three parts:

2. (1) His pioneering beginnings. After defending his doctoral thesis in 1975, he taught at the University of British Columbia, was a visiting scholar at the University of California, Berkeley, and at the London Business School. During these years, he began to publish groundbreaking work alongside Professor Dr. Brennan, applying stochastic modeling to interest rates, bonds, and contingent claims. In 1972 and 1973, elegant models for pricing financial derivatives had been published by Black, Merton, and Scholes, marking the advent of continuous-time finance with the introduction of stochastic mathematics. Stochastic calculus is a branch of mathematics that deals with processes involving random or unpredictable elements. This calculus is particularly useful in finance as it helps model the behavior of inherently uncertain and variable financial markets.

In those vibrant early days of "financial engineering," Eduardo was in the right place at the right time, advancing mathematical developments in fixed income and real asset investments. "My work since has been rooted in mathematical modeling and an interest in stochastic modeling and uncertainty."(he says)

From this era stem several of his most cited works such as "A Continuous Time Approach to the Pricing of Bonds," "The Valuation of American Put Options," and "Evaluating Natural Resources Investments."

3. (2) The strengthening of an academic career. In 1986, he joined the faculty of Anderson School of Management at UCLA, in a historic recruitment led by Professor Dr. Richard Roll, another prominent figure in modern finance. At UCLA, where he directed the Chair of Real Estate Assets and Natural Resources Economics, he remained for over thirty years. During these productive years, he continued to model the stochastic behavior of prices in fixed income, equities, commodities, and real assets. He published on capital structure, the temporal structure of interest rates, asset allocation, oil, electricity prices, and investments in natural resources.

In 2000, at the midpoint of his career at Anderson School, he published along with Francis Longstaff the seminal paper "Valuing American options by simulation: a simple least-squares approach," one of his most cited papers. This research redefined the unresolved valuation method of American options (versus European options) and opened a new pricing path using simulation.

For his impact and significance, special mention deserves his developments in the real options method for valuing investments under uncertainty. Real options provide

great flexibility in investment analysis, the potential to choose the best time to invest, expand, or exit an investment, etc., proposing itself as an alternative and complementary method to the traditional discounted cash flow method (NPV), and facilitating decision-making and capital flow to previously challenging environments.

Indeed, he is co-editor with Professor Dr. Lenos Trigeorgis of the University of Cyprus, of the book "Real Options and Investment Uncertainty," published in 2001 by MIT Press, a compilation of advances and classical studies in the field and becoming the reference book of the discipline.

From the same era dates the paper "The Rational Pricing of Internet Companies," which amid the dot-com stock market boom and widespread uncertainty about valuing such companies, became a model of reference, modeling uncertain elements like costs and future demand. For this seminal work, he received the Graham and Dodd Award from the *Financial Analysis Journal*. Throughout his career, Eduardo has applied real options to the exploitation of natural resources, investment projects, and the valuation of patents and R&D models.

4. (3) His recent contributions. Into the 21st century, his work has evolved towards issues related to energy transition, climate finance, and environmental economics, with papers like "Stranded Fossil Fuel Reserves and Firm Value," "Optimal Carbon Abatement in a Stochastic Equilibrium Model of Climate Change," and topics such as the optimal exploitation of fisheries in the oceans, or, currently, investigating about the pricing of water.

I can say that with more than 100 articles published in leading journals in the field, over 25 book chapters, having served as associate editor of more than 20 journals, including *The Journal of Finance*, *Journal of Financial Economics*, and *Journal of Financial and Quantitative Analysis*, and being a research associate of the *National Bureau of Economic Research*, Eduardo is as versatile and tireless a researcher as one can find.

I cannot overlook in this journey his involvement in transferring his theoretical models to financial industry practice, now termed as "impact practice." He has consulted for national agencies and over 40 companies and institutions, including *Merrill Lynch*, *British Petroleum*, *Wells Fargo*, *Pacific Stock Exchange*, *UBS*, *HSBC*, and many others. He has authored monographs and delivered over 80 professional conferences, helping to extend his models in the financial sector (today, we have representatives from several entities using his models present here).

The singular fecundity of a half-century dedicated to financial economics leads me to describe him as a *Renaissance researcher of finance* over the last 50 years.

I conclude this part with his words: "I move on, I change," Schwartz says. "I started on derivatives, then did work with interest rate models, credit risk models, and, more

recently, commodity models and real options, the application of option concepts to value projects and companies."

5. With the remaining time, I would like to talk about his exceptional commitment to education and his fascinating personality, which has earned him countless friends and co-authors around the world.

There is Professor Eduardo, educated and smiling, intertwined with Researcher Doctor Schwartz. His generosity and availability make him a beloved mentor to young professors, postdocs, and PhD students. Each year, for decades, he has welcomed a small community of postdocs and PhD students at Anderson School to collaborate with them. In the vibrant 1990s, I remember witnessing young tenure-track professors enter his office with sparkling eyes, seeking advice on their developments and models, with the excitement of those who believe they have made a valuable contribution. He would listen and swiftly ask the right questions and identify the challenging points. Eduardo was always constructive in his critiques, focusing on key issues in a matter of minutes.

In the renowned finance seminars, where weekly, the research works of professors were presented, the presentations of job market candidates were especially interesting. The dialogue between the abundant and knowledgeable faculty of Anderson and the candidates could become very challenging. It was not unusual for candidates not to get past the second page of their presentation due to the sharp questions of the faculty. In these dynamics, I always remember hearing Eduardo speak with constructive and balanced words, almost replicating in English his soft South American accent, with courtesy and valuing the contributions of the researchers. Something that, in that competitive atmosphere, was highly valued by all the young researchers.

Due to his approachable character and proximity, Eduardo was a reference for all the young Spanish speakers at Anderson School. A long-awaited occasion was the annual meeting at Eduardo's house, where MBA students, doctoral candidates, visiting professors, and faculty enjoyed his hospitality and generosity, forming friendships. His wife, Gloria, actively contributed to this, being a wonderful hostess and facilitator of community relations.

6. I conclude, leaving a key piece for the end: his love for teaching. Eduardo embodies a commitment to teaching. On one occasion, I asked him about his classes, as they might have seemed, to me, too basic for his level of knowledge. He told me, "You know? Teaching the basics of finance is the most difficult. You must deeply understand the fundamentals of the discipline, put together the cornerstone pieces, and provide students with a solid structure where other pieces will later fit. That's why I like it. It's a challenge. Teaching the beginning of any discipline is the most difficult." He may not remember that conversation. I was impressed by this well-tuned vision of

teaching. His website at UCLA reads, "I see my job, mainly, as teaching students how to think. The specific material, they'll forget. But if they learn to think they will learn to solve the problems they'll face later in their careers." His meticulous dedication is evidenced by the numerous excellence awards with which, over the years, his students have recognized the quality of his classes.

Now a professor emeritus at UCLA, far from retiring, his relentless curiosity, versatility, and work capacity keep him very active at Simon Fraser University, holding the "Ryan Bedie" Chair of Finance, and teaching doctoral courses.

When he comes to Comillas, he always has his office open for professors, already having various collaborations underway. It is worth noting that some friends from other Spanish universities also know how to capitalize on his availability and generosity.

With this exposition of Eduardo's contributions, I hope to have summarized Professor Schwartz's contribution to the field of finance. In this dynamic field, our praise encompasses not only his outstanding academic achievements and professional excellence but also his generosity in sharing his knowledge. May his contributions continue to inspire and guide future generations of economists and financial experts worldwide.

> "THUS, HAVING CONSIDERED AND PRESENTED THESE FACTS, DISTINGUISHED AUTHORITIES AND FACULTY MEMBERS, I HEREBY ERNESTLY REQUEST WITH ALL DUE CONSIDERATION THAT DR. EDUARDO SCHWARTZ BE AWARDED AND CONFERRED THE HIGHEST DEGREE OF DOCTOR *HONORIS CAUSA* BY THE UNIVERSIDAD PONTIFICIA COMILLAS"

V. Formal speeches

Prof. Mr. Robert F. Engle

THE IMPACT OF CLIMATE RISK ON FINANCIAL MARKETS

RECTOR MAGNIFICUS,
DISTINGUISHED AUTHORITIES,
PROFESSORS,
STUDENTS,
LADIES AND GENTLEMEN.

I. SCIENCE

Science knows that if the energy coming to the earth is greater than the energy escaping from the earth, its temperature will rise. The layer of greenhouse gasses around the earth is trapping heat that in the last million years would have been emitted back into space. The rapid increase in CO2 and other greenhouse gasses is due to the rate at which we humans burn fossil fuels. These fuels were created over countless millennia by plants which converted the sun's energy into organic molecules which have been stored in the earth and sea. By burning these fuels, we release the energy and the carbon that has been lying dormant.

As the planet warms, glaciers melt, the sea rises, weather patterns change and droughts and floods occur in different locations and intensities. These changes are unprecedented since humans inhabited this earth, but they have occurred through other causes in the millions of years before. We can see it in the fossil records where species became extinct, water covered much of the land we now live on and temperatures were much higher than today. The planet will probably survive what we are doing to it, but we may not.

II. SOLUTIONS

We should adapt as much as possible to a warmer world. This is called "adaptation." Adaptation requires changing many things in our economy from increased air conditioning and building insulation to moving our cities to higher land or building enormous sea walls and dikes to protect existing city locations. These costs can be

considered relative to the alternatives using conventional cost benefit analysis. The people paying the cost are also the beneficiaries.

We should also slow the pace of climate change by reducing our emissions of GHG. We call this "mitigation." Decarbonizing the global economy is also very costly, however the beneficiaries are not the ones paying the cost. The beneficiaries are all the people of earth including the unborn generations.

Economists have been trying to do cost benefit on this problem. What are the damages we expect in the distant future and what will it cost us today to reduce them. Conceptually there is a Social Cost of Carbon (SCC) which is measured in dollars (or Euros) per ton of greenhouse gas emissions that summarizes the present discounted value of all future damages to the whole planet from an additional ton of emissions. If anyone who emits CO2 was asked to pay the SCC, then only emissions that occur would be those where the benefits to the emitter exceed the costs to the rest of the world.

If a carbon tax on all emissions were introduced, there would be enormous changes in our economies. Many industries would have to raise their prices dramatically to pay for their emissions, and demand might go to zero. There would be a scramble to purchase solar panels and wind turbines and maybe nuclear reactors to generate power more inexpensively than from fossil fuels. The winners would be deluged with capital from investors and the losers would see their stock prices head toward zero. This is an example of transition - it is clearly a risk for some companies and an opportunity for others. The risk of transition affects asset prices today as equity of fossil energy companies trades at prices which are low relative to their earnings.

Another approach to mitigation came out of Paris. Almost 10 years ago most nations of the world signed an agreement in Paris that committed them to make their economies emit no net emissions by 2050. Commitments to netzero emissions means that negative emission strategies can be used to offset positive emissions. The agreement is not binding except as public pressure can enforce it. Countries can choose their own approach to reach netzero. It is a landmark departure from using the price of carbon as a target to using quantity of emissions as a target. Scientific research finds that if the planet is entirely netzero by 2050 we will avoid the worst damages of global warming.

III. POLICY CHOICES

There are four classes of policies that can be used by governments to bring their economies to netzero.

TAX CARBON EMISSIONS
SUBSIDIZE RENEWABLE ENERGY
REGULATE EMISSIONS
HOPE

The hope policy is based on hoping that consumers, employees, investors and corporations will voluntarily adopt greener behavior! This relies on the goodness of each of these people to do the right thing to help the planet. Economists are skeptical that people can be convinced to do this because of the "free rider" problem. Anyone who decides not to participate receives the benefits of those that do without having to give up things that are polluting. Hope is the main policy that governments are relying on while they debate the alternatives.

Today, the EU is primarily taxing carbon with the Emission Trading System. The US is primarily subsidizing renewable energy with the IRA, Inflation Reduction Act. China is primarily regulating by forcing fossil energy companies to reduce emissions and putting government resources into designing and implementing green technologies which are subsidies to renewable energy. All of us are relying on HOPE to make these more effective. Coordination and collaboration are essential if we are to achieve the Paris Accord outcome.

IV. RESEARCH AT VRI

The Volatility and Risk Institute at NYU Stern that I Co-direct is carrying out research to answer these difficult questions from a financial perspective. Financial markets are forward-looking and therefore are quite sensitive to the risks of climate change. Asset prices today reflect investor expectations about future events, and these include both physical and transition risks. In our research at the VRI we have constructed some climate sensitive portfolios which are designed to appreciate when climate risk goes up and depreciate when it goes down. We call these CLIMATE HEDGE PORTFOLIOS.

Some of these are simply short fossil energy producers, others are emission weighted returns or green minus brown returns. Others are developed statistically by looking at the performance when there is climate news. A new index based on property and casualty insurers is designed to hedge physical risk. And we have some new ones in progress.

What can we do with these hedge portfolios?

- We can invest in them directly
- We can invest in stocks that have a high beta on these hedges
- We can invest in publicly available "sustainable" funds that have a high climate beta
- We can assess the risks to the financial sector by examining the climate beta of banks, insurers and other financial companies
- Here are some results from VLAB.STERN.NYU.EDU

Table 1 gives performance metrics for over 200 funds that are publicly available. Some are mutual funds and ETFs. Over the last 5 years the return, volatility and Sharpe ratio have been given for each fund. Then the table reports correlations with two measures of climate news. The last three columns present measures from modern finance. The CAPM alpha is the intercept in a regression on the Market return. The climate betas are the coefficients on either the Stranded Assets (SA) Portfolio or the Climate Efficient Factor Mimicking Portfolio (CEP) in a regression with the Market, three FF factors, Oil returns and both climate hedge portfolios.

5 YEAR PERFORMANCE: TWO FLAVORS OF GREEN

				Correlation		Climate Efficient Factor Mimicking Portfolio		
Security	Return	Volatility	Sharpe Ratio	Cos Sim	Tag Index	α_{CAPM}	β_{SA}	β_{CEP}
Invesco Solar ETF	15.79%	43.76%	0.27	-0.042	0.052	5.13 (0.30)	-0.21 (-3.51)	0.39 (2.80)
SPDR S&P Kensho Clean Power ETF	15.94%	36.55%	0.33	-0.080	0.058	3.46 (0.26)	-0.08 (-1.84)	0.35 (3.03)
Invesco WilderHill Clean Energy ETF	2.03%	44.92%	-0.05	-0.054	0.002	-9.88 (-0.60)	-0.16 (-3.77)	0.30 (2.83)
iShares Global Clean Energy ETF	10.00%	32.23%	0.18	-0.083	0.061	-1.48 (-0.12)	-0.13 (-3.11)	0.29 (2.96)
Global X Lithium & Battery Tech ETF	10.84%	34.13%	0.20	-0.055	-0.057	-0.63 (-0.05)	-0.39 (-8.11)	0.28 (4.21)
KraneShares MSCI China Clean Technology Index ETF Fund	3.52%	35.07%	-0.02	-0.051	-0.062	-2.49 (-0.17)	-0.42 (-5.48)	0.27 (2.94)
First Trust NASDAQ Clean Edge Green Energy Index Fund	14.23%	40.63%	0.25	-0.070	0.018	0.58 (0.04)	-0.13 (-3.34)	0.27 (2.98)
Invesco Global Clean Energy ETF	6.19%	32.38%	0.07	-0.058	0.031	-6.23 (-0.54)	-0.21 (-6.88)	0.26 (3.73)
VanEck Low Carbon Energy ETF Fund	11.24%	30.70%	0.23	-0.079	0.021	-1.35 (-0.14)	-0.15 (-4.28)	0.25 (3.87)
ALPS Clean Energy ETF	5.85%	38.01%	0.05	-0.060	0.039	-7.14 (-0.51)	-0.08 (-1.82)	0.22 (2.31)

Table 1

Results: Five year regressions of S&P 500 stocks

GREENTESTRANK	PC1RANK	NAME
1	61	BERKLEY W R CORP
2	3	POOL CORP
3	271	PROCTER & GAMBLE CO
4	16	NASDAQ INC
5	36	CINCINNATI FINANCIAL CORP
6	82	AMERICAN WATER WORKS CO INC
7	223	PEPSICO INC
8	31	AMERICAN TOWER CORP NEW
9	74	P N C FINANCIAL SERVICES GRP INC
10	13	REGENCY CENTERS CORP

GREENTESTRANK	PC1RANK	NAME
610	610	HESS CORP
611	618	DIAMONDBACK ENERGY INC
612	613	A P A CORP
613	616	MOSAIC COMPANY NEW
614	619	DEVON ENERGY CORP NEW
615	609	HALLIBURTON COMPANY
616	615	MURPHY OIL CORP
617	611	MARATHON OIL CORP
618	617	PIONEER NATURAL RESOURCES CO
619	599	CONOCOPHILLIPS
620	614	EDG RESOURCES INC

Table 2

Regressions of stock returns of SP500 companies on standard risk factors and 4 climate hedge portfolios. Top 10 and bottom 10 rankings based upon either the t-statistic of the average beta or the t-statistic on the first principle component of the hedge portfolios.

V. IMPACT ON FINANCIAL INSTITUTIONS

Banks and insurers lend to many institutions. If these institutions are exposed to climate risk, the financial company should face climate risk.

- CLIMATE BETA measures the exposure to movements in climate hedge portfolios. These tables show results for transition risk.
- CRISK, (Climate Risk) measures the capital adequacy of the institution after a climate stress event. It is based on the beta and the financial health of the company. It is an estimate of how much capital the institution would need to raise in order to continue to function normally after the stress event. Some banks are undercapitalized even before the climate event and therefore CRISK does not reflect just climate risk.

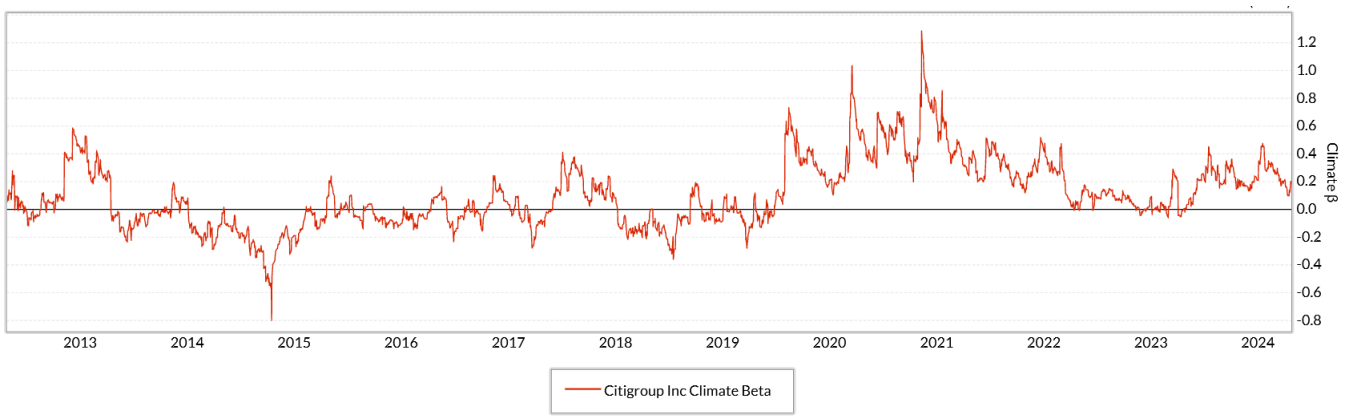


Figure 1: Climate Beta of Citigroup

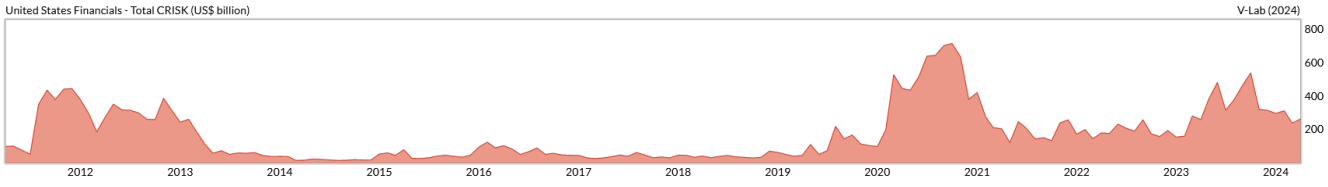


Figure 2: Total CRISK of US Financials

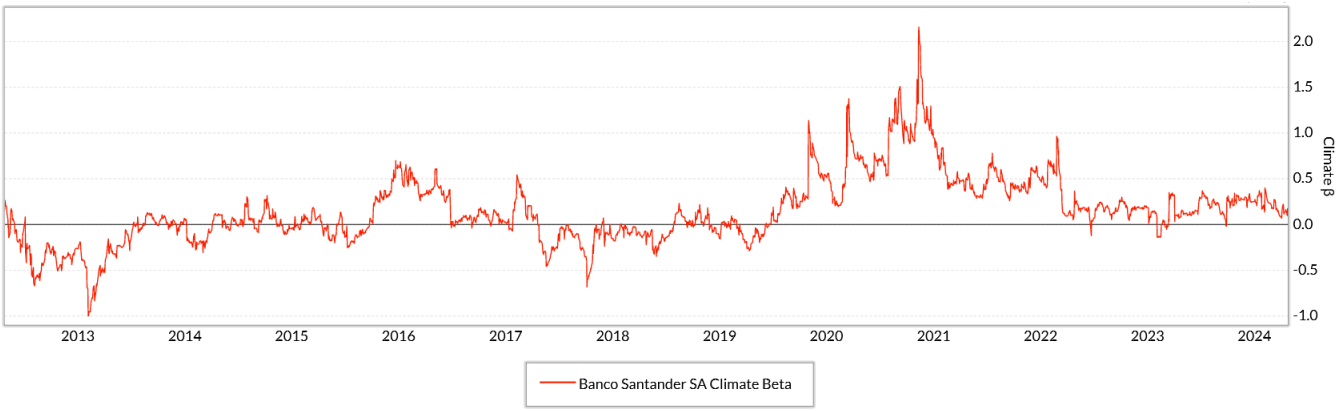


Figure 3: Climate Beta of Banco Santander

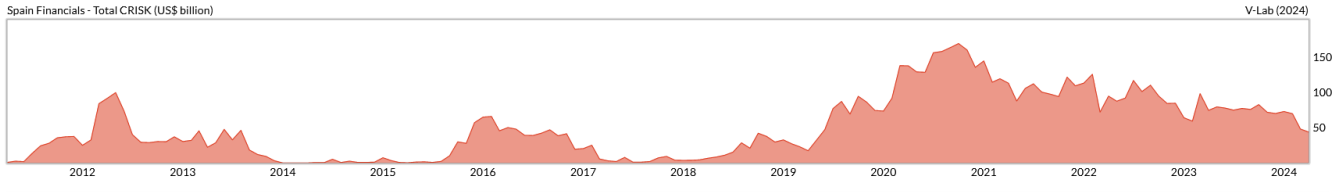


Figure 4: Total CRISK OF SPAIN

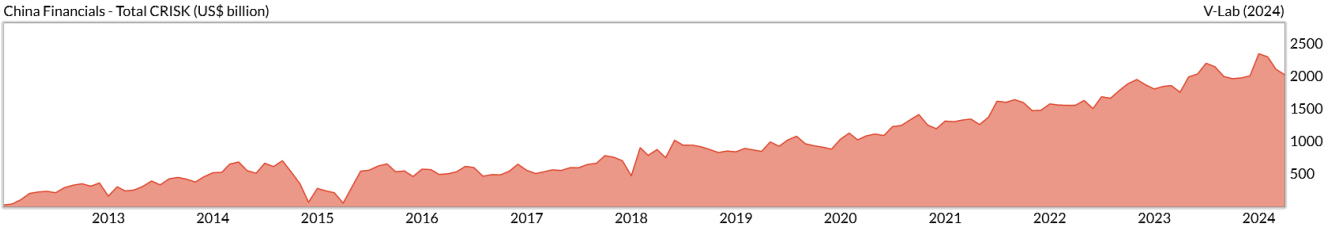


Figure 5: TOTAL CHINA CRISK

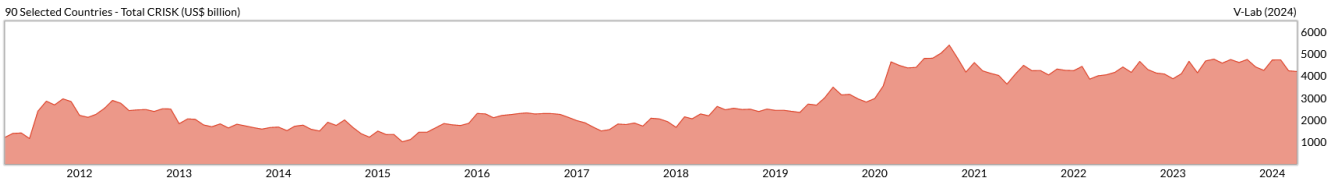


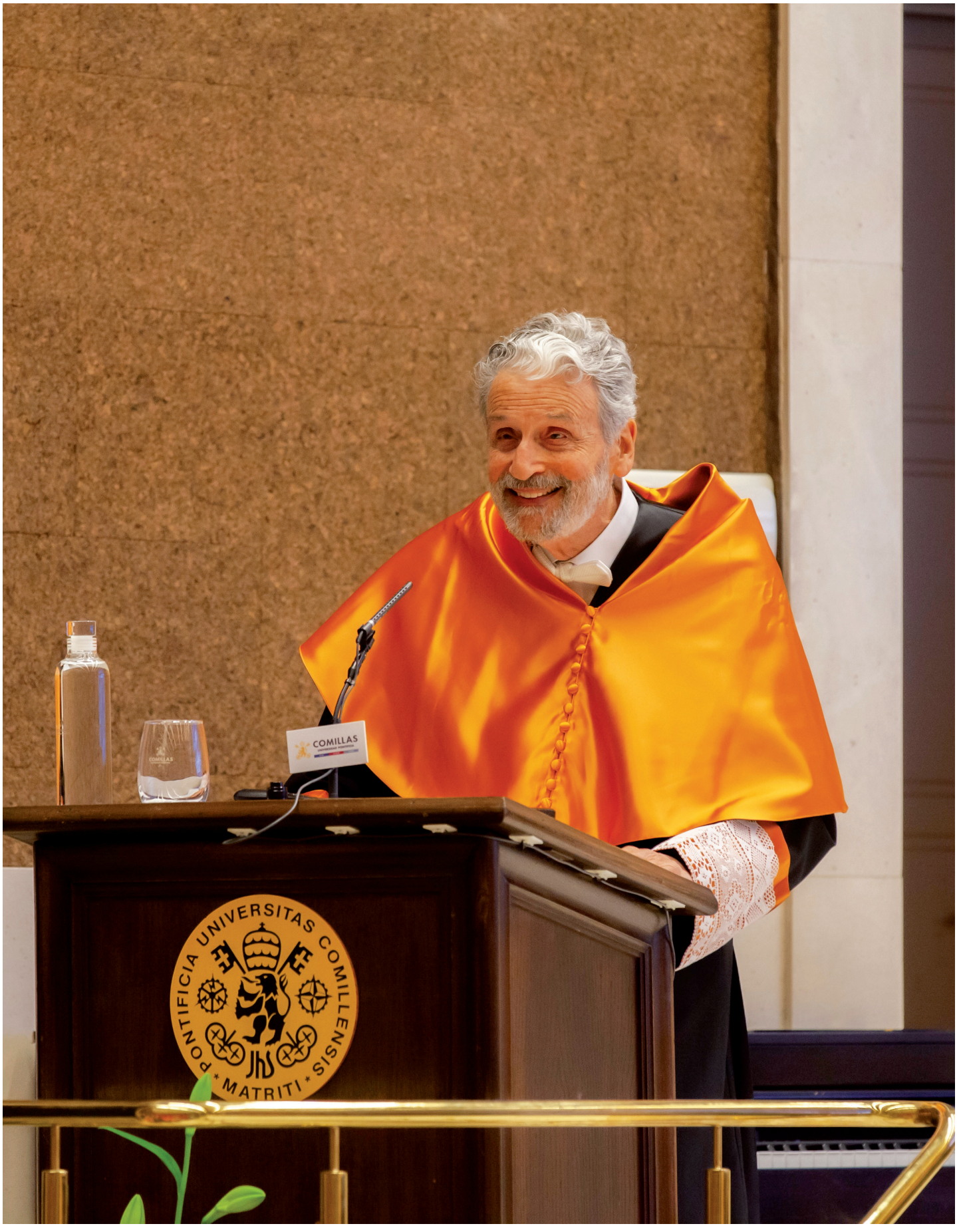
Figure 6: TOTAL WORLD CRISK

VI. CONCLUSIONS

- The risk of climate change impacts asset prices today.
- These risks include both physical risks and transition risks.
- We see this for stocks, for portfolios and for financial institutions.
- To reduce the expected damages from climate change, we must transition to a lower carbon economy. This costly transition will be amply funded by private capital if it appears profitable. Public policy through subsidies, taxes, and regulation can create the needed conditions. Political leaders must be willing to carry out the required policies. Only then can we be confident that our children and their children will have a healthy planet to live on.

Figure 7: THREE OF MY GRANDSONS WONDERING WHAT KIND OF WORLD WILL THEY INHERIT

Figure 8: IF WE CAN TELL THEM THAT WE HAVE A PLAN….



Prof. Eduardo Schwartz

REFLECTIONS ON AN ACADEMIC CAREER IN FINANCIAL ECONOMICS

RECTOR MAGNIFICUS,
DISTINGUISHED AUTHORITIES,
PROFESSORS,
STUDENTS,
LADIES AND GENTLEMEN.

First, I would like to share with you the deep emotion I feel right now. It is a very great and unexpected honor for me to receive this honorary title from your illustrious University.

On the one hand, receiving this honor from the University of Comillas, and the Faculty of Economics and Business Sciences in particular, makes me feel very close to your university and your beautiful city. It adds another piece of the world to my life that I feel a part of.

On the other hand, I am excited that it was my colleagues from the financial economics department, and especially Dean Teresa Corso, who nominated me for this distinction. My friendship with Teresa dates back more than 25 years, when, having just graduated from her doctorate in Finance, she visited the University of California in Los Angeles (UCLA), where I was teaching, and we jointly carried out research work on the convergence of interest rates in the European Monetary Union.

My academic efforts have always been guided by intellectual curiosity and I have never dreamed of receiving an honor of this nature. Getting to share this great honor with people as distinguished as those who have received this recognition until now, and especially today the distinguished Professor Robert Engle, is enough to make me feel the most sincere and humble of gratitude.

It never occurred to me in the sixties, when I received my degree in Industrial Engineering at the University of Chile, that one day I would find myself in front of you

sharing this event. My career as an academic is certainly unconventional, as I spent eight years working for various companies as an engineer and as an executive in my native country, Chile. In fact, when I moved to Canada to pursue my graduate studies in business administration at the University of British Columbia, devoting myself even remotely to academic life was not on my mind. There, however, I began working with a young professor, Michael Brennan. This collaboration awakened in me an intellectual curiosity that had been latent during the previous years, and I soon realized that I could and should dedicate the rest of my life to academic work. However, I would not be here before you if it had not been for the advice and encouragement of great and respected colleagues such as Michael Brennan and Francis Longstaff, with whom I have collaborated for many years.

What we have come to call financial economics deals in part with any problem that is related to the fair valuation of any asset, whether it is an asset that we could classify as purely financial (a bond, a stock, an option) or a real asset (for example, general investment goods, or natural resource investments). The task of finding the fair valuation of assets is a very important and essential part of obtaining the optimal allocation of resources in the economy. Only by understanding this concept can we appreciate the fundamental role that finance plays in economic development.

There is a second role that financial economists have played and that is, in essence, complementary to the previous one: the organization and continuous improvement of the functioning of financial markets, whether fixed income, variable income, exchange rates or derivatives. These are key markets and instruments necessary to achieve the efficient allocation of resources, which allows a stable growth of our economies.

After this simple introduction to the general area of finance, I will give you a brief outline of my research in the context of this discipline. Although my work could be described as quite "technical," I will try to summarize my contributions to financial theory in a few words.

I began my research career dedicated to the search for methodologies to obtain the correct valuation of financial assets. That is, basically fixed income assets, and financial derivatives such as options and futures. Little by little my research broadened its horizons, and in addition to venturing into the field of real estate assets, I began to study real assets. If we can understand a financial asset as a security for which a price is paid and whose possession gives the right to receive certain future flows of money (for example, the coupon of a bond or the dividends of a share), in the same way a real asset can be considered in the same framework. A copper mine, for example, is an asset for which a price is paid, and whose possession will give the right, in the future, to receive the income from the sale of copper. This means that we can apply

similar valuation formulas, which are used for purely financial assets, to real assets. It is to this task that I have dedicated a substantial part of my work.

An extension of the same options theory that applies to the valuation of financial options can also be used to value these "real" assets. Although I will not go into detail on this topic, since a summary that would do it justice would require more time than I have available, I count myself among the group of researchers who gave the initial push to what is now called "real options theory", which is now attracting great attention from researchers belonging even to fields not directly in finance.

As in the case of a financial option, where the exercise price of the option is paid and the underlying asset is obtained (be it a stock, a bond or a commodity), in the case of a natural resource such as a gold or copper mine, or an oil field, the cost of extraction is paid to obtain the underlying asset (gold, copper, or oil). In this way, financial option valuation methods can be used to obtain the value of real options, such as natural resources.

In the same way that the value of an option depends fundamentally on the random process of the underlying asset (for example, a stock), the value of a natural resource depends fundamentally on the random process of the underlying commodity. As a result of this, I spent a lot of effort studying the random process followed by commodity prices.

Later my work focused on topics such as the application of real options to the analysis of research and development projects, especially applied to pharmaceutical companies and the development of new drugs. It is fascinating to think how these companies continue to function as great engines of the economy despite the fact that they need to spend a lot of money on research and development, that their projects are subject to numerous uncertainties—for example, whether they will be completed successfully, whether the product will be approved, whether there will be a market for the product obtained—and that it will take years to begin enjoying the income generated by such projects. The study of these companies, and research and development projects in general, is exciting not only from the point of view of theoretical finance, but also from the perspective of real economics.

In recent years, in addition to the topics already mentioned, I have dedicated part of my effort to studying some financial aspects of climate change, sustainability and environmental and resource economics issues. I am pleased to mention that in some of these studies I am collaborating with professors from this illustrious university.

Having described the importance of finances in the new economic environment, I would like to take the opportunity now to talk to you not only about the Professor and his research work, but about the man who today feels immensely happy to be with you in this ceremony.

In addition to my close friendship with Dean Teresa Corso and my connection with the University of Comillas and its faculty, my relationship with Spain, Spanish academics and Spanish academic institutions is long and deep. I have presented multiple seminars at Spanish universities and at academic conferences in Spain. I can mention: the University of Alicante where I received a DHC in 2001, the Carlos III University where I held a Chair of Excellence in 2009, and the University of Valladolid, where I have visited several times and have many friends.

I want to tell you that I feel very lucky to be accompanied on this occasion by my dear wife Gloria, who has been my partner throughout a life full of enormous satisfaction. Gloria has been for me the person who has always been there when I needed her. Together we have formed a family of three daughters and 8 grandchildren who have filled us with joy.

Finally, I ask you to allow me one more minute to conclude my acceptance speech by reiterating the great honor that it represents for me to become part, in such a special way, of the university community of the University of Comillas. Even more so in the company of the very distinguished academic and Nobel Prize winner, Robert Engle. I want to tell you that I will always remember this day with great affection.

Thank you!

VI. Speach by the Rector Magnificus


COMILLAS
UNIVERSITAS

Honorary Doctors Prof. Robert Engle and Prof. Eduardo Schwartz,
Marianne Engle,
Gloria Schwartz and family,
Excellencies,
Professors and Members of the University Staff,
Rector Julio Martínez,
Students,
Alumni,
Distinguished guests,
Ladies and Gentlemen.

It is a great honor to stand here in front of you today, especially in front of you both, Robert Engle and Eduardo Schwartz, new members of the academic community of Comillas. As Professor Teresa Corzo and Professor Isabel Figuerola already mentioned, it is a tremendous honor for all the members of Comillas, and especially for those of its Faculty of Economics and Business Administration, to bestow our Doctor *Honoris Causa* upon both of you. We all are very happy to celebrate this important event, and to celebrate your exceptional contributions in economics, finance and climate related risks, which have already inspired a good number of members of Comillas, both professors and students.

We all are very happy to state that Robert Engle and Eduardo Schwartz are already members of Comillas in 2024, a year in which our University is celebrating its 120th anniversary. On March 17th 1904 the Holy See approved the awarding of academic grades in our University. At that time the University was located in a small town of Spain called Comillas. At that time three faculties were the core of the University, those of theology, philosophy and canon law. Some decades later, in 1968, Comillas moved to Madrid, where the Jesuits already ran two important academic centers, ICAI and ICADE, the current University School of engineering, and the current faculties of economics and law. The six of them and the San Juan de Dios University School of Nursing and Physical Therapy, which was integrated in Comillas some years later, are currently the seven main academic centers of our university.

Since the very beginning of Comillas the students are at the center of our University. In doing so Comillas was following the regulations of the educational system

of the end of the XVIth century of the Society of Jesus called *Ratio Studiorum*. Educational system which was updated at the beginning of the 80s by an international group of Jesuits meeting in Rome. Let me read one of its main statements:

"The young men and women who are students in a Jesuit school have not reached full maturity; the educational process recognizes the developmental stages of intellectual, affective and spiritual growth and assists each student to mature gradually in all these areas. Thus, the curriculum is centered on the person rather than on the material to be covered. Each student is allowed to develop and to accomplish objectives at a pace suited to individual ability and the characteristics of his or her own personality".

The *Ratio Studiorum* was also updated by a former General of the Jesuits, Fr. Peter-Hans Kolvenbach, who led the Society of Jesus from 1983 till 2008. Fr. Kolvenbach gave many speeches on the Jesuit universities all over the world. In many of them it is stated and underlined that the students play a central role at the Jesuit universities. He stated at Georgetown that the goal of the Jesuit education is the intellectual development of the talents that God gave to every student and the total development of the person. Some years later he said at Santa Clara University, that "the real measure of Jesuit universities lies in who our students become. For 450 years, Jesuit education has sought to educate «the whole person» intellectually and professionally, psychologically, morally and spiritually. But in the emerging global reality, with its great possibilities and deep contradictions, the whole person is different from the whole person of the Counter-Reformation, the Industrial Revolution, or the 20th century. Tomorrow's "whole person" cannot be whole without an educated awareness of society and culture with which to contribute socially, generously, in the real world. Tomorrow's whole person must have, in brief, a well-educated solidarity".

Going back to our University, which is already yours, Eduardo and Robert, we can attest that what we have said about our origins and the last decades is still present today. A few years ago, a good number of professors of Comillas prepared the skills profile of a professor from Comillas. One of its chapters is dedicated to the process of teaching and learning. In our University, this is focused on the students, so that they can acquire a deep, reflective, critical, experiential, and collaborative learning, which brings them a comprehensive training, and which allows them to promote changes and improvements in our world today.

If the students are at the center of one of the main activities at Comillas, human beings, societies, communities and cultures are at the core of the research that we do in our University. We are a University and we share research efforts, goals and aims with many other Universities all over the world. Comillas is then a research University. As such we try to search for knowledge and truth. Our research gives rigor to our teaching and academic soundness to our institution. It also produces papers and books

which offer solutions to current problems. In addition, research allows us to attract and retain internal and external talent. Many of our researchers, both senior and junior, are very gifted. Some of them have also an international dimension due to their participation in international research activities and projects. Comillas is very interested in reinforcing all these characteristics of our research. Comillas is also interested in continuing its research on different topics and fields: quantitative and qualitative finances, migrants, different forms of poverty, sustainability, energy, education, mental health, bioethics, gender, pollution, different family topics, theological, philosophical and canonical issues and so on. In doing so we are close to one of the main principles of the Jesuits, the promotion of justice in our Universities. As it is stated in an important Jesuit document published in 2014 entitled «The Promotion of Justice in the Universities of the Society», "University education is a privileged place for the long-term promotion of justice in all the aspects of its work: the *formative education* it offers to students has governing influence on who they will be in the future; the *research* it carries out helps to analyze the structural causes of injustice and proposes ways to make significant improvements in the lives of the disadvantaged, including means of public advocacy". Following these orientations our researchers, with their own care about our world and their own concern with justice, offer their knowledge, intelligence, imagination and work to the service of our Institutes, Chairs and research groups. In doing so Comillas can both open itself to what is still new and unknown from our world, and question scientifically principles and values which can be evident for some other people.

Let me finish these references to the researchers and research in Comillas mentioning our interest and effort to focus also on different aspects of climate change and environmental issues. The publication in 2015 of Pope Francis' Encyclical Letter *Laudato Si'* helped us to increase our interest and concern on those important topics which regard to God, its creation, humanity and especially to the most vulnerable people of the world. As Pope Francis states in his own appeal at the beginning of the Encyclica, "The urgent challenge to protect our common home includes a concern to bring the whole human family together to seek a sustainable and integral development, for we know that things can change. The Creator does not abandon us; he never forsakes his loving plan or repents of having created us. Humanity still has the ability to work together in building our common home. Here I want to recognize, encourage and thank all those striving in countless ways to guarantee the protection of the home which we share. Particular appreciation is owed to those who tirelessly seek to resolve the tragic effects of environmental degradation on the lives of the world's poorest. Young people demand change. They wonder how anyone can claim to be building a better future without thinking of the environmental crisis and the sufferings of the excluded." *Laudato Si'* focuses on ecology, justice, solidarity; it focuses also, as we can read from LS 189 onwards, on how politics and economy in dialogue can contribute to human fulfilment.

Dear Eduardo and Robert, the mention of Pope Francis' Encyclica and of the important topics of climate change and environmental issues allows all of us to remember your expertise in those areas. Both of you have participated as keynote speakers in our Climate Finance Conference celebrated in Comillas yesterday and the day before. Eduardo and Robert, your speeches entitled «Water as a commodity in hydro power generation» and «CRISK, termination risk and green washing: Measuring Climate Risk Exposure in capital markets» were very much appreciated by the participants of the conference. In addition, you, Eduardo, have mentioned in your speech that in recent years you have dedicated part of your effort to study some financial aspects of climate change, sustainability and environmental and resource economics issues. Effort and studies made in collaboration with professors from Comillas. On your part, Robert, and as Professor Figuerola mentioned in her *Laudatio*, you are conducting the work of forming portfolios that synthetically hedge climate risk exposure. In addition, you have already shared with our students and with our professors in different seminars your concern on the difficulty to measure climate change, its consequences and their economic costs, as well as on the negative emission policies. You have also shared with us your understanding of Integrated Assessment Models which evaluate the economic consequences of climate change.

Dear Robert and Eduardo, your expertise in climate change and environmental issues is one of the reasons for the bestowal of the University highest recognition "Doctor honoris causa". Perhaps it is a very important one, but not the main one. Let me underline though the two fundamental reasons why you receive this special award today.

I have been talking in my speech about two important characteristics of Comillas, its research and the centrality of the students in our learning process and the role of our teachers and professors. Both of you are outstanding researchers and teachers. Let me mention, dear researcher Robert, your development of groundbreaking econometric methods that have transformed empirical analysis in Economics and Finance. Let me also mention the high value of the ARCH model, invented in 1979, that you developed for statistical modeling of time-varying volatility, and which allowed you to demonstrate that these techniques capture accurately the properties of many times series analysis. And let me finally make reference to the award of the Nobel Prize in Economics for your studies on volatility. While being with us in Comillas one year ago you stated that "in the markets, volatility was higher during the financial crisis. Also in the late 1990s, with the collapse of the technology sector [the dot-com crisis]. And, even further back, the Great Depression was an extremely volatile period for stocks. There are always periods of high and low volatility, and what really drives volatility is how fast people's expectations are changing: what they read in the news https://english.elpais.com/economy-and-business/2023-05-12/twitter-whipped-up-financial-panic-and-fueled-svb-failure-researchers-say.html and how that affects their views of the markets".

On your part, dear researcher Eduardo, we can remember again the beginning of your extraordinary academic career with so many excellent papers. In your own words "My work since has been rooted in mathematical modeling and an interest in stochastic modeling and uncertainty". We can also remember that you count yourself among the group of researchers who gave the initial push to what is now called *real options theory,* which is now attracting great attention from researchers belonging even to fields not directly in finance. We can finally remember your revolutionary contribution "Valuing American options by simulation: a simple least- squares approach", and the big amount of papers and book chapters in the main journals and publishing companies all over the world.

Let's move to the second important characteristic of Comillas already mentioned, the centrality of the students in our learning process and the role of our professors and teachers. If we look back at your careers, we can state that both of you are extraordinary professors, experts and masters of a good number of students. Professor Figuerola said about you, master Robert, that you have established an extraordinary legacy, marked by the creation of pioneering analytical tools, as well as your co-authorship and mentorship of numerous PhD students. Your significant influence has greatly enriched their professional and personal lives. You have also imparted your ideas and insights, and you have nurtured a generation of leading economists across the globe. How about yourself, master Eduardo? As Professor Corzo stated, Eduardo is an enthusiast and passionate professor. He has always been extremely generous in receiving young teachers and researchers becoming for all of them their best mentor. He is excellent at putting always the right questions. He is excellent too at giving the thorough and careful feedback to his students. In your own words, Eduardo, taken from your web from UCLA University, "I see my job, mainly, as teaching students how to think. The specific material, they'll forget. But if they learn to think they will learn to solve the problems they'll face later in their careers".

Dear Eduardo and Roberto, it is a tremendous honor for all the members of Comillas to bestow our Doctor *Honoris Causa* upon both of you. From now onwards you are full members of our academic community. Your gifts and talents for many academic activities have accompanied many of us during the last years. Your scientific excellence, especially in both teaching and research, has inspired a good number of professors and researchers from Comillas, and especially those of its Faculty of Economics and Business Administration. We are very happy today because our University, which is mainly a teaching and research University, is enriched and fortified with your skills and expertise in teaching and research. You make Comillas a better and more international University. This is really a great news for all of us. Thank you very much for that. At the same time, we count on both of you to help us to develop the new missions that our University has started to carry out in the last years, which in the interest of time I shall only list: the transfer of scientific and technological knowledge

to the productive fabric, the lifelong learning, the social leadership, the entrepreneurial spirit. Thank you very much in advance for all the help that we will receive from you in the future in all those different fields.

I am about to finish my speech. A week ago Robert, Eduardo, their families and some members of our academic community paid a visit to the Galería de las Colecciones Reales, The Royal Collections Gallery. That day we all were invited to take an extraordinary journey through five centuries of art and culture in a remarkable building. This gallery is an open window onto all the royal sites managed by Patrimonio Nacional (El Escorial, Aranjuez, La Granja, Yuste, Descalzas Reales and many more), but it also shows our efforts to research, restore, preserve and promote Spain's heritage. On Level -1, dedicated to the Habsburgs, the itinerary starts with the last of the Trastámara dynasty, showing how the Catholic Monarchs began the custom of royal collecting. One of the most memorable Habsburg reigns was undoubtedly that of Philip II, a great patron of the arts who launched many ambitious projects, including the iconic site of El Escorial. This floor also offers a rare glimpse of Madrid's origins: the remnants of the ninth century city wall. Level -2, dedicated to the Bourbons, explores themes such as music, royal factories and workshops, or the construction of the royal palaces of Madrid and La Granja. The end of the itinerary explains Patrimonio Nacional's role as custodian of this vast cultural legacy.

Comillas' history is not as long as Spanish's history under the Habsburgs and the Bourbons. In fact, and as I mentioned before, we were born 120 years ago in the small town of Comillas, in the North of Spain. Comillas though has a vast academic and university legacy. As well as Patrimonio Nacional plays an important role as custodian of the vast cultural legacy of the Habsburgs and the Bourbons, Comillas needs members of its academic community to become custodians of that legacy, to become its own "Patrimonio Nacional". Dear Robert, dear Eduardo, let me invite you to become members of the "Patrimonio Nacional" of Comillas. As new and full members of the Universidad Pontificia Comillas let me invite you to help us guard our academic and university legacy for many more decades. Be your wisdom and your inspiration the best companionship to all the members of our university, students, professors, staff and Alumni, in order to achieve that particular goal.

Thank you very much!

VII. Photo gallery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