The use of Mathematics in Economics and its Effect over a Scholar's Academic Career*
(Preliminar version: do not cite, do not mock.)

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Abstract

In this article, a database that characterizes the main socio-demographic features and the academic output of 438 scholars is presented. People surveyed is divided in two groups: A group of scholars chosen on the basis of them winning at least one of seven worldwide known awards in Economics, and a second selected randomly from the faculty of top 20 Economics Departments in the world. This research finds the link between a strong formation in mathematics, their use, and the probability of been recognized as a Famous Scholar in Economics. In this matter, results show that more mathematics has a negative impact on the probability of winning a Nobel Prize or becoming a famous scholar; however, mathematics has a positive effect on the probability of winning a Nobel when the scholar is already famous. Also, an analysis of the evolution of mathematics and empirical research in Economics through time is presented. Results show that Arrow and Debreu's (1954) article had a clear impact of the consolidation of an upward trend in the use of mathematics in Economics. Also, a structural break in the trend of the empirical works in Economics occurred when personal computers became available for most U.S universities.

Keywords: Nobel Prize, Mathematics, Economics, Reputation.

JEL classification numbers: B3, C14, C82, N01

All our mathematics is constructed. It is a construction we make in order to think about the world... [It] is the only way we have to think logically about things we observe...The book of Nature is not written in mathematics; rather, mathematics is the only language we know to explain nature logically.

Ingrid Daubechies

When you have mastered numbers, you will in fact no longer be reading numbers, any more than you read words when reading books. You will be reading meanings.

W. E. B. Du Bois

Politics is for the present, but an equation is something for eternity.

Albert Einstein

Mathematics is not about numbers, equations, computations, or algorithms: it s about understanding

William Thurston

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1 Introduction

For decades, the increasing use of formal methods in social sciences has generated controversy. Of these, economics has been the primary focus of criticisms. Particularly, most of the debate and criticism has centered on the so-called mathematization of economic theory, and the related bias towards formal methods in economics that could lead to a loss of substance and economic content in favor of rigor and form. The debate is ongoing and it is difficult to find absolute positions even within the most prominent expositors of either side. Nobel Prize recipients like Samuelson (1954), Debreu (1986), and Krugman (1998) have addressed the issue and have in general defended the use of mathematics. Others, like McCloskey, Katzner, Leamer & Solow (1991) and Lawson (2001) have been critical on the subject.

Additionally, it has been noted that leading universities and the students themselves regard mathematical knowledge as fundamental in the study of economics. In a survey conducted among graduate students in six leading universities in the U.S., Colander & Klamer (1987) reported that only 3% of students find a thorough knowledge of the economy very important for professional success, compared to 57% who considered excellence in mathematics as fundamental. However, Colander (2005) finds a change in this tendecy with recent data, where 9% of the students consider a thorough knowledge of the economy very important for professional success, while only 30% considered excellence in mathematics as fundamental. The main worry can be summarized in Kuttner (1985) claim that "departments of economics are graduating a generation of idiots savants, brilliant at esoteric mathematics yet innocent of actual economic life" (p. 21).

The motivation for this article arose from this growing concern about the overuse of mathematics. The central question is how mathematics affects the probability of winning a Nobel Prize in Economics, which can be considered as the most influential recognition in the field. In the article the determinants of the probability of becoming famous by the most important networks in economics are analyzed, and in particular how the use of mathematics or the mathematical background of the scholar affects those chances. For the analysis, wdatabase of 438 scholars divided into three groups was constructed. The first one has 64 individuals that have won the Nobel Prize in Economics; the second one has 205 individuals selected on the basis of them winning at least one of the following awards: John Bates Clark Medal (JBCM), Distinguished Fellowship of the American Economic Association (DF), Richard T. Ely Lecturer (RTEL), Foreign Honorary Member of the American Economic Association (FHM), President of the American Economic Association (PAEA) and President of the Econometric Society (PES) [1]); the third group has 169 scholars randomly selected from the academic faculty of the top twenty Economics Departments according to Ideas/Repec ranking of 2010. For the third group, the selection is restricted to academics with at least 'associate professor' position. These groups are labeled as Nobel Laureates, Famous Scholars, and Non-Awarded Scholars.

Taking into account the parameters by which the selection was made for each one of the groups, it is safe to say that the data base is made up mainly by scholars within the mainstream of economics. Although the term is quite loose and does not have a precise meaning, it refers in general to economics taught in prominent universities (Colander 2000).

For these authors, all the articles available in JSTOR[2] are compiled and reviewed. In order to assess the relative importance of mathematics in their work, the number of equations per paper and per footnote is counted, doing an independent count for the total econometric results (to differentiate

[1] JBCM (1947-2009), DF (1965-2009), RTEL (1962-2009), FHM (1975-2007), PAEA (1930-2010), PES (1931-2010). The sample window is explained by the starting time in which the prize is awarded and the time that the data was collected. Further information can be obtained in the appendix A.

[2] Although there are other databases like ECONLIT specialized in economics, three arguments make JSTOR the most convenient database for the purpose of this article:: 1) JSTOR contains articles written before 1900, allowing to have access to the academic production of the oldest scholars; 2) JSTOR also contains journals dedicated to other sciences and areas of knowledge different than economics; and 3) JSTOR contains journals that have been discontinued or completely absorbed by other publications.

between pure mathematics and quantitative or empirical methods) and the number of mathematical appendixes per paper[3]. Although similar methods have been used before[4], this paper contributes to the literature by constructing, for the first time, a database, that combines an objective measures of proximity to mathematics (average number of equations per paper, B.A. in mathematics and PhD in mathematics among others) and sociodemographic information of each of the authors revised.

The scholars' main socio-demographic and academic characteristics, including their country of birth, whether they are naturalized U.S. citizens, gender, their area in the PhD and other related control variables, are used to identify relevant features that shed light on the trend their academic production follows and to find whether there is a significant difference on the mathematics used between the Nobel Prize recipients and the rest of scholars in our sample.

As a general result, the use of mathematics only increases the probability of winning a Nobel Prize if the scholar is already famous, otherwise it reduces the probability of becoming famous or winning a Nobel Prize. Being famous as measured by academic standards is interpreted (in this article) as a person who has a deep understanding of economic theory and ideas that are socially accepted as brilliant contributions to the state of the art. Since mathematics is a natural language for scientific diffusion in economics, the probability of winning a Nobel Prize rises when there are brilliant ideas that are communicated through a language that other academics understand, and therefore, easy to disseminate. Winning any of the prizes stated above is considered a good proxy for being famous. These results are in line with a vision where formality and rigor should be accompanied by a solid understanding of the economic theory. The conclusions are robust to different econometric analysis.

This paper contributes to the literature in economics in at least four different ways. First, to the best of the authors' knowledge, a work as this one has never been made in extension and sample. The authors are not aware of any article in the literature which addresses these questions and answers them in the way this article does. Second, the database presented here fills an empty space in the literature. For the first time, there is a large data base of scholars that unites academic and socio-demographic information with the academic production in economics. This database has a great potential to test several hypotheses about what economists do and the role of mathematics in the history of the economic thought. Third, an outline of the mathematization in the XXth century is made, measured by the increase in the average number of equations per paper in our sample. There is statistical evidence that several structural breaks happened between 1920 and 1954. In particular there is enough statistical evidence to prove the popular belief that 1954 is the point in which the intensive use of mathematical tools in economics was consolidated with the publications of the Arrow and Debreu's seminal paper

[3]For this article, an equation is defined as any expression that has either variables or numbers, or both, on both sides, such as: $x0 = x1$, $z0 > z1$, $w \subset W$ and $p = 1$: What is considered an econometric table in this article is any econometric result in the form of a table, not a graph. Charts are not included because our intention is to measure the effect of using a strictly formal mathematical language. Although a graph is a functional construction and a mathematical tool in the strict sense of the word. The choice between writing an equation and using a graph has a substantially different effect on the measurement of the so-called "mathematization" of economics. A mathematical appendix is one where a theorem is explained, demonstrated or expanded. Data appendixes were not taken into account since they do not represent mathematical expressions.

[4]For example, Grubel & Boland (1986) found an increasing trend in the use of mathematics in the American Economic Review from 1950 to 1983, by counting the number of graphs, diagrams and tables of data as well as equations present in the publication. In a similar exercise, (Mirkowski 1991), tabulated the number of pages with mathematical discourse (*although he does not explicitly state what he considers mathematical discourse*) in every volume from 1887 to 1955 of four economic journals: the *Revue D'Economie Politique* , the *Economic Journal* , the *Quarterly Journal of Economics* , and the *Journal of Political Economy* . The author found that between 1887 and 1924 the journals devoted less than 5% of their pages to mathematical discourse. After 1925, however, about 20-25% of the pages were mathematical, when increasingly mathematical neoclassical articles occupied most of the pages. Debreu (1986) quantified the number of pages published per year by the five main periodicals treating mathematical economics (Econometrica, the Review of Economic Studies, the International Economic Review, the Journal of Economic Theory, and the Journal of Mathematical Economics) and found a phase of decline from 1930 to 1943, and then a period of "nearly exponential" growth (1944-1977) in which the number of pages grew at an annual rate of 8.2%.

"Existence of a Competitive Equilibrium for a Competitive Economy". Our results are also align with Debreu (1991) hypothesis where he states that during the period 1944-1977 there was a significant increase in the amount of pages published in journals related with mathematical economics. Fourth, probabilistic models are characterized for the probability of winning a Nobel Prize and being famous in terms of other awards and educational and socio-demographic background.

This paper is organized as follows: the next section presents the literature review where a brief history of the use of mathematics in economics is outlined and the main points in debate about the mathematization of economic theory. An analysis of the use of mathematics through time is made, and it disentangles some facts about the historic trend. Section 3 presents descriptive statistics of the sample, analyzing such things as geographical origins and scholars' academic formation. Section 4 presents the econometric analysis and the results. Finally, section 5 concludes.

2 Mathematics in Economics

The mathematics-economics debate is ongoing and a number of authors, both economists and non-economists, have addressed the subject. The incidence of mathematics in economics has undoubtedly increased, and nowadays advanced knowledge in mathematics is a necessity for any economist beyond the undergraduate degree.

Mirkowski (1991) argues that the perception that the use of mathematics in economics is a natural and inevitable result is a wrong one, "*but rather was characterized by two primary ruptures in the history of economic thought, episodes marking the inflection points in the rise of mathematical discourse*". According to him, the first endeavors into mathematical economics came from noticing the numerical character of prices, and the first economists to use mathematical economics ("precursors") looked explicitly to the physics of motion, which were referred to as "rational mechanics" in the 18th century, as a point of reference in their theorizing.

The first introduction of mathematics into economics came during the eighteenth century with authors such as Richard Cantillon and Adam Smith, although they were focused only on mathematical-verbal description with phrases that imply mathematical relationships such as "*lower or more than, or equal to*". Thomas Malthus, David Ricardo, and John Stuart Mill used mathematics in a more formal manner, using numbers, arithmetical procedures, and ratios in order to make inferences about economic behaviors. After about 1870 came the first of the two ruptures above mentioned. The incursion into political economy by scientists trained in physics, all familiar with the concept of equilibrium in a field of force, led them to link potential energy to the concept of "*utility*" and "*copied the physical mathematics literally term for term and dubbed the result mathematical economics*" (Mirowski (1991)). By this time the use of formal equations, algebra, calculus, geometry, and other basic mathematical tools was common.

During the nineteenth century, a second set of economists, including Johann Von Thunen, Herman Gossen, Augustin Cournot, William Jevons, Leon Walras, Carl Menger, and Vilfredo Pareto, started to use mathematical functions as a formal way to present economic arguments by using marginalist procedures as a methodology to present economic intuition. Cournot was the first one to use calculus in economic theory. In fact, Debreu (1984b, p 231) states that the publication of Cournot's Researches into Mathematical Principles of Wealth in 1838 symbolized the birth of mathematical economics.

The second rupture occurred between 1925 and 1935. The reason was, again, the entrance of scientists and engineers into economics, which included future Nobel recipients such as Frisch, Koopmans, Tinbergen, Allais and Arrow. They discovered that neoclassical theory was made up mostly of formal models previously mastered in physics, and, with only slight knowledge of the long tradition of economic theorizing, applied their mathematical techniques to the theory.

From this moment on, and particularly after World War II, the use of mathematics has intensified. Evidence of this is that in 1940 less than 3% of the pages of volume 30 of the American Economic Review included mathematical expressions, while in 1990, 40% of the pages of its eightieth volume include sophisticated math (Debreu 1991). Debreu also argues that mathematics is necessary in economics for its logical rigor, because it facilitates abstraction, and because it is an "*impartial spectator*" in the analysis of economic problems. The greater logical solidity of more recent analysis has contributed to the rapid contemporary construction of economic theory.

Natural or not, what this process has led to is a way of theorizing in which there is a separation of form and content, as Debreu has argued (1986, 1991). Before 1930, approximately, the "mathematical structure" of economic articles did not pass the test of having its economic interpretations removed. Nowadays, one can remove all economic interpretation and the mathematical arguments will still stand on their own. This logical rigor helps the cumulative process of knowledge, making it easier for researches to build on previous findings.

Although, there are many arguments both in favor and against the use of mathematics in economics, this article takes no side whatsoever. The results found here are merely trying to give an objective account of the use of mathematics in economics through history and the effect they have on a scholar's academic career.[5]

2.1 On the use of mathematics through time

The purpose of this section is to analyze how the use of mathematics and the production of empirical results have evolved through time. Using time-series for the period from 1894 to 2006, an analysis based on the trend of the average number of equations and the average number of econometric outputs published per article each year is proposed in order to identify possible structural changes. The path of these series is examined to establish which years are possible candidates as turning points in the trend. With this information a Chow's test is performed to verify the presence of structural changes at these time points.

Before showing the results, it is necessary to note that it is possible to have a natural bias towards articles published between 1930 and 2006. This can be seen in the fact that the mean amount of articles per year for this period is 103.7, while from 1894 to 1929 and from 2006 to 2010 is much lower. There are three plausible explanations for this. First, for the period before 1930 academic production in Economics was considerably less than for the previous years where Economics turned more popular. Furthermore, there was a trend to publish books rather than papers. Figure 1 also shows how since 1920 there is an increase in the average articles published per year. Second, compared with the post-war period, just a few journals were available for publication in Economics and mathematical Economics before 1940 (among them Quarterly Journal of Economics, American Econometric Review, Econometrica and the Review of Economic Studies). As Debreu states, few journals to publish imply less pages published (Debreu 1991). Third, it could be related with the availability of articles in JSTOR, especially for the latest period (after 2006) where the "moving wall" policy applies. The "moving wall" is defined as time period from 0 to 7 years, depending on the journal, between the last issue published and the last issue available in JSTOR.

Figure 1 shows that including observations after 2006 might lead to inappropriate conclusions regarding the trend of the time series. Thus, observations after 2006 are omitted. Given the "moving

[5]Mathematics has at least three important roles in economic theory argues Rader (1972). First, the production of mathematics is in part on accumulation from other sciences. Second, mathematics is a valuable aid in long sequences of reasoning where it is easy to make mistakes. Third, mathematics makes possible a great degree of generality than verbal or graphical methods of discourse. Nevertheless, there are economists who object to use mathematics and their objection may be summarized as Rader suggests in three statements: 1. Mathematical treatment implies quantification, which is impossible for the whole of economics –some variables are not measureable or observable; 2. The search for mathematic generality is a tedious enterprise that substitutes convoluted definitions and notation manipulation for new ideas; 3. A common question about the use of mathematics in economics is that, even where mathematics does apply, the use of given mathematics results can lead to perverse orientation of economic theory because the mathematic theory is developed along lines not relevant to questions of economic interest.

wall" the number of articles available at JSTOR for this period might be not a representative sample of the academic production for those years. For the years before 1930, the trend does not change if those observations are omitted, so they are included.

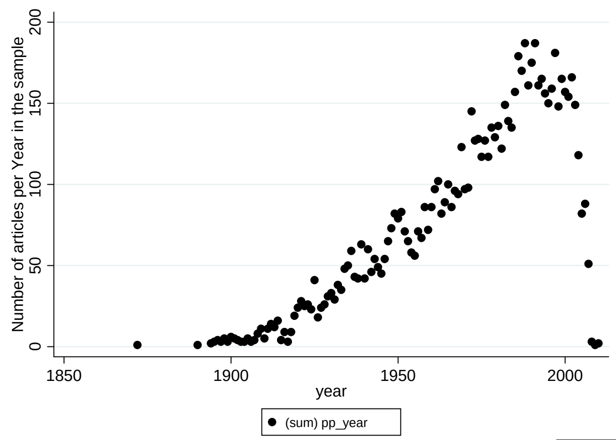

Figure 1: Number of articles published in economics through time. Source: JSTOR. Calculations: Authors.

To identify the turning points in the history of the mathematization of Economics by using a formal method, the trend of the series of equations per article per year (from now on, equations pa.py) is isolated using the Hodrick-Prescott filter to create a smooth representation that is more sensitive to long-term changes than to short[6]. Figure 2 shows how sharp have increased the slope of the trend. There are three interesting facts in figure 2; first it seems to be an increasing trend in general; second, in the 80's there is a period of a diminishing use of mathematics; and third, after the 90's the trend becomes steeper.

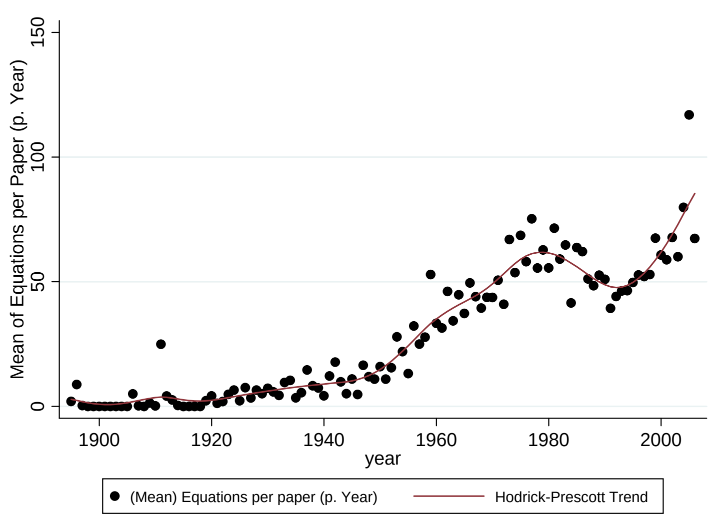

Figure 2: Use of Mathematical expressions over time. Source: JSTOR. Calculations: Authors.

Figure 3 shows that the density distribution on the average equations pa.py has a clear bimodal pattern. The two maximum are located around 10 and 45 equations pp.py, respectively. This is

[6]Following Backus & Kehoe (1992), the smoothing parameter is set at 100.

an interesting distribution as it signals the possibility of dividing the sample between two possibly independent groups. On one hand, a series of years whose average number of equations is relatively low, and another with a higher average. This distribution reinforces the hypothesis of one, or many, key years that mark one or more structural changes. It might suggest that given this separation, there are two types of individuals working in Economics. The ones that use more mathematics and the ones that uses less.

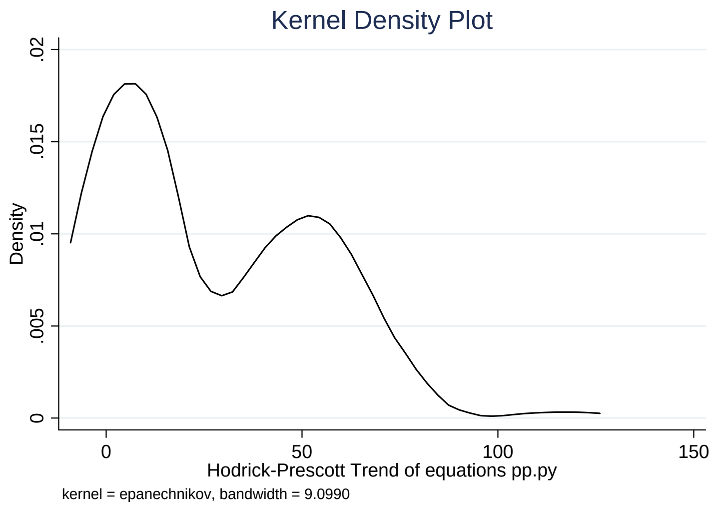

Figure 3: Density distribution of the average equations per paper per year

To fulfill the purpose explained in this section, the Box-Jenkins methodology is used to identify the time series of the Hodrick - Prescott trend of equations pa.py and then perform a Chow's Test by estimating several OLS models using as dummy variables for each starting year of the decades between 1920 and 2000. According to the unit root tests used[7], the first difference of the series is stationary. To identify the process the autocorrelation and partial autocorrelation functions are analyzed, and there is sufficient evidence to conclude that it is an AR (3) process[8].

As mentioned before, to test for the presence of structural breaks Chow's Test is used. The points to test are all the start points of the decades following 1920. The variables to test are dummies that capture the effect of whether the data is posterior to the reference year. The model is:

$$\begin{aligned} &equations_t = \\ &a_0 + a_1 equations_{t-1} + a_2 equations_{t-2} + a_3 equations_{t-3} + \\ &a_4 d_y + a_5 equations_{t-1} d_y + a_6 equations_{t-2} d_y + a_7 equations_{t-3} d_y + \epsilon_t, \end{aligned} \quad (1)$$

where d_y indicates whether the observations correspond to a year equal to or greater than the one that is being tested. Table 1 shows the results. The use of mathematics in Economics has continuously evolved since 1920. There is statistical evidence to say that there were structural changes in the trend of the series in 1930, 1940, 1950, 1960 and 2000.

[7] The test performed where the augmented Dickey-Fuller Test, the Elliot-Rothenberg-Stock efficient test for autogressive unit root and the Phillips-Perron test.

[8] The Akaike-Schwarz Information (AIC) criterion confirms that this is the best specification among the ones tested.

VARIABLES	(1) Equations	(2) Equations	(3) Equations	(4) Equations	(5) Equations	(9) Equations	(10) Equations
Equations (t-1)	2.701***	2.858***	2.820***	2.892***	2.969***	2.968***	2.937***
	(0.124)	(0.133)	(0.118)	(0.0870)	(0.0790)	(0.0246)	(0.0793)
Equations (t-2)	-2.550***	-2.823***	-2.747***	-2.885***	-3.024***	-2.971***	-2.959***
	(0.239)	(0.267)	(0.237)	(0.175)	(0.162)	(0.0503)	(0.164)
Equations (t-3)	0.838***	0.975***	0.933***	1.000***	1.061***	1.003***	1.030***
	(0.122)	(0.139)	(0.122)	(0.0888)	(0.0843)	(0.0261)	(0.0852)
y_1920	-0.0118						
	(0.0240)						
y_1920_L1	0.285**						
	(0.126)						
y_1920_L2	-0.455*						
	(0.245)						
y_1920_L3	0.181						
	(0.125)						
y_1930		0.0443*					
		(0.0233)					
y_1930_L1		0.129					
		(0.135)					
y_1930_L2		-0.183					
		(0.272)					
y_1930_L3		0.0452					
		(0.141)					
y_1940			0.0466**				
			(0.0209)				
y_1940_L1			0.161				
			(0.120)				
y_1940_L2			-0.249				
			(0.243)				
y_1940_L3			0.0828				
			(0.125)				
y_1950				0.0728***			
				(0.0252)			
y_1950_L1				0.0861			
				(0.0911)			
y_1950_L2				-0.107			
				(0.183)			
y_1950_L3				0.0132			
				(0.0930)			
y_1960					0.144***		
					(0.0538)		
y_1960_L1					0.00709		
					(0.0835)		
y_1960_L2					0.0371		
					(0.171)		
y_1960_L3					-0.0528		
					(0.0889)		
y_2000						3.306***	
						(0.637)	
y_2000_L1						-0.940***	
						(0.266)	
y_2000_L2						2.681***	
						(0.650)	
y_2000_L3						-1.833***	
						(0.401)	
y_1954							0.0868**
							(0.0345)
y_1954_L1							0.0426
							(0.0836)
y_1954_L2							-0.0362
							(0.172)
y_1954_L3							-0.0154
							(0.0895)
Constant	0.0311	-0.0132	2.72e-05	-0.0108	-0.00986	0.0136**	-0.0167**
	(0.0228)	(0.0213)	(0.0156)	(0.00939)	(0.00887)	(0.00667)	(0.00757)
Observations	109	109	109	109	109	109	109
R-squared	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Robust standard errors in parentheses
*** p¡0.01, ** p¡0.05, * p¡0.1

Table 1: Structural changes in the number of equations used over time. Source: JSTOR. Calculations: Authors

It seems to be a popular belief that 1954 is the point in which the intensive use of mathematical tools in Economics was consolidated with the publications of the Arrow and Debreu's seminal paper "Existence of a Competitive Equilibrium for a Competitive Economy". To prove whether this hypothesis is true or not, a Chow's Test with a dummy variable for 1954 is used. As expected, there is enough statistical evidence to conclude that with 99% of confidence, there was a structural change in 1954.

The main conclusion of the analysis of the evolution of the use of mathematics (measured as equations pa.py) in Economics is that it has increased consistently over time. However, this analyzes have not said anything regarding the evolution of the empirical work in the field. Given the development of more powerful statistical methods and new computational systems, it is natural that the quality and the quantity of empirical works in Economics increase over time. Though, have the amount of empirical works increased over time?

To answer this question, a similar procedure to that used for analyzing the evolution of the use of mathematics through time is used. A time series with average amount of econometric outputs per article per year (econometric outputs pa.py) is constructed and following the same methodology used in the previous analysis the process is identified as an ARIMA (2,2,2). Figure 4 shows how the use of econometric outputs has changed. A clear turning point in the trend can be seen around the final years of the fifties. Specifically, there is a structural break in the trend in 1957. Although there is no proper evidence to associate both events, 1957 is remembered as the year when IBM announced to the public its first personal computer[9]. The availability of more powerful computer equipment may have promoted the development of better and more efficient techniques to perform empirical research.

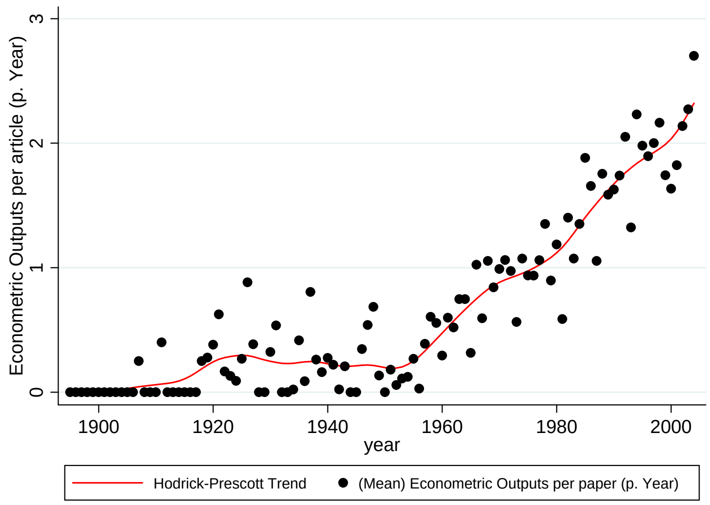

Figure 4: Average amount of econometric outputs per paper per year. Source: JSTOR. Calculations: Authors.

In this section, it is shown that the use of mathematics in Economics has increased consistently over time. The evidence seems to be consistent with the common wisdom that Arrow and Debreu's (1954) paper have a clear impact in the consolidation of the use of mathematics in Economics. Our results are also align with Debreu (1991) hypothesis where he states that during the period 1944-1977 there was a significant increase in the amount of pages published in journals related with mathematical Economics[10]. However, previous structural changes in 1930, 1940, and 1950 showed that this transformation initiated almost thirty years before than Arrow and Debreu's contribution. It is also shown, that the empirical work in Economics has also increased with time, the systematic increasing in the average number of econometric outputs per year per paper initiated in 1957, where a structural break was located; this coincides with the year when personal computers became available for most of the universities in the United States.

3 Data Analysis

This section describes some of the most important socio-demographic statistics of our sample. Our specific intention is to show a descriptive analysis to justify and explain the inclusion of certain control variables in the model. This analysis is also revealing because it shows several remarkable facts about the academic and geographical origins of the scholar included in the sample.

[9]http://www.columbia.edu/acis/history/610.html

[10]"1944 marked the beginning of a period of explosive growth in which Econometrica and the Review of Economic Studies were joined in 1960 by International Economic Review, in 1969 by the Journal of Economic Theory, and in 1974 by the Journal of mathematical Economics. In 1977, thee five periodicals together published over 5000 pages. During the period 1944-1977, the index more than double every nine years". Debreu, 1991, pp.1.

3.1 A Brief review of the sample

The database compiles some of demographical information on the scholars, such as gender, date of birth, and country of birth and whether they became naturalized U.S citizens. It also collected information on the academic background, namely, where (both university and country) they got their B.A, M.A or Ph.D. and what subject of study was chosen. In summary, our database contains many of the relevant measurable information that could explain award winning.

3.1.1 Generalities

The average number of papers per author in the database is 19.1, although there is a large variation present. The average number of pages per paper is 17.5 and of footnotes 15.8. Our variables of interest are the average number of equations per paper, 56.0; the average number of equations on footnotes, 5.3; average of mathematical appendixes per paper, 0.51; and econometric tables per paper, 1.75.

Table 2 shows descriptive statistics for three different groups in our sample: Nobel Laureates, Famous Scholars and Non-Awarded Scholars. Non-Awarded Scholars have, in average, more equations per page, equations on footnotes, mathematical appendixes and Econometric tables than scholars that have won any of the awards considered. Nonetheless, in average, scholars who have not won any award have less than a half of the papers published.

Nobel Prize Winners (N=64)						
	Papers	Pages per Paper	Equations	Equations per Foo.	Math Appe.	Econometric T.
Mean	25.88	15.97	50.12	3.4	0.42	0.52
SD	21.02	5.59	52.79	4.34	0.47	1.08
Min/Max	1/119	9.02/37.33	0/212.38	0/26	0/1.2	0/6.21
Famous Scholars (N=205)						
	Papers	Pages per Paper	Equations	Equations per Foo.	Math Appe.	Econometric T.
Mean	22.61	15.57	39.01	3.02	0.49	1.38
SD	19.17	5.06	61.62	7.13	0.77	3.6
Min/Max	1/156	6.45/50	0/478.31	0/86.27	0/9.09	0/37.39
Non-Awarded Scholars (N=169)						
	Papers	Pages per Paper	Equations	Equations per Foo.	Math Appe.	Econometric T.
Mean	12.2	20.45	78.91	9.03	0.58	2.69
SD	10.41	6.63	74.08	29.33	0.64	3.78
Min/Max	1/52	1.2/45	0/494	0/247	0/4	0/22.4

Table 2: source: JSTOR. Calculations: Authors.

Figure 5 shows a kernel desnity estimation, with bandwidth equal to 4, of the mean number of equations per page for different groups. As can be seen, Non-Awarded Scholars have a right hand tail bigger than everyone else, with Nobel Laureates in the middle and Famous Scholars with the smaller tail.

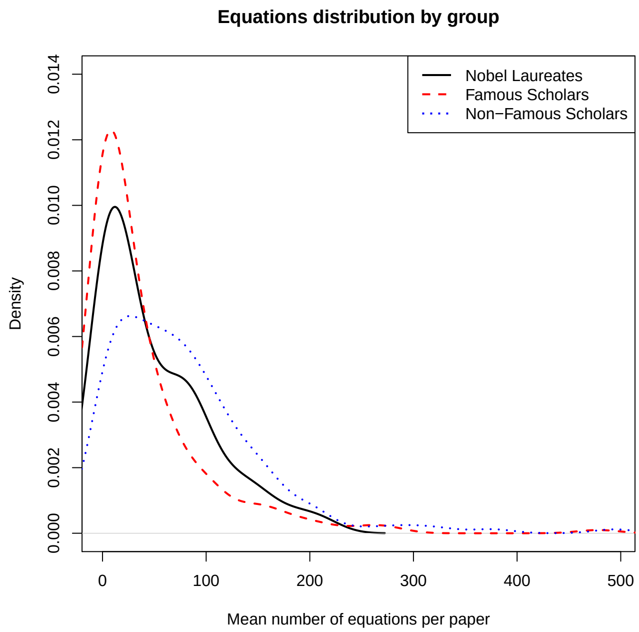

Figure 5: Kernel density estimation of the mean number of equations per group, with a bandwidth of 4

Table 3 shows the mean difference in the use of mathematics for different groups. Performing a t test for the difference in means one can see that Non-Awarded Scholars use a greater number of equations when compared to Nobel Laureates and Famous scholars. When a proportion test is used to test if the difference of the proportion of scholars above the median (e_i) is greater in one group that in other the result shows that there are less Famous Scholars than Nobel Laureates that use more equations than the median, but that there are in proportion more Non-Awarded Scholars over the median than anyone else. For example Nobel Laureates and Famous Scholars use on average 37.261 less equations per paper than Non-Awarded Scholars, also the proportion of scholars above the median is 0.332 greater for Non-Awarded Scholars than for Nobel Laureates and Famous Scholars. What these results indicate is that Non-Awarded scholars used more mathematics in average, but that restricting ourselves to Famous Scholars and Nobel Laureates the last ones use more equations on average.

Groups	Mean difference in the use of equations	Proportion difference of e_i
Nobel vs Famous	11.111	0.162^{**}
Nobel vs Non-Awarded	-28.794^{***}	-0.175^{**}
Nobel Vs Famous + Non-Awarded	-6.921	-0.037
Famous Vs Non-Awarded	-39.905^{***}	-0.351^{***}
Nobel+Famous vs Non-Awarded	-37.261^{***}	-0.332^{***}

Table 3: Mean difference in the use of equations by group. Source: JSTOR. Calculations: Authors.

Table 4 shows some socio-demographic characteristics of the scholars in our sample. First of all, the percentage of women in our sample is very low. Regarding Nobel Prize winners, the sample includes only to Elinor Ostrom (2009's award winner). Among the scholars with prizes different than Nobel, only 8 women have been distinguished with one or more of the prizes studied. In the control group, another 8 women were randomly selected. It is also notable the presence of U.S. citizens in the subgroups of the samples. For all cases, Americans constitute more than 40% of the sample. For Nobel winners, 67% are either U.S. born (53%) or naturalized (14%) citizens. Other countries with a high percentage of Nobel winners are England, Canada, Russia, Norway and Germany. These six countries (excluding naturalizations) account for almost 80% of the sample.

	% of Women	% U.S Citizens	% U.S B.A	% U.S P.hD
Nobel Laureates	1.56%	53.13%	57.81%	75.00%
Famous Scholars	3.90%	54.63%	58.54%	67.32%
Non-Awarded Scholars	5.03%	42.11%	62.86%	87.58%

Table 4: source: JSTOR. Calculations: Authors.

Table 4 also shows that most scholars have studied in U.S. based universities (for both B.A and PhD studies). It is noteworthy that Non-Awarded Scholars is the group with smallest proportion of American citizens, but with the greater proportion of scholars with a B.A. and PhD in the U.S.A. The main socio-demographic difference in the sample between groups is the year of birth of the scholars. As can be seen in the left graph of figure 6, Non-Awarded scholars are the younger group, while Famous Scholars and Nobel Laureates are very similar. However, if the age when Famous Scholars and Nobel Laureates received their first prize is compared with the current age of Non-Awarded Scholars the distribution is very similar (right graph of figure 6). This last comparison is reasonable because Non-Awarded scholars would become famous once they win their first prize.

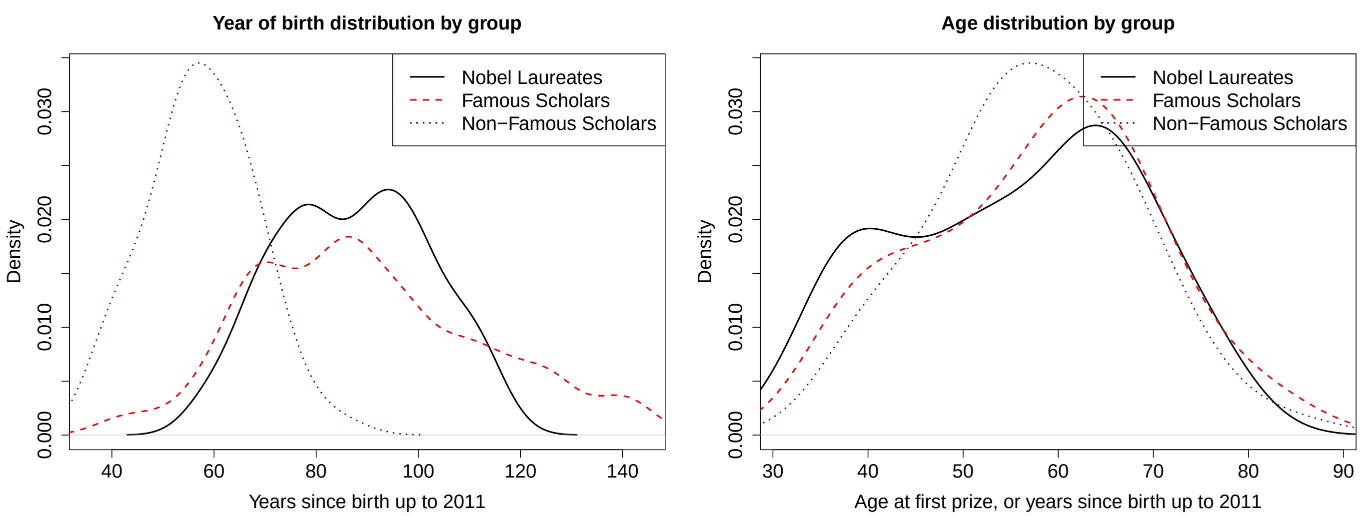

Figure 6: Kernel density estimation of year of birth/age per group, with a bandwidth of 5

According to table 5 Economics is the predominant subject of study chosen for B.A.'s and Ph.D.'s. However, there is an important presence of mathematics in the sample. Comparing the subsamples, it is clear that the Nobel Prize laureates have the largest percentage of scholars with a B.A. or a PhD in mathematics. With exception of the Nobel laureates, almost 70% of the scholars have a B.A in economics. For B.A, Harvard University is the one with more Nobel laureates, followed by University of Chicago and Yale University. Regarding PhD, again Harvard University has the most Nobel Laureates, followed by University of Chicago and Columbia University. A similar ranking is observed for those scholars who received other awards different to the Nobel Prize.

	% B.A economics	% B.A math	% PhD economics	% PhD math
Nobel Laureates	39.1%	32.8%	78.1%	12.5%
Famous Scholars	68.9%	22.3%	85.6%	5.2%
Non-Awarded Scholars	68.8%	17.4%	89.8%	3.7%

Table 5: source: JSTOR. Calculations: Authors.

3.1.2 Prizes

Table 6 shows the distribution of awards in our sample for the Nobel Prize recipients. In order to understand what the table says, consider the first row. PAEA is the row associated with the presidency of the AEA, the number in the parenthesis means the number of presidents in our sample. Eight is the number of Nobel Prize recipients (remember there are 64 recipients) which were presidents of the AEA after (or the same year) being Nobel recipient. Then there are 14 scholars which were presidents of the AEA before being elected as a Nobel recipient. The fourth column shows that 34.4% of all the Nobel winners were presidents of the AEA in any moment (before or after the Nobel announcement). The last column shows that 22.8% of the presidents of the AEA were Nobel recipients. Remarkably, the award with the largest percentage of Nobel winners is PAEA and the one with lowest one is FHM. As expected, none of the JBCM winners who have also won a Nobel, won the Nobel before winning the JBCM, since its an award given to scholars under 40. It is curious that 37% of the presidents of the AEA were elected as presidents after they won the Nobel. From the entire sample, 164 scholars (61.19% of our sample) have only won one award[11]. Most of them are DF (31.1%), followed by PAEA (25%) and PES (12%). The average age of winning a Nobel is 66 years, which is the second highest average age, after the DF. This means that, on average, every author who won a Nobel and another prize or prizes won the other prize first, except for the DF appointment.

Award	After or S.Y.	Before	% Nobels	% of Prize	Mean Age
PAEA (80)	8	14	34.4	27.5	61.33
RTEL (47)	2	10	18.8	25.5	61.10
DF(87)	1	16	26.6	19.5	68
FHM (39)	1	4	7.8	12.8	53
JBCM (31)	0	12	18.8	38.7	37.51
PES (71)	12	18	31.3	28.2	49.84

Table 6: source: JSTOR. Calculations: Authors.

4 Econometric Results

The objective of the econometric analysis is to determine the influence of academic formation in mathematics and the use of mathematics over the academic career of a scholar. The population in the database is divided into three sets. Nobel Laureates, Famous Scholars and Non-Awarded Scholars. The idea is to measure the effect of the use of mathematics on the probability of winning a Nobel Prize or becoming a Famous Scholar. To that end, a theoretical and methodologically way of approximating what is defined in this article as an academic formation in mathematics and use of mathematics will be

[11] There are 20 scholars with three awards. Some examples from this group which are Nobel recipients are: Robert E. Lucas Jr. (PAEA and PES), George J. Stigler (PAEA and RTEL) and Oliver E. Williamson (RTEL and DF). Nine scholars have won 4 awards. All of them were Nobel recipients. This group includes Paul A. Samuelson, Gerard Debreu and Amartya Sen. There are only 3 scholars in the exclusive list of recipients of 5 awards. All of them are Nobel recipients, JBCM, RTEL, PAEA and PES: James Tobin, Kenneth J. Arrow and Robert M. Solow.

described. Next, several discrete choice models are proposed in order to find which socioeconomic and academic factors are determinant in explaining the probability of being awarded the Nobel or being famous.

Before setting up the model, a more general debate must solve. When analyzing the incidence of academic formation and the mathematics used by scholars over the possibility of achieving success and academic recognition, it is necessary to solve a problem regarding the possible interaction of these with unobservable factors. The problems stems from the existence of a series of factors that because of insufficient information are non-observable, such as IQ and size and quality of the scholar's social network, that may influence the election of a Nobel winner or other prestigious award.

The argument goes as follows; it will be demonstrated that there are diverse ways of relating the mathematization of economic theory to a reputation or networking problem, and then it will be shown that a consequence of mathematization is sophistication and more rigor, and then, requires to have greater abilities. Among the reasons for which mathematics have become so important in economics, Katzner (2003) mentions: 1) a way to take advantage of human capital, and 2) a form of academic recognition. Katzner explains that given the characteristics of economics as an area of knowledge, it became a common meeting place for top level mathematicians who sought to apply their knowledge in different and original ways. Likewise, the appropriation of mathematics became a way to access the type of academic respect formal sciences such as physics and chemistry reflect. In this sense, academic recognition resulted from formalization and from the enforcement of the rigor and logical structure of economic reasoning. Katzner's interpretation reveals a profound connection between a mathematics formation, the intensive use of mathematics, and personal and academic qualities of individuals who work in economics and achieve academic success. The link between recognition and mathematics is direct. Given the great reception of mathematics as a tool of formalization, having an academic background in mathematics is a natural requirement to access a common language in the scientific community. Studying mathematics, and using them intensively, results in an advantage over other scholars because one knows in depth the language in which innovations are being disseminated. The power to publish in this language does this as well.

This last point about the dissemination of innovations is also related to Katzner's arguments. Since the first advances in mathematical economics were done by mathematicians and physical scientists, who made contributions outside their typical areas of study, and being these so successful, a steady specialization was unleashed. Not only is more mathematics done, but they are also more sophisticated.

Now regarding the model, mathematical formation and intensive use of mathematics, as variables, must be approximated since they are not observable. To restrict a mathematical formation to those who have a B.A. or a PhD in mathematics lacks rigor since there are others who studied with a curriculum with a high concentration of mathematics or those who learned mathematics by personal interest, however this is a preliminary approximation. The best technique then is to directly revise the sample and to establish a good measure about the use of mathematics. In this case, as was explained in the introduction, the equations per paper and per footnote were counted in each one of the articles of our sample. Variables regarding their academic formation were also included, in this case, the subject of study of BA's and PhD's. This way, there is explicit information on whether a scholar studied economics, mathematics, or another subject and which one. Dummy variables for those who have won any of the awards which classify a scholar as famous were also included. This allows a control for academic success, reputation and to some extent, for networking, given that with the interconnection of the prizes; it is possible that winning one of them results in a social referent that will allow a nomination for another prize. With respect to academic formation, a factor that should also be included is the quality of the formation received, nevertheless this variable is expected, and observed, to be non significant since almost every scholar on the sample had an outstanding education. An objective way of doing this is very complicated, and the information is scarce. A dummy variable reporting if the scholar studied at a department of economics classified as top 10 in 2010 according to the ranking at Ideas.org was used. One might think that the 2010 ranking does not reflect the past. This is true and having a time series to reconstruct the information would be ideal. Nonetheless, as this information is not available, this is a good approximation. Gender and year of birth variables are also included. Finally, a variable indicating whether the scholar is or not in the book "Who's who in economics" (Blaug & Vane 2003) was included; Although, this variable was not significant to several specifications.

Because the main objective is to explain the probability of winning a Nobel in Economics or becoming famous through the average equations per article and other proxy variables for the use of mathematics, a Probit model is used. Different combinations of variables where used to this end. An AIC maximization criteria was used to select the final variables of the econometric outputs which are in fact reported[12], this is the reason why there are different specifications for different models. Nevertheless, all variables were used to run every model and results were found robust.

The model to estimate is:

$$P(Y = 1|X, M) = \Phi(\beta X + \gamma_1 M) + \epsilon, \tag{2}$$

X is a set of controls, M measures the use of mathematics which can either be the average number of equations used, or a dummy variable, e_i which is equal to one if someone uses more equations than the median of the population under study. γ_1 will show the general effect of using more mathematics on the probability of belonging to group Y (which can either be the group of Nobel laureates or famous scholars or both).

Five different exercises where performed, using all the reasonable combinations of treatment and control groups: Nobel Laureates compared to Famous Scholars, Non-Awarded Scholars and both, Famous Scholars compared to Non-Awarded Scholars and Nobel Laureates plus Famous Scholars compared to Non-Awarded Scholars. Tables 7-11[13] show the results.

As can be seen in table 7, which comapres Famous Scholars to Nobel Laureates, more mathematics -measured as *equations*, e_1 and *math*- have a positive impact on the probability of winning a Nobel Prize. Results confirm that having won the JBCM raises the chance to become a Nobel Laureate, while other prizes have a negative effect, which can be the result of the fact that other awards are usually given when scholars are older and that the probability of winning the Nobel Prize is a concave function on the age of the scholars when they win their first prize. In other words, you need to reach certain age (or experience) in order to be eligible for a Nobel Prize, but after some threshold it might be to late. A variable for different birth periods is included because, as was noted before there is a

[12] All econometric outputs are available upon request.

[13] *Pages* is the mean number of pages of all the papers written by a scholar; *e_foot* is the average number of equations per foot note; *jbcm_d*, *df_d*, *fhm_d* and *pes_d* are dummy variables indicated whether a scholar has won the John Bates Clark Medal, has been a Distinguished Fellow, has been a Foreign Honorary Members or has been President of the Econometric Society; *top*10*_phd* is equal to one if the scholar did his PhD in a top ten university in 2010 according to 2010 REpEc ranking; *age_award* indicated the age when the scholar won his first award; *phd_math* and *phd_other* are dummy variables for a PhD in Mathematics and in an area different to economics; *math* and *other* indicate if a scholar did his undergraduate studies in mathematics or an area different to economics; *d*_1880, *d*_1900, *d*_1920, *d*_1940 and *d*_1960 are dummy variables that indicates whether a scholar was born in a twenty year period that start in the year indicated by the variable, for example *d*_1880 is equal to one if the scholar was born between 1880 and 1899; *dummy_age* is a dummy variable that indicates whether a scholar was born after 1934 - 20 years before the structural change in the use of equations (1954) - to capture a change in the way of doing economics; *se* is the mean number of econometrics outputs per paper; *pp* is the mean number of footnotes per paper; *equations* is the average number of equations per paper; *Famous* is equal to one if a scholar is famous by our definition, and *Namy* is the mean number of mathematical appendixes per paper per person; *e*1 is a dummy variable indicating whether a scholar has more equations per paper than the median for "Famous" and "Nobel Laureates" scholars; *e*2 has a similar meaning to *e*1 but using "Nobel Laureates" and "Non-Awarded" scholars in our sample to calculate the median; *e*3 has a similar meaning to *e*1 but using all scholars in our sample to calculate the median; *e*4 has a similar meaning to *e*1 but using "Famous" and "Non-Awarded" scholars in our sample to calculate the median; *e*5 has a similar meaning to *e*1 but using all scholars in our sample to calculate the median.

structural change in the mean number of equations per year, which means there is a change in the way economics is done. Having a PhD in an area different from mathematics and economics increases your chances of winning a Nobel Prize. *pages* has a positive effect which can be explained by the fact that there is space restriction in most journals, thus if you are allowed to extend yourself it must be because you are writing about something worthy.

Table 7: Nobel Vs Famous

	Model 1	Model 2	Model 3	Model 4
(Intercept)	-30.618^{***}	-30.064^{***}	-28.623^{***}	-27.103^{***}
	(6.541)	(6.031)	(6.123)	(5.397)
equations	0.008^{**}	0.008^{**}		
	(0.003)	(0.003)		
e1			0.948^{**}	0.965^{***}
			(0.329)	(0.275)
math	$0.498^{\dagger}$	0.472	0.466	$0.532^{\dagger}$
	(0.300)	(0.292)	(0.304)	(0.289)
phd_other	1.383^{**}	1.353^{**}	1.334^{**}	1.274^{**}
	(0.433)	(0.425)	(0.451)	(0.434)
gender	-1.650	-1.333	-1.466	
	(1.012)	(0.948)	(1.060)	
d_1900	1.397^{**}		1.521^{**}	
	(0.482)		(0.499)	
d_1920	1.260^{*}		1.160^{*}	
	(0.496)		(0.528)	
d_1940	1.077^{*}		0.938	
	(0.549)		(0.593)	
dummy_age		-0.144		-0.148
		(0.310)		(0.314)
jbcm_d	3.436^{***}	3.448^{***}	3.113^{***}	3.110^{***}
	(0.962)	(0.890)	(0.896)	(0.817)
df_d	-1.779^{***}	-1.417^{***}	-1.826^{***}	-1.408^{***}
	(0.345)	(0.306)	(0.361)	(0.312)
fhm_d	-0.970^{*}	$-0.753^{\dagger}$	-1.009^{*}	$-0.765^{\dagger}$
	(0.474)	(0.451)	(0.466)	(0.438)
paea_d	-0.802^{*}	-0.713^{*}	-0.830^{*}	-0.643^{*}
	(0.340)	(0.316)	(0.352)	(0.315)
age_award	0.747^{***}	0.769^{***}	0.686^{***}	0.680^{***}
	(0.183)	(0.169)	(0.172)	(0.152)
(age_award)^2	-0.005^{***}	-0.005^{***}	-0.004^{***}	-0.004^{***}
	(0.001)	(0.001)	(0.001)	(0.001)
pages	0.048	$0.049^{\dagger}$	0.080^{*}	$0.054^{\dagger}$
	(0.029)	(0.027)	(0.034)	(0.028)
se			-0.172	-0.142
			(0.117)	(0.108)
pp			-0.025	
			(0.017)	
N	252	252	252	252
AIC	179.305	184.802	178.364	183.891
BIC	391.071	368.332	418.366	367.422
$\log L$	-29.653	-40.401	-21.182	-39.946

Standard errors in parentheses

† significant at $p < .10$; $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$

Table 8 shows that there is little evidence that using more mathematics will lead to a Nobel Prize, when Nobel Laureates and Non-Awarded Scholars are compared because *equations* and e_2 have a negative effect. However, it seems that a mathematical formation, measured by *math*, does have a positive effect. This suggests that the use of mathematics will increase the probability of winning a Nobel Prize only if you are famous, but that a mathematical formation aids to the probability in either case(see tables 7 and 8). Being famous as measured by academic standards means that you have a deep understanding of economic theory and ideas that are socially accepted as brilliant contributions to the state of the art. Since mathematics is a natural language for scientific diffusion, the probability of winning a Nobel Prize rises when there are brilliant ideas that are communicated through a language that other academics understand, and therefore, easy to disseminate. The use of mathematics by itself is not a sufficient condition to achieve the Nobel Prize. *dummy_age* has a negative effect, which means that economist born before 1934 have a greater probability of winning the Nobel Prize. The average amount of econometric outputs (se) has a negative effect on the probability of success. This last result might be interpreted as follows, if someone only writes empirical papers they usually try to prove theories instead of proposing them, and academia does not recognize this kind of contribution. Finally, the average number of footnotes per page (pp) has a negative effect; it appears that deviation from the main text are not welcome in academia, while the number of equations per footnote (e_foot) has a positive effect.

Table 8: Nobel Vs Non-Awarded

	Model 1	Model 2	Model 3	Model 4
(Intercept)	2.593***	2.994***	2.162***	3.203***
	(0.619)	(0.656)	(0.534)	(0.691)
equations	−0.013**	−0.010*		
	(0.004)	(0.005)		
e2			−1.436**	−1.310**
			(0.437)	(0.500)
math	1.121*	1.332**	1.002*	1.350**
	(0.482)	(0.512)	(0.453)	(0.512)
other	0.608	0.609	0.506	0.657
	(0.399)	(0.419)	(0.398)	(0.437)
d_1940	−0.932*		−0.803*	
	(0.400)		(0.391)	
d_1920	0.158		0.499	
	(0.462)		(0.463)	
dummy_age		−2.141***		−2.248***
		(0.449)		(0.464)
namy	−0.573			
	(0.385)			
se	−0.233*		−0.250*	
	(0.113)		(0.123)	
pp	−0.109***	−0.104***	−0.102***	−0.113***
	(0.028)	(0.029)	(0.027)	(0.030)
e_foot	0.128**	0.097*	0.096*	0.095*
	(0.040)	(0.039)	(0.047)	(0.040)
N	116	116	116	116
AIC	98.564	80.127	97.460	77.379
BIC	208.707	157.228	196.590	154.479
$\log L$	−9.282	−12.064	−12.730	−10.689

Standard errors in parentheses
† significant at $p < .10$; $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$

Table 9 shows the results when Nobel Laureates are compared with everyone else (Famous and

Non-Awarded Scholars). The variable *Prize* is a dummy variable equal to one if the scholar won any of the seven awards excluding the Nobel Prize. Mathematics has a negative effect when measured as *equations* and $e3$, but it has a positive effect if you are an award winner. Once again, it seems that the more use of mathematics will lead to a higher probability of success in academia only if it goes hand by hand with a deep understanding of economic theory and with brilliant ideas. The effect of the variable *Prize* is negative, which can is the effect of most of the award winners not becoming Nobel Laureates. Having a B.A. in mathematics still has a positive effect on the probability of winning a Nobel Prize. Dummy variables for different periods of birth are includes, as well as *dummy_age* to control for the fact that there is a difference in the age distribution per groups. The average amount of econometric outputs (se) still has a negative effect. Finally, the average number of footnotes per page (*pp*) has a negative effect; it appears that deviation from the main text are not welcome in academia. Having a PhD or a B.A. in a subject different to mathematics or economics still has a positive effect.

Table 9: Nobel Vs Famous+Non-Awarded

	Model 1	Model 2	Model 3	Model 4
(Intercept)	-0.806	0.542	-0.520	0.461
	(0.558)	(0.398)	(0.559)	(0.490)
equations	-0.006	-0.004		
	(0.004)	(0.004)		
e3			-1.027^{*}	-0.919^{*}
			(0.408)	(0.396)
Prize	-1.322^{***}	-1.330^{***}	-1.691^{***}	-1.633^{***}
	(0.362)	(0.351)	(0.376)	(0.367)
Prize*equations	0.008^{*}	0.009^{*}		
	(0.004)	(0.004)		
Prize*e3			1.523^{***}	1.499^{***}
			(0.458)	(0.447)
gender	-1.018	-1.020	-1.084	-1.148
	(0.791)	(0.789)	(0.858)	(0.908)
math	$0.455^{\dagger}$	$0.421^{\dagger}$	$0.405^{\dagger}$	$0.379^{\dagger}$
	(0.233)	(0.224)	(0.236)	(0.230)
other	0.502^{*}	$0.420^{\dagger}$	$0.435^{\dagger}$	$0.398^{\dagger}$
	(0.229)	(0.220)	(0.235)	(0.228)
phd_other	0.858^{*}	0.989^{**}	0.928^{*}	1.060^{**}
	(0.364)	(0.359)	(0.374)	(0.374)
d_1900	1.428^{***}		1.470^{***}	
	(0.354)		(0.364)	
d_1920	0.951^{**}		0.903^{**}	
	(0.339)		(0.346)	
d_1940	0.427		0.362	
	(0.366)		(0.369)	
dummy_age		-0.768^{**}		-0.810^{***}
		(0.244)		(0.241)
se	$-0.163^{\dagger}$	-0.101	$-0.163^{\dagger}$	-0.126
	(0.091)	(0.082)	(0.092)	(0.088)
pages	0.032		0.034	0.033
	(0.023)		(0.022)	(0.022)
pp	-0.035^{**}	-0.023^{*}	-0.037^{**}	-0.035^{**}
	(0.013)	(0.011)	(0.013)	(0.013)
N	304	304	304	304
AIC	273.790	281.267	266.659	274.509
BIC	481.943	444.816	474.813	452.926
$\log L$	-80.895	-96.633	-77.330	-89.254

Standard errors in parentheses

† significant at $p < .10$; $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$

Table 10 shows that an increase in the use of mathematics, when measured as $e4$, appears with a lower probability of becoming famous. This means that mathematics is not what makes a scholar famous, but good ideas. This goes hand in hand with the idea presented before that the more use of mathematics will lead to a higher probability of success in academia only if it goes hand by hand with a deep understanding of economic theory and with brilliant ideas. Also, a PhD or a B.A. in an area different to economics or mathematics reduces the probability of becoming famous, which compared with the results in table 7 is interesting. It seems that studying an area different to economics only gives you an advantage once you are famous. This can be interpreted as follows, having a different area of study might help you bring new ideas into the field, but this only helps if you are famous, which means you have a deep understanding of economic theory and can take advantage of this. *pages* has now a negative effect, this can be explained by the fact that the journals with the tighter space restriction are the most important ones while less prestigious journals are laxer about space restrictions, thus *pages* only has a positive effect if you publish in the top journals, and has a negative effect otherwise. The average amount of econometric outputs (se) still has a negative effect on the probability of success. Finally, *dummy_age* has a significan effect in the model. Therefore, the age effects of the scholars are controled.

Table 10: Famous Vs Non-Awarded

	Model 1	Model 2	Model 3	Model 4
(Intercept)	3.042***	3.834***	3.291***	4.293***
	(0.536)	(0.550)	(0.566)	(0.619)
equations	−0.004*	−0.003†		
	(0.002)	(0.002)		
e4			−0.778**	−0.647*
			(0.262)	(0.265)
other	−0.638*	−0.328	−0.676*	−0.450
	(0.307)	(0.304)	(0.311)	(0.310)
phd_other	−0.309	0.192	−0.274	−0.007
	(0.734)	(0.700)	(0.784)	(0.726)
	(0.026)	(0.024)	(0.026)	(0.026)
gender	−0.308	−0.238	−0.347	−0.330
	(0.487)	(0.473)	(0.490)	(0.481)
d_1900	5.388		5.227	
	(202.205)		(201.016)	
d_1920	0.894*		0.977**	
	(0.358)		(0.370)	
d_1940	−0.212		−0.069	
	(0.280)		(0.294)	
dummy_age		−1.652***		−1.438***
		(0.340)		(0.360)
se	−0.173**		−0.212***	−0.183**
	(0.063)		(0.063)	(0.061)
pages	−0.108***	−0.095***	−0.110***	−0.100***
N	245	245	245	245
AIC	178.278	177.842	172.834	166.170
BIC	318.328	275.877	312.885	278.210
$\log L$	−49.139	−60.921	−46.417	−51.085

Standard errors in parentheses

† significant at $p < .10$; $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$

Finally, table 11 shows the result when the group of Nobel Laureates and Famous Scholars is compared to Non-Awarded Scholars. If success in economics academic career is defined as being considered famous (under our criteria) or to win a Nobel Prize, once again, more mathematics by itself is not enough to success in economics, and can in fact have a negative effect. It also shows that a mathematical formation, measured by *math* still has a positive effect. It seems that understanding mathematics is necessary but not sufficient to achieve academic success. This might be the result of mathematics being a natural language for scientific diffusion. Once again (*pp*) has a negative effect; it appears that deviation from the main text are not welcome in academia. Also, the average amount of econometric outputs (se) has a negative effect on the probability of success.

Table 11: Nobel+Famous Vs Non-Awarded

	Model 1	Model 2	Model 3	Model 4
(Intercept)	3.110***	3.945***	3.262***	4.326***
	(0.462)	(0.556)	(0.484)	(0.616)
equations	−0.009***	−0.005†		
	(0.002)	(0.003)		
e5			−1.129***	−0.916**
			(0.280)	(0.299)
math	0.771*	0.897**	0.769*	0.935**
	(0.319)	(0.329)	(0.311)	(0.326)
gender	−0.349	−0.163	−0.482	−0.281
	(0.432)	(0.471)	(0.435)	(0.484)
d_1920	0.413		0.534	
	(0.322)		(0.330)	
d_1940	−0.711**		−0.570*	
	(0.251)		(0.260)	
dummy_age		−1.854***		−1.853***
		(0.347)		(0.361)
e_foot	0.055*	0.043†	0.046*	0.045*
	(0.022)	(0.022)	(0.020)	(0.019)
se	−0.137*		−0.141*	
	(0.068)		(0.070)	
pages	−0.048*	−0.050†	−0.051*	−0.052†
	(0.024)	(0.027)	(0.024)	(0.028)
pp	−0.052***	−0.055**	−0.052***	−0.062***
	(0.015)	(0.017)	(0.015)	(0.017)
N	309	309	309	309
AIC	202.623	177.600	196.872	170.970
BIC	351.957	297.066	346.205	290.436
$\log L$	−61.312	−56.800	−58.436	−53.485

Standard errors in parentheses
† significant at $p < .10$; $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$

4.1 Propensity Score Matching

There is another way of performing a similar analysis, and it is by means of Propensity Score Matching (PSM), which enables an unbiased calculation of the treatment effect in observational experiments where there is no randomization of the group assignments for the subjects. This reduces the noise brought by other variables and isolates the treatment effect. By using PSM, one can find if the number of equations used by a group with characteristic X is substantially higher than the number used by people without that characteristic. The idea is to pair people from group with characteristic X with someone that it is almost identical as them, except for the fact that he does not has the specific characteristic X. The difference between the numbers of equations used by these two individuals is measured, and finally the average difference is calculated. In other words, assume there are two scholars which have the same probability of winning the Nobel Prize, assume one of the actually won it and the other one does not. It is desirable to know if the difference among these two scholars can be explained by the number of equations they used. The mathematical expression that summarizes this idea is:

$$E(Equations^1|X = 1) - E(Equations^0|X = 1) \quad (3)$$

The first term is the number of equations used by people from group X, the second the number of equations used by someone who is a perfect candidate to be in group X, except for the number of equations he indeed uses. Nearest neighbor matching is used with an underlying probit model that used as explanatory variables: gender, the PhD dummies, the BA dummies, the mean number of footnotes per paper and the mean number of econometrics outputs per paper, and the dummy variables for the years of birth, which are the main socio-demographic and academic variables in the data base.

The estimated difference for different groups is shown in tables 12. The analysis is performed with and without bootstrapping[14] methods to calculate its standard error; however the results are very similar, with the exception of the mean difference between Nobel and Non-Awarded being significant to at a 5% level. Only the standard errors without bootstrapping are presented. As can be seen Nobel Laureates use more equations on average than Famous Scholars, and Non-Awarded Scholars use more equations than both Famous Scholars and Nobel Laureates,

	Nobel vs Famous	Nobel vs Non-Awarded	Nobel Vs Famous + Non-Awarded	Famous Vs Non-Awarded	Nobel + Famous vs Non-Awarded
Mean Difference	$30.90^{\dagger}$	-24.10	4.52	-40.50^{***}	-38.70^{***}
SE	17.10	16.80	8.91	13.40	14.10
Number of observations	252.00	116.00	304.00	240.00	304.00

† significant at $p < .10$; $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$

Table 12: PSM without bootstrapping

As a general conclusion of both of the econometric exercises performed before, the use of mathematics only improves the probability of winning a Nobel Prize if you are famous (table 9). Otherwise it seems to reduce the probability of both winning a Nobel Prize and any of the awards mentioned before (table 11). It also seems that a mathematical formation is desirable in either case. The following explanation is proposed: one can think of famous scholars as people with a deep understanding of economic theory and with ideas that are socially accepted as brilliant, this allows them to change paradigms and formulate new methods; since mathematics is a natural language for scientific diffusion, the probability of winning a Nobel Prize rises when there are brilliant ideas that are communicated through a language that other academics understand. As a final remark it appears that being an empirical researcher, as measured by the average number of econometrics outputs (se) has a negative effect on the success of someone's academic career (tables 10 and 11). This last result might be interpreted as follows: if someone only writes empirical papers they usually try to prove theories instead of proposing them. Usually, revolutionary theories are the ones that have a higher impact on someone's academic career and not empirical corroborations.

5 Conclusions

The Nobel Prize is by itself the highest recognition granted by the scientific community to researchers whose contributions are considered to be worthy and have a high impact over the accumulation of research and knowledge. In what extent the mathematics used by these winners is an important factor in order to be worthy to receive the award is a difficult question to answer. However, there is enough statistical evidence in order to start to think about these matters more seriously.

The results are reconciled in the following way: A clever person with tenure can be recognized in the scientific economic community thanks to its brilliant, innovative, creative and challenging ideas, not

[14]The standard error is calculated without taking into account that the propensity score is estimated, so a bootstrap estimator is introduced, with 5,000 simulations, for it. Nevertheless, it is not clear if bootstrapping is appropriate in this context.

to empirical corroborations. Formalization through the use of mathematics it is a way to disseminate these ideas over a greater segment of the community. As a result of this combination, the person might be seriously considered for the Nobel Prize committee.

Apart from defending or attacking the mathematization of economics, it is important to stress its power for the formalization and universalization of knowledge. There are several for and against arguments for the extreme formalization of the economics. However, our data base has presented results that go beyond political or ideological issues. The possible interpretations of our results concern this article. The authors do not believe that more mathematics is better, but apparently if you are already a known scholar in the prestigious economic worldwide network and you are interested in being recognized with a Nobel Prize, you can increase your probability of winning one by publishing good papers with intense mathematical content.

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A Awards

The goal of this section is to explain and justify the election of seven particular awards in economics as proxies of academic success. The authors are aware that there are hundreds of academic prizes that are awarded in recognition to great contributions to economic thought and research in economics. However, the seven awards proposed here are the most important and distinguished and convey well the concept of academic success. Also, many other prices are very recent, which could induce noise in our econometric results.

The best known award in Economics is undoubtedly the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel, commonly known as the Nobel Prize in Economics. The Presidency of the American Economic Association is also included and different awards and honors given by this association: the John Bates Clark Medal, the Distinguished Fellow and Foreign Honorary Member distinctions and the appointment as Richard T. Ely Lecturer. Finally, the Presidency of the Econometric Society is included. This selection allows the inclusion of scholars from different countries.

Among prizes not included are: Yrjö Jahnsson Award, which can is comparable to the JBCM but in Europe, it is not used because it has only been given since 1993; The Grossen Prize Bianual and The Nakahara Prize, which are given to the most prominent economist under 45 in Germany and in Japan respectevly, are not included because they only been given since 1997 and 1995; The Frisch Medal given by the Econometric Society for research published in Econometrica during the previous five years, is not included because it has only been given since 1978 and it is award for a single paper and not for a series of academic contributions. The Royal Economic Society Prize has been given since 1902. The only reasong why it is not included is because most Nobel Laureates are U.S. citizens or are naturalized U.S citizens.

Next, a brief description of each one of the prizes is presented and their relevance with the election of the Nobel Prize winner.

A.1 The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel (1969-2009). (Nobel Prize in Economics)

On 1968, the Central Bank of Sweden created a special award to commemorate its tercentenary anniversary. The award recognizes scholars who make the most relevant and significant contributions to the economics field and is awarded by the Royal Swedish Academy of Sciences under the same principles of a Nobel Prize. Each year a committee specially set up to analyze and filter the nominations (receiving between 200-300 nominations). Then, the committee presents its selection to the Social Science Class of the Academy who suggests a Laureate to the entire Academy. The entire Academy meets to take the final decision. (Lindbeck, 2001).

Up to 2009, the Nobel Prize in Economic Sciences has been awarded forty-one times to sixty-four scholars. The laureates belong to a wide socio-demographic group, but with common academic characteristics. The most remarkable characteristic is that until 2008, all the laureates were men. In 2009, Elinor Ostrom became the first woman to receive the Nobel Prize in Economic Sciences. As can be seen in the review of the database, most of the laureates were born in the United States or became naturalized U.S. citizens . The exclusive list doesn't include Latin American or African scholars, as well as scholars under the age of fifty.

The sixty-four prizes have awarded specific contributions and life-time contributions. According to Lindebeck (2001), the Academy has sought to award "particularly important contributions" early and also chronologically, that is, giving prizes following the order of the contributions. Furthermore it has included different views of the world and different methods of analysis, taking a pluralistic approach to economics when selecting winners. To regard a contribution as "worthy" of the prize they take into account the impact it has had on economics as a whole, its originality and its practical importance. The selected contributions, in many cases, just happen to be the initial steps that led the development of knowledge in many areas of the economics. These contributions are also considered to have an impact on society and public policy.

A.2 Presidency of the American Economic Association (1930-2010)

The American Economic Association (AEA) was established in 1885, with the objective of promoting and consolidating the study of political economy and the economic phases of political and social questions (Bell, 1953). Since then, the fellowship has founded three of the most recognized journals, and its member list includes names like Milton Friedman, Paul Samuelson and Robert Solow, among others. With time, the tradition and the academic reputation of its members made the AEA one of the two most important academic societies in Economics, the other one being the Econometric Society. Inside the AEA the most important honor is the Presidency of the association; the candidates are always American members of the economic elite, including many Nobel award winners. Some statements of famous economists reflects the importance of being president of the AEA, for example, William Vickrey (President in 1992) stated "*Becoming the group's president is the greatest tribute, short of the Nobel prize, that an economist could receive*" referring to the presidency of the AEA. (New York Times, Jan 4, 1992).

Although the Association was established in 1885, only the presidents from 1930 on are choosen, in order to make our data comparable with the other awards. Also, this period of time is very appropriate since the election process of the Nobel winners is intended to choose scholars who had made lifetime achievements and does not allow to prize dead people. Almost four decades (1930-1968) seems an adequate period of time to consolidate the academic work of a scholar as a contribution to economic thought worthy of winning the Nobel Prize.

Since 1930, eighty members have been elected as Presidents and twenty-two of them are also Nobel Award winners. Among those who also won the Nobel award, only eight of them were elected as Presidents of the AEA after they won the Nobel Prize. On average, it takes five years for a President of the AEA to win the Nobel Prize since he was elected President of the association. Since 1930, only two women have been elected as presidents, this is less than three percent of the total elected presidents.

A.3 John Bates Clark Medal (1947 - 2009)

The John Bates Clark Medal (JBCM) was created in 1947 by the Executive Committee of the American Economic Association to honor "*that American economist under the age of forty who is adjudged to have made a significant contribution to economic thought and knowledge*" (American Economic Association, 1948). The selection and evaluation of candidates is led by a special committe exclusively created for this purpose. The Committee is composed by representatives selected from different parts of the country and different schools of thought. The Committee is intended to select and review the profiles and curriculums of several scholars worthy of the award. The whole list is reduced to three to five names. These candidates are then submitted to another committee, the Electoral Committee. This one is composed of eighteen members, all of which are members of the Committee of Honors and Awards and the Executive Committee.

Thirty scholars from our sample have won the medal; among them twelve are also Nobel Prize recipients. On average, it takes twenty two years to be a Nobel award winner after you have been elected as JBCM winner. As of 2009, the Medal will be awarded annually (it was awarded bi-anually before 2009), this decision was likely taken "*to recognize the fact that the field, and its personnel, have grown significantly since the 1940s*" (New York Times, January 2, 2009) and many went unawarded. As was stated before, almost 40% of the total winners of the medal have also won the Nobel Prize. This statistic has made the JBCM a commonly used predictor of the future Nobel laureates. Statements like "*Another indicator of a possible future Nobel laureate is being recipient of the John Bates Clark Medal*" (Zahka, 1992) or "*The Clark is often a harbinger of things to come*" made by the founder of the world famous Marginal Revolution blog, Tyler Cowen, in 2009, provide evidence of this. For our sample only one woman has been chosen as recipient of the Medal, Susan Athey.

A.4 Richard T. Ely Lecturer (1962-2009).

The AEA holds an annual meeting to present papers on general economic subjects. In 1962, it instituted the Richard T. Ely Lecture, as the main address of the meeting, in honor of one of the founders of the AEA. The list of former lecturers includes Kenneth Arrow, Stanley Fischer, and Simon Kuznets, among others. A proof of the high distinction of this appointment, is that more than a quarter of the lecturers have also been Nobel Prize Laureates. Taking into account that since 1962, forty-seven scholars have been appointed as Richard T. Ely Lecturers, ten of them would later win the Nobel Prize and two were elected as lecturers having already won the Nobel Prize. For those then scholars, it took on average eight years to win the Nobel after being elected as lecturer. Less than the five percent of the lecturers have been women. Scholars from all over the world are considered for this prize, so it is important for our sample because it includes data from non-American scholars, since the seven prizes considered in this paper are those granted by the AEA, most of them only for Americans.

A.5 Foreign Honorary Members (1975-2007).

As was just stated, most of the awards and appointments given by the AEA are for American economists only. However, each year the AEA recognizes the contributions of foreign scholars electing tem as Foreign Honorary Members (FHM). Along with the RTEL, and the Presidency of the Econometric Society, the FHM is our source of information about successful foreigners (defined as non-american scholars).

Since 1975, thirty-nine scholars have been elected as Foreign Honorary Members. The list includes names as Jean Tirole , Robert Aumann and Amartya Sen. From those thirty-nine, five are also Nobel Prize Winners and none of them are women. On Average, it took ten years to win the Nobel award after a FHM distinction. There is only one exception, Reinhard Selten, who won the Nobel Prize in 1994 and was elected as FHM in 1995.

A.6 Distinguished Fellow (1965-2009).

The award of Distinguished Fellow (DF) is given by the American Economic Association to high profile and recognized economists in the United States and Canada. In contrast to the JBCM, it is not subject to age restrictions. The award was instituted in 1965 and since then, eighty-seven economists have been recipients. Twelve of these have been awarded the Nobel Prize in Economics, all of them after being granted the DF honor. On average, the Nobel Prize winners received this prize eight years after the DF appointment. Compared with the other awards considered in this paper, the DF is the prize that includes most women in its list of winners, of a total of eighty-one fellows elected, three of them have been women, that is only 3.7%.

Some references to the DF distinction in the literature are: "*There are two other AEA awards of significance. One is to be selected a Distinguished Fellow, the other is to be selected as the Richard T. Ely lecturer at the annual meeting of the Association*" (Zahka, 1992). Herbert Simon (1991) also wrote "*The year 1976 brought a more surprising event: my election as a Distinguished Fellow of the American Economic Association. In view of my inactivity in the association (in fact, I had never been even a member), I had to suspect that my selection was another step on the way to a Nobel nomination. At the AEA national meeting, where I accepted the award, Albert Ando hinted as much. Kenneth Arrow, evidently the moving spirit behind my nomination for the AEA's election, had to educate the younger economist on the selection committee on who I was and on my standing as a Fellow of the Econometric Society*".

A.7 Presidency of the Econometric Society (1930-2010).

In 1930, by initiative of Irving Fisher and Ragnar Frisch, the Econometric Society was founded as "*an international society for the advancement of economic theory in its relation to statistics and mathematics*" (Aide Memoire, 2008). According to the society's Constitution, its main object is "*to promote studies that aim at a unification of the theoretical-quantitative and empirical-quantitative approach to* *economic problems and that are penetrated by constructive and rigorous thinking similar to that which has come to dominate in the natural sciences*" (Gordon, 1997).

Today, the Society has more than five hundred fellows, and is globally recognized as one of the two most prestigious academic societies in economics. Its reputation was built over the years by the quality of its publications, meetings and fellows. The most important publication of the society is *Econometrica*, which was founded in 1933, and is well known by the scientific rigor and the high academic level of its content. The Society has two other journals, *Quantitative Economics* and *Theoretical Economics*, the last one under the Society's management since 2009.

Being elected as president or fellow of the Society is considered a great honor by most of the members of the economics profession. This election recognizes the contributions and achievements of the elected scholars (Hamermesh & Schmidt, 2003). Before 1960, the Fellows and the officers of the Society were elected by the Council of the Society; but now, they are elected by mail ballot of the active Fellows. The Society's Constitution does not allow the election of two president of the same region on two consecutive years. Thus, the society's presidents in consecutive years are rotating between the following six regions: North America, Europe, Latin America, Australasia, Far East, and India-Southeast Asia, although only scholars from the U.S., Israel, Japan and some European countries have been elected as presidents (Gordon, 1997). Many of the former Presidents of the Society have been elected as Nobel winners. This exclusive list includes names like Kenneth Arrow, Robert Lucas, and Robert Solow among others. Although there are many Nobel winners who have been PES it is important to clarify that the criteria for electing a scholar as PES or Nobel as well as the council who elects them are very different, so there is no endogeneity problem regarding these two prizes.

B Scholars

The following table shows all the scholars in our data base. The authors are organized in alphabetical order by group. The first column contains Famous Scholars, followed by Non-Awarded Scholars and Nobel Laureates.

Table 13: Scholars in the data base.

Famous	**Non-Awarded (Yet)**	**Nobel Laureate**
Abba P. Lerner	Alan J. Auerbach	A. Michael Spence
Abram Bergson	Alan Manning	Amartya Sen
Alan S. Blinder	Albert Marcet	Bertil Ohlin
Alan W. Heston	Alberto Alesina	Clive W.J. Granger
Albert B. Wolfe	Alberto Bisin	Daniel Kahneman
Albert O. Hirschman	Alessandro Lizzeri	Daniel McFadden
Alexander Gerschenkron	Alvaro Sandroni	Douglass C. North
Alexander K. Cairncross	Alvin E. Roth	Edmund S. Phelps
Alfred E. Kahn	Andrew Caplin	Edward C. Prescott
Alice M. Rivlin	Andrew F. Newman	Elinor Ostrom
Allan H. Meltzer	Andrew Postlewaite	Eric S. Maskin
Alvin H. Hansen	Anthony J.Venables	Finn E. Kydland
Alvin S. Johnson	Antoine Bommier	Franco Modigliani
Andrei Shleifer	Antoine Faure-Grimaud	Friedrich A. von Hayek
Andreu Mas-Colell	B. Douglas Bernheim	Gary S. Becker
Andrew F. Brimmer	Balazs Szentes	George A. Akerlof
Angus Maddison	Barton L. Lipman	George J. Stigler

Continued on next page

Table 13 – continued from previous page

Famous	**Non-Awarded (Yet)**	**Nobel Laureate**
Angus S. Deaton	Benjamin Friedman	Gerard Debreu
Anna J. Schwartz	Bent Nielsen	Gunnar Myrdal
Anne O. Krueger	Botond Köszegi	Harry M. Markowitz
Anthony B. Atkinson	Brian A. Jacob	Herbert A. Simon
Ariel Rubinstein	Bronwyn H.Hall	James A. Mirrlees
Armen A. Alchian	Bruce Greenwald	James E. Meade
Arnold C. Harberger	Bruce Preston	James J. Heckman
Arnold Zellner	Bruno Biais	James M. Buchanan, Jr.
Arthur F. Burns	C. Fritz Foley	James Tobin
Arthur L. Bowley	Calestous Juma	Jan Tinbergen
Arthur S. Goldberger	Canice Prendergast	John C. Harsanyi
Assar Lindbeck	Casey Mulligan	John F. Nash Jr.
Avinash K. Dixit	Cecilia Rouse	John R. Hicks
Calvin B. Hoover	Charles W. Calomiris	Joseph E. Stiglitz
Carl S. Shoup	Ching-to Albert Ma	Kenneth J. Arrow
Charles F. Roos	Christopher J. Flinn	Lawrence R. Klein
Charles L. Schultze	Christopher Jencks	Leonid Hurwicz
Charles P. Kindleberger	David A. Wise	Leonid V. Kantorovich
Charles R. Plott	David M. Cutler	Maurice F. C. Allais
Christopher A. Sims	David S. Lee	Merton H. Miller
Claudia Goldin	Derek A. Neal	Milton Friedman
D. Gale Johnson	Dilip Mookherjee	Myron S. Scholes
Dale T. Mortensen	Dirk Krueger	Oliver E. Williamson
Dale W. Jorgenson	Dmitriy Stolyarov	Paul A. Samuelson
Daron Acemoglu	Drew Fudenberg	Paul R. Krugman
David Cass	Edward A. Snyder	Ragnar Frisch
David E. Card	Efe A. Ok	Reinhard Selten
David F. Hendry	Efraim Benmelech	Richard Stone
David Landes	Esther Duflo	Robert A. Mundell
David M. Kreps	Faruk R. Gul	Robert C. Merton
Don Patinkin	Fernando Alvarez	Robert E. Lucas Jr.
Donald J. Brown	Frank A. Wolak	Robert F. Engle
E.A. Goldenweiser	Frank P. Stafford	Robert J. Aumann
Edmond C. Malinvaud	Frank Schorfheide	Robert M. Solow
Edward F. Denison	Gavin Wright	Robert W. Fogel
Edward H. Chamberlin	George J. Borjas	Roger B. Myerson
Edward S. Mason	George J. Mailath	Ronald H. Coase
Edwin E. Witte	George-Marios Angeletos	Simon Kuznets
Edwin G. Nourse	Glenn Ellison	Theodore W. Schultz
Elhanan Helpman	Godfrey Keller	Thomas C. Schelling
Emmanuel Saez	Graham T. Allison	Tjalling C. Koopmans
Ernest L. Bogart	Hanming Fang	Trygve Haavelmo
Evsey D. Domar	Harold L. Cole	Vernon L. Smith
Finis Welch	Howard Pack	Wassily Leontieff
Francois Divisia	Igal Hendel	William Arthur Lewis
Frank H. Hahn	Ingo Vogelsang	William F. Sharpe

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Famous	Non-Awarded (Yet)	Nobel Laureate
Frank H. Knight	J. Bradford DeLong	William S. Vickrey
Franklin M. Fisher	J. Wesley Hutchinson	
Frederick C. Mills	James B. Ramsey	
Fritz Machlup	James M. Malcomson	
Gardner Ackley	Janet Currie	
Geoffrey H. Moore	Javier Hidalgo	
George E. Barnett	Jean-Paul Décamps	
George P. Shultz	Jeffrey H. Silber	
George W. Stocking	Jeffrey R. Russell	
Gordon Tullock	Jeremy Stein	
Gottfried Bombach	Jerry Wind	
Gottfried Haberler	Jianjun Miao	
Guy H. Orcutt	Joel Horowitz	
Guy Laroque	Joel Slemrod	
H. Gregg Lewis	John A. List	
Harold A. Innis	John C. Hershey	
Harold Hotelling	John Dinardo	
Harry A. Millis	John M. Quigley	
Harry G. Johnson	John Vickers	
Hendrik S. Houtthaker	Jonathan Gruber	
Henri Theil	Joseph Gyourko	
Henry J Aaron	Kai-Uwe Kühn	
Herbert E. Scarf	Kenneth I. Wolpin	
Herbert H. Giersch	Kevin Roberts	
Herbert Stein	Kiminori Matsuyama	
Herman O. A. Wold	Larry G. Epstein	
Hirofumi Uzawa	Larry Sjaastad	
Howard S. Ellis	Lawrence J. Christiano	
Hugo F. Sonnenschein	Lester G. Telser	
I.L. Sharfman	Liran Einav	
Irma Adelman	Lucy White	
Irving B. Kravis	Luigi Pistaferri	
Irving Fisher	Marcelo J. Moreira	
Jack Hirshleifer	Marcia M. A. Schafgans	
Jacob Marschak	Margaret Bray	
Jacob Mincer	Mark Schankerman	
Jacob Viner	Mark V. Pauly	
Jacques Dreze	Martin Browning	
Jagdish Bhagwati	Martin Pesendorfer	
János Kornai	Massimo Morelli	
Jean Tirole	Matthew S. Bothner	
Jean-Jacques Laffont	Melvin Stephens Jr	
Jean-Michel Grandmont	Michael J Piore	
Jerry Hausman	Michael Jansson	
Joan V. Robinson	Michael Woodford	
Joe Bain	Michel Cavagnac	

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Famous	Non-Awarded (Yet)	Nobel Laureate
John Chipman	Michel Simioni	
John D. Black	Mihir A. Desai	
John D. Sargan	Morton Owen Schapiro	
John H. Williams	Muhamet Yildiz	
John Kenneth Galbraith	Nancy L. Rose	
John M. Clark	Nancy Stokey	
John M. Keynes	Noel Capon	
John Moore	Oliver Linton	
John Pencavel	Olivier J. Blanchard	
John Sutton	Padma Desai	
Joseph A. Pechman	Pankaj Tandon	
Joseph A. Schumpeter	Panle Jia	
Joseph J. Spengler	Patrick J. Kehoe	
Joseph S. Davis	Peter J. Hammond	
K. N. Raj	Peter J. Klenow	
Kelvin J. Lancaster	Peter M. Robinson	
Kenneth E. Boulding	Petra E. Todd	
Kevin M. Murphy	Philippe Aghion	
Lars Hansen	Phoebus J. Dhrymes	
Lawrence H. Summers	Pierre Collin-Dufresne	
Lionel C. Robbins	Pierre-Andre Chiappori	
Lionel W. McKenzie	R. Glenn Hubbard	
Lloyd A. Metzler	Ricardo Lagos	
Lloyd S. Shapley	Richard Cooper	
Ludwig E. von Mises	Richard E. Walton	
Marc Leon Nerlove	Richard J. Gilbert	
Marcel Boiteux	Robert D. Willig	
Margaret G. Reid	Robert E. B. Lucas Jr.	
Martin Bronfenbrenner	Robert Gibbons	
Martin Hellwig	Robert H. Topel	
Martin S. Feldstein	Robert J. Willis	
Matthew B. Hammond	Robert M. Anderson	
Matthew Rabin	Robert Shimer	
Menahem E. Yaari	Robert W. Staiger	
Mervyn A. King	Roger B. Porter	
Michael Bruno	Roger G. Noll	
Michael Rothschild	Roland Bénabou	
Michio Morishima	Ronald D. Lee	
Morris A. Copeland	Ronald F. Ferguson	
Moses Abramovitz	Stanley Reiter	
Nicholas Georgescu-Roegen	Stefan Ambec	
Nicholas Stern	Steffen Habermalz	
Oliver M. W. Sprague	Stephen M. Walt	
Orley Ashenfelter	Stephen Morris	
Oskar Morgenstern	Sudhir Anand	
Partha Dasgupta	Suzanne Scotchmer	

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Famous	Non-Awarded (Yet)	Nobel Laureate
Paul H. Douglas	Tilman Börgers	
Paul Rosenstein-Rodan	Timothy F. Bresnahan	
Peter A. Diamond	Timothy G. Conley	
R.C.O. Matthews	Ulrich Dortszelski	
R.G.D. Allen	Urban J. Jermann	
Rene Roy	V. Kasturi Rangan	
Richard A. Easterlin	Victor Chernozhukov	
Richard A. Musgrave	Wei Jiang	
Richard A. Posner	Wilfred J. Ethier	
Richard Blundell	William Julius Wilson	
Robert B. Wilson	William P. Rogerson	
Robert Dorfman	Wolfgang Pesendorfer	
Robert E. Hall	Yacine Ait-Sahalia	
Robert Eisner	Yeon-Koo Che	
Robert J. Gordon		
Robert Summers		
Roger Guesnerie		
Ronald W. Jones		
Roy Radner		
Rudiger Dornbusch		
Ryutaro Komiya		
Sanford J. Grossman		
Sherwin Rosen		
Solomon Fabricant		
Stanley Fischer		
Stanley L. Engerman		
Stephen J. Nickell		
Steven D. Levitt		
Sumner H. Slichter		
Susan C. Athey		
T. N. Srinivasan		
Takashi Negishi		
Thomas J. Sargent		
Tibor Scitovsky		
Timothy Besley		
Torsten Persson		
Victor R. Fuchs		
W. M. Gorman		
W. Max Corden		
Walter Erwin Diewert		
Walter W. Heller		
Walter Y. Oi		
Werner Hildenbrand		
Wesley C. Mitchell		
William A. Brock		
William D. Nordhaus		

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Famous	Non-Awarded (Yet)	Nobel Laureate
William J. Baumol		
William J. Fellner		
William Z. Ripley		
Zvi Griliches		

C Universities

The universities used to select the Non-Awarded scholars were choosen on the basis of them being in the top 20 according to the RePEc raking of august 2010. It is important to note that, although there has been some variation, the raking has not change much in recent years. Table 14 shows the universities used.

Ranking	University
1	Harvard University, Cambridge, Massachusetts (USA)
2	University of Chicago, Chicago, Illinois (USA)
3	Massachusetts Institute of Technology (MIT), Cambridge, Massachusetts (USA)
4	Princeton University, Princeton, New Jersey (USA)
5	London School of Economics (LSE), London, United Kingdom
6	University of California-Berkeley, Berkeley, California (USA)
7	Oxford University, Oxford, United Kingdom
8	New York University, New York City, New York (USA)
9	Columbia University, New York City, New York (USA)
10	Stanford University, Palo Alto, California (USA)
11	Toulouse School of Economics (TSE), Toulouse, France
12	Boston University, Boston, Massachusetts (USA)
13	University of Pennsylvania, Philadelphia, Pennsylvania (USA)
14	Northwestern University, Evanston, Illinois (USA)
15	University of Michigan, Ann Arbor, Michigan (USA)
16	University of California-San Diego (UCSD), La Jolla, California (USA)
17	Columbia University, New York City, New York (USA)
18	University College London (UCL), London, United Kingdom
19	University of California-Los Angeles (UCLA), Los Angeles, California (USA)
20	Brown University, Providence, Rhode Island (USA)

Table 14: Top 20 universities according to the RePEc ranking of August 2010