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The Nobel Prize time gap

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The time lag between the publication of a major scientific discovery and the conferment of a Nobel Prize has been rapidly increasing for the natural science disciplines (chemistry, medicine-physiology, and physics), but has not yet matched the corresponding "waiting period" for the Nobel Prize in Economics. The aim of the present study is to empirically examine the time gap between pioneering work and Nobel recognition and discuss possible explanations for its variation across time and disciplines. The analysis provides evidence to support the argument that attributes such as bestowments of accolades widely regarded as Nobel Prize precursors, citation indices, and sharing of the award between multiple recipients, may explain this variation, but only to some extent. In the discussion that follows, the notably longer waiting period in economics is attributed to factors such as the laureates' age, the impact of which the current study cannot empirically examine. Since the Nobel Prize cannot be awarded posthumously, the Nobel Committee members may tend to grand the award to older economists before they pass away and become ineligible.

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Introduction

The 2019 Nobel Prize in Economics was awarded to Abhijit Banerjee, Esther Duflo, and Michael Kremer for their work in transforming the research on global poverty alleviation. The research performed by these notable scientists had already had a clear impact on many nations' economic policies by the time their work was recognized by the Nobel Prize Committee. However, their original results had had an effect as far back as the mid-1990s (Economic Sciences Prize Committee, 2019). Therefore, about a quarter of a century elapsed before their pioneering contributions were rewarded with a Nobel Prize.

Extended time lags between the publication of a pioneering work and the complete evaluation of its impact are not uncommon in the field of economics, where the "waiting period" for a Nobel Prize has been longer than in any other discipline where Nobel Prizes are awarded.[1] The current study utilizes data for Nobel laureates in economics, chemistry, medicine and physiology, and physics, in order to investigate the time lag between the publication of substantial scientific accomplishments and their recognition with the conferment of a Nobel medal. The study also examines the expected reasons for the growing gap between publication and recognition of work across disciplines, and discusses probable factors why this time lag is more pronounced in the field of economics.

The issue of this Nobel Prize delay has been mostly overlooked by the existing literature, in spite of how important dissemination of academic research and the pace at which this occurs is considered to be. Receiving a major award signals that the qualities of the scholars awarded have come to the attention of their peers, it provides validation, and promotes the related research fields (Merton, 1973). With each new Nobel Prize, attention will be devoted to the subject matter of the research, which received the award, and with that, other researchers may be influenced to pursue similar topics and build on the progress that was made. In addition, the Nobel Prize may serve as both a direct and an indirect incentive for innovation, and bring prestige to the affiliated institutions (Frey and Neckermann, 2009; Frey and Gallus, 2014). As such, a scientific explanation of any factors that may explain the length of time between the publication of a significant scientific work and the bestowal of a Nobel Prize is essential in developing a more complete understanding of the reward system for the sciences.

Another good reason to investigate the delay between prominent work and the conferment of a Nobel Prize is that it indicates how the landscape of science changes over time. In other words, how long Nobel laureates have to wait for their award underscores the evolving complexity of scientific work. During Alfred Nobel's lifetime, a scientist could discover something amazing on their own, and Mr. Nobel's last will and testament reflected that. Nowadays, though, breakthrough science is usually a multi-year effort by teams, which can number in the thousands. On top of that, the theoretical discovery is often done by one team and the empirical confirmation by another, maybe decades later, and the delay in Nobel Prize recognition may reflect that.

The issue of the Nobel Prize time gap is also related to the problem of public understanding of science. The work of Nobel laureates is so distant from the general public's grasp of scientific matters, that it takes the specialized knowledge of the different Nobel Prize Committees to even understand it. This increasing complexity of scientific knowledge, as well as the democratic deficit in science resulting from it, may be reflected in the time it takes for a breakthrough scientific discovery to be awarded the Nobel medal. Therefore, the time lag itself is not as important as the underlying reasons behind it. Studying those reasons, therefore, may identify whether this growing "deficit of time" is totally or partially caused by the current curriculum in science education, and, also, what can be done to improve it.

The rest of this paper is organized as follows: the following section provides the literature review, while the subsequent sections describe the data used and the modeling framework. The empirical findings section presents and discusses the estimation results, while the final section provides a summary of the concluding remarks.

Literature review

Determining the time of scientists' most impactful publications falls into the vibrant research field of the *science of science*, a discipline, which has emerged to investigate discoveries in research fields that have achieved a certain degree of maturity (Clauset et al., 2017). Researchers who have sought to determine when Nobel laureates published their most prominent work (more specifically, the work, which led to their recognition with a Nobel Prize) have been forced to rely on a wide variety of approaches. A major obstacle in their efforts is the fact that the Nobel Prize Committees do not systematically indicate the publications for which Nobel Prizes are awarded.

The data set of Jones (2010) identifies great achievements in science, which led to Nobel Prizes in economics, physics, chemistry, and medicine or physiology (referred to hereafter simply as "medicine"). He determines the year(s) in which the pioneering research is performed by obtaining information from the official website of the Nobel Foundation and, in cases where the time period of the key research is not identified, by consulting printed materials. In a similar manner, Jones and Weinberg (2011) determine the years at which Nobel laureates produced their prize-winning work using the Nobel Foundation's website combined with other sources, such as biographies and citation indices.

Schlagberger et al. (2016) identify the paper(s) in which the researchers publish their Nobel prize-winning work in the fields of physics, chemistry and medicine (all three referred to hereafter as "the natural sciences") from 1994 to 2014. In their identification, they cite the Nobel Foundation's website and a variety of secondary resources, such as literature databases and Encyclopedia Britannica. Similarly, Li et al. (2019) specify the publication period of scientific work honored with a Nobel Prize in the natural sciences from 1900 to 2016. They perform this task by extracting information from the website of the Nobel Foundation, laureates' official biographies, Google Scholar and other resources.

There are also studies that determine the time of scientists' Nobel prize-winning publications with a focus on a single discipline. These include Zhou et al. (2014), who examine landmark papers written by Nobel laureates in physics from 1901 to 2012, via the application of bibliometric methods. Liang et al. (2018) selected the research that led to the bestowal of Nobel Prizes in medicine by utilizing the website of the Nobel Foundation, as well as laureates' biographical texts.

Studies examining the timing of economics Nobel laureates' prize-winning contributions include Van Dalen (1999), who identifies the year of publication of economists' prize-winning work from 1969 to 1998. Van Dalen uses the Nobel Prize Committee's reports, biographies, and citation indices. Weinberg and Galenson (2019), on the other hand, determine the years when economics Nobel laureates published their work(s) with the highest number of citations, instead.[2] They argue that laureates' most cited works frequently coincide with the works for which they received their Nobel Prizes. Even in the cases they do not, Weinberg and Galenson point out that "the opinion of Nobel

Prize Committee is not necessarily preferable to that of economics discipline as a whole".

Possible determinants of Nobel Prize conferment are a vital focus of this strand of research (see, e.g., Gingras and Wallace 2010; Chong et al., 2012). Seminal work in this area, published by Inhaber and Przednowek (1976) and Ashton and Oppenheim (1978), emphasizes the ability of bibliometric data (e.g., the number of citations) to forecast Nobel Prize winners in the fields of chemistry, medicine, and physics. Other studies focus on understanding the link between early career distinctions and winning the Nobel Prize.[3] There also papers demonstrating the impact of laureates' age, nationality, and affiliated institutions (see, e.g., Chong et al., 2012).

Studies that examine Nobel Prizes from a science-of-science perspective include Chan and Torgler (2013), who estimate that the time delay between prize-winning discoveries and the scientists' recognition with a Nobel Prize is twice as long in medicine than in physics. Additionally, according to the findings of Becattini et al. (2014), the time lag between work and recognition has continuously been increasing ever since the commencement of the Nobel Prizes. As a result, Nobel Prize winners in the natural sciences are being bestowed their awards at an increasingly older age, which poses a threat to the prestige and authority of the Nobel Prize by increasing the risk that important work cannot be recognized by it due to the death of its authors.

However, none of these studies uses a quantitative method to examine the factors, which may impact the Nobel Prize time gap. Baffes and Vamvakidis (2011) make a step in that direction by examining the existence of statistically significant correlations between the age of each scientist when the Nobel Prize is awarded with factors such as the age of the laureates when the Nobel-worthy research is published, the age at which they earned their last degree, their gender, the existence of a backlog of high-achieving individuals in their field, and whether they had conducted their ground-breaking research in a developed country.

Following the spirit of Baffes and Vamvakidis (2011), Polemis and Stengos (2022) use panel data models to determine the underlying reasons behind the Nobel Prize time lag in the natural sciences. Their findings suggest that the Nobel Committees favor older nominees, since the delay gap decreases as the age of the laureates when they publish their scientific achievements increases. Other parameters they find to have an effect on the time delay include the age at which the Nobel laureates receive their last education degree, the number of recipients who share the award for the same research, and certain demographic factors, such as geographic origin and the gender of the laureates.

The present paper extends the results of the latter study from the natural sciences to economics. The factors examined include a measure of the impact that the contribution of the laureates had at the time of their award, and whether the laureates had previously received an accolade widely perceived as a Nobel Prize precursor (i.e., the Lasker Award and the John Bates Clark Medal). The current study also re-examines the impact of some of the factors mentioned above, such as gender of the laureates, age at which they were awarded their doctoral degree, whether their prize was shared, and whether there is a backlog of potential laureates in the specific discipline.

Data

There is fairly wide consensus that the Nobel Prize represents the ultimate accolade in the disciplines in which it is awarded.[4] Conferred for the first time in 1901, it has been awarded annually (with few exceptions) in the fields of physics, chemistry, medicine, literature, and peace, ever since, with a memorial prize in economic sciences established in 1968. In many years the prize is shared by two or three researchers, so that, by 2019, a total of 616 awards had been given to 613 scientists in the natural sciences (Marie Curie, John Bardeen and Frederick Sanger are repeat winners), while in the economic sciences, a total of 84 prizes had been awarded to the same number of individuals. Since the Nobel Prize in Literature in the majority of the cases is granted for life achievements (instead of the publication of a single work) and the Nobel Peace Prize is usually awarded for accomplishments other than pioneering publications, the current study focuses on examining the time delay between the publication of ground-breaking work and Nobel Prize bestowment only in the disciplines of chemistry, medicine, physics and economics.

Years elapsed between work and recognition. The primary source of information for the timing of prize-winning publications by natural sciences laureates is the database of Li et al. (2019). Jichao Li and his collaborators constructed a data set of entire career histories of nearly all Nobel Prize winners in chemistry, medicine and physics by collating information collected mainly from the Nobel Foundation's website. As described in Li et al. (2019), they use many different approaches to ensure the reliability of their results, including comparison with manually collected CVs, Google Scholar profiles, and other supplementary sources. Given the amount of information about Nobel laureates that became available to them, they also took the opportunity to identify each laureate's prize-winning work. A discussion of their findings is provided in Fortunato (2014).

The author of the present paper repeats this "identification exercise" for the economics laureates. As with Li et al. (2019), the main source of information is the Nobel Foundation's website. In cases where the information contained in nobelprize.org is not sufficient as to accurately identify the period in which the prize-winning research was first published, official biographies and citations indices are consulted. In many occasions, correspondence with the laureates themselves, or with individuals with substantial publications on a specific laureate's work, is conducted.

Any efforts in identifying Nobel laureates' prize-winning publications are usually clouded by the nebulousness of concepts like academic quality and impact. In the current paper an impactful publication is considered to be one containing an idea, which has improved the overall understanding of economic phenomena. The problem with measuring impact using quantitative measurements such as citation indices is that they are merely indicators of academic productivity, and there is therefore the possibility of dismissing innovative scientists if their performance according to an arbitrary scale is weak.

In order to circumvent this problem of quantitative measurement, Van Dalen (1999) uses a number of milestones in scientists' careers in order to thoroughly assess the productivity of Nobel-winning economists, including (a) the paper that challenged or started challenging the current level of knowledge and practice enough to change and innovate the field (i.e., the "breakthrough publication"), and (b) the paper generally perceived as the laureate's best piece of work (which Van Dalen designates as the "motherlode publication").

The author of the present study determines the time of economics Nobel laureates' prize-winning work as the midpoint between the publication of those landmark contributions (i.e., their "motherlode" and "breakthrough" publications). Since Van Dalen (1999) identified those seminal publications for all laureates up to the year 1998, the current study extends the identification of landmark pieces of work of Nobel-winning economists up to the year 2019. A detailed description of the original findings of Van Dalen (for the period: 1969–1998) and

Table 1 Nobel Prize laureates grouped according to the number of years elapsed between the publication of their most prominent work and the time they received the Nobel Prize, by discipline (1901–2019).

Time gap	Economics	Chemistry	Medicine	Physics	All sciences
1–10	0%	24%	29%	31%	25%
11–20	5%	36%	41%	31%	32%
21–30	45%	25%	21%	19%	25%
31–40	36%	13%	8%	13%	14%
41–50	12%	1%	1%	4%	3%
51–60	2%	1%	0%	2%	1%
Mean lapse	31.4	18.2	16.8	18.5	19.5
No. of laureates	84	175	211	204	674

Source: Author's calculations utilizing the website of the Nobel Foundation, Web of Science and other supplementary sources, and correspondence with Economics Nobel laureates. The primary source of information for the recipients of Nobel Prize in the disciplines of Chemistry, Medicine-Physiology and Physics is the database of Li et al. (2019).
Of the 616 Nobel Prizes awarded in the natural sciences and the 84 Nobel Prizes awarded in economics (in total 700), 26 are not included in the data above, either because they concern laureates who received their award in the period 2017–2019, which is not included in the database of Li et al. (2019), or because the identification of their prize-winning work was not possible.

Table 2 Number of years elapsed between the publication of Nobel laureates' most prominent work and the obtainment of a Nobel Prize, grouped by discipline and decade (1901–2019).

Decade	Economics	Chemistry	Medicine	Physics	All sciences
1901–1910	—	16	16	12	14
1911–1920	—	12*	10*	9*	10*
1921–1930	—	11*	15*	12	12*
1931–1940	—	10*	11*	9*	10*
1941–1950	—	17*	11*	17*	14*
1951–1960	—	16	11	12	13
1961–1970	32*	16	17	17	18*
1971–1980	32	17	15	17	19
1981–1990	34	18	19	20	21
1991–2000	32	21	21	25	24
2001–2010	30	23	22	28	26
2011–2019	31	30*	26*	28*	29*
Mean Lapse	31.4	18.2	16.8	18.5	19.5
No of Laureates	84	175	211	204	674

Calculations marked with a (*) denote cases where data are not available for the whole decade, or decades containing years in which the Nobel Prize was not awarded in the specific discipline. In most of the cases this is due to World War I (1914–1918) and World War II (1939–1945). Specifically, the Nobel Prize was not awarded in 1916–17, 1919, 1924, 1933, and 1940–42, in Chemistry, in 1915–18, 1921, 1925, and 1940–42, in Medicine-Physiology, and in 1916, 1931, 1934, and 1940–42, in Physics. It is also noted that the Economics Nobel Prize was first awarded in 1969 and that the database of Li et al. (2019) does not include the period 2017–2019.

the identification performed by the author of the current paper (for the period: 1999–2019) is provided in the Appendix (Supplementary Information).

Table 1 presents, for the period 1901–2019, the distribution of laureates by field according to the number of years elapsed between the time they publish their prize-winning work and the year at which they receive the Nobel Prize. When the prize-winning research occurs over a period of time, as is often the case, then the midpoint is calculated. Several generalizations can be drawn from Table 1. First, although very few of the laureates (5%) receive the Nobel Prize more than 40 years after the time they published their award-winning work, a significant percentage (18%) receive the award more than 30 years after their most influential publication. Even more of them (25%) have to wait for a period of 21–30 years for recognition. For the majority of laureates (32%) the time delay between the publication of their work and the conferment of a Nobel Prize ranges between 11 and 20 years. A significant percentage of the laureates (25%) receive their award within 10 years after the publication(s) they were awarded it for.

Second, the scientific work of Nobel laureates in medicine tends to be recognized earlier than any other discipline, with an average waiting period of 17 years. In contrast, the economics Nobel laureates tend to wait the longest in order to enjoy the fruits of their accomplishments, since they spend on average 28 years anticipating the Nobel award. This is about 10 years more than the laureates in chemistry and physics have to wait for before Nobel Prize recognition.

Third, in economics, the largest portion of laureates (45%) had to wait for 21–30 years from their most prominent work to pass before they received a call from Sweden. In the other three disciplines examined, the highest proportion of laureates only has to wait a shorter period (i.e., 11–20 years) before their award. Furthermore, after three decades have passed from the publication of their most important work, more than 80% of all laureates in chemistry, medicine, and physics had already received the award. By contrast, in economics, about 50% of the laureates would have to wait for an additional decade or two before they are named as Nobel Prize winners. In this field, moreover, none of the laureates receive the Nobel Prize within 10 years of their prize-winning work, while in chemistry, medicine, and physics, the proportion of awards within a decade are 24%, 29%, and 31%, respectively.

As noted in Becattini et al. (2014), the time lag between work and recognition has been continuously increasing ever since the commencement of the Nobel Prizes. In order to examine this particular claim in depth, Table 2 reports the number of years elapsed between the publication of the prize-winning work and the Nobel Prize conferment, separately for each decade. The numbers in Table 2 provide evidence that the time lag between laureates' work and recognition has been increasing ever since the decade of 1951–1960 for all disciplines examined, with the notable exception of economics. More specifically, for the Nobel laureates in chemistry, the average time gap between work and award has increased from 16 years in 1951–1960 to 30 years in 2010–2019, while in physics the time gap per decade goes from 12 years in 1951–1960 to 28 years in 2010–2019. For the Nobel laureates in medicine, the average time gap has increased from 13 years in 1951–1960 to 29 years in 2010–2019. In contrast, for the economics Nobel laureates, the average time gap between publication of landmark pieces of work and the obtainment of the Nobel Prize has remained relatively steady over the decades, ranging from 30 to 34 years for the entire period examined.

Variables used to examine years elapsed between work and recognition. In an attempt to shed more light on the variation of the time lag between pioneering work and Nobel Prize conferment, the current study employs a variety of information. Firstly, the data set reports the impact of each scientist's prize-winning work, using their number of citations—a widely employed metric of academic performance (Gingras and Wallace, 2010)—as a proxy for this. In order to represent the amount of information the members of the Nobel Prize Committee had access to at the time of their decision to grant the Nobel Prize to the specific laureate, the number of citations reported is the one the notable publications had at the time of the Nobel Prize announcement. This is determined through Google Scholar, which, according to Harzing (2012), constitutes a reliable source of such information.

Table 3 Summary data for each variable by Nobel Prize discipline, averages between 1969 and 2016.

Variable	Economics	Chemistry	Medicine	Physics	All sciences
Laureates/year	1.6	2.1	2.4	2.4	2.1
Age at Ph.D/MD	27.9	26.8	27.1	27.2	27.2
Age at award	67.1	63.0	61.5	60.9	62.7
Female laureates	1%	1%	10%	0%	3%
Precursor award	15%	8%	13%	17%	13%
Citations	2449	961	1234	1409	1454
Memberships	24,728	141,872	—	39,116	—
Nobel delay	31.9	21.5	19.9	23.4	23.6
No of laureates	78	99	113	115	405

Mean values of data for each variable for the period 1969–2016. Data for laureates in the natural sciences is available for the period 1901–2016, whereas data for economics laureates is available for the period 1969–2019. To ensure a consistent and statistically robust comparison, the numbers on this table represent the mean values of the years for which data in all four Nobel disciplines is available, namely 1969–2016.

When the Nobel Prize is given for a series of publications, as is often the case, then their average is used.[5]

The data set also includes information on whether each laureate had received an accolade widely regarded as a Nobel Prize precursor by the time of their award. This is to capture any effect the laureates' early career performance had in accelerating the committee members' decision to bestow them the Nobel Prize.[6] Of the elite accolades considered to be Nobel precursors, the current data set uses the John Bates Clark Medal (JBCM) as a leading indicator for the Nobel prize in economics, and the Lasker Award (LA) as a precursor of the Nobel prize in the natural sciences. The JBCM was established in 1947 and it is considered the most prestigious early career recognition for economists.[7] The LA has been awarded annually since 1945 and it has gained a reputation in the literature for identifying future Nobel laureates.[8]

Another early career performance indicator is considered to be the age at which scientists receive their Ph.D or MD.[9] A number of studies consider that having obtained a doctoral degree by the age of 25 is an indication of academic excellence (see, e.g., Jones and Weinberg, 2011). Other studies assert that the age of PhD obtainment is not a good indicator of future distinction (Van Dalen, 1999), and choose to examine *at which specific institution* scientists received their PhD, instead of *when* they received it (see, e.g., Schlagberger et al., 2016). This data is usually supplemented with records of the rankings of the academic departments of the institutions at which the scientists earned their doctoral degrees (Chan et al., 2018).

Another way to examine the possible influence of the award of a doctoral degree on the "waiting period" for a Nobel Prize is to consider the future laureate's "academic age", that is, the number of years elapsed since they have received their Ph.D/MD (see, e.g., Chan and Torgler, 2012).[10] One may also examine the influence of the length of time between the laureate's obtaining a doctoral degree and publishing their most influential paper. The latter two measurements, however, give rise to a simultaneity concern when used as independent variables in regressions using the "Nobel Prize waiting period" as a dependent variable. This is because the "number of years elapsed between Ph.D/MD and the publication of a substantial work" and the "number of years lapsed between the publication of the substantial work and the conferment of the Nobel Prize" are both determined by the time at which the major scientific discoveries were made (Jones and Weinberg, 2011).[11] These are therefore variables that are *simultaneously determined* and may not be used together in econometric analysis.

The time lag between reporting a scientific discovery worthy of a Nobel Prize and the conferment of the Nobel medal may also have something to do with how long the prize has been awarded for in the specific discipline. The Economics Nobel Prize was established much later than any other discipline in which Nobel Prizes are bestowed, probably creating a larger backlog of potential winners, which may be at the root of the longer time gap between significant achievements and Nobel awards compared to the other disciplines. As a proxy for this backlog of potential Nobel Prize winners, the current study reports the total membership numbers in the following professional associations: American Chemical Society (ACS), American Physical Society (APS), and American Economic Association (AEA).[12] The existence of such backlogs of notable scientists may contribute to urging the Nobel Prize Committee members to practice the option of splitting the award between up to three winners in a specific year. Therefore, the data set of the present study also includes information on whether each laureate receives an unshared Nobel Prize or if, instead, the honor is shared between two or more persons.

There has been discussion related to the small number of female Nobel winners. Therefore, the current database also includes the gender of each laureate, in order to examine whether the "gender bias in Nobel Prizes" discussion (see, e.g., Lunnemann et al., 2019) has influenced the Nobel Committee in any way (Economic Sciences Prize Committee, 2019).[13] Since the Nobel nominators include past laureates, former committee members, and professors from Scandinavian countries (see Mixon and Upadhyaya, 2014), it is possible that research conducted in Scandinavian countries may become widely known among the nominators faster, and therefore result in an earlier Nobel Prize. For this reason, this study also examines whether laureates who conducted their prize-winning work in a Scandinavian country tend to receive their awards sooner. The data therefore records whether the laureates were affiliated with a Scandinavian institution at the time of their award.

Table 3 presents summary data for the variables the current paper examines to study the variation in the time gap between pioneering work and Nobel Prize recognition. For consistency and better comparison, the means of all variables are presented for 1969–2016, which is the period for which there is data available for all Nobel Prize categories. The average number of Nobel laureates per year for the period 1969–2016 is 2.4 for physics and medicine, whereas the chemists and the economists lag behind with an average 2.1 and 1.6 laureates per year, respectively. There is no considerable variation in the age at which scientists obtain their PhD/MD across disciplines, but there are notable differences with regard to the age at which they receive the Nobel Prize. The mean age of Nobel Prize conferment is 61 for physicists and medical researchers, 63 for chemists and 67 for economists.

The Nobel category with the highest proportion of female laureates in the period 1969–2016 is medicine, with 10%, while in both chemistry and the economic sciences the corresponding

Table 4 Panel data unit root test results.

	Individual data		Yearly data	
	Test statistic	*p*-value	Test statistic	*p*-value
Nobel Prize Delay	373.861	0.000	230.175	0.000
	−15.922	0.000	−14.027	0.000
Citations	397.243	0.000	208.045	0.000
	−17.151	0.000	−13.489	0.000
Age at Ph.D/MD	404.018	0.000	242.415	0.000
	−16.085	0.000	−14.697	0.000
Memberships	725.420	0.000	119.455	0.000
	−25.949	0.000	−9.596	0.000

All variables are in natural logarithms except "Memberships", which is in log first differences (i.e., rate of growth). The tests are performed using Fisher-ADF, an alternative approach to panel unit root testing, which uses Fisher's (1932) results to derive tests that combine the *p*-values from individual Augmented Dickey-Fuller (ADF) unit root tests. The null hypothesis is that all panels contain unit roots. The test statistics are computed using the Normal and the Chi-square distributions.

percentage is 1%. None of the Nobel laureates in physics is a woman in the period 1969–2016. In the Nobel categories examined in the present study, the one with the highest percentage of Scandinavia-affiliated laureates is medicine with 6%, while the discipline with the least Scandinavian affiliation is chemistry, with 3%.[14] With regard to the precursor awards, a percentage of 17% of the laureates in physics had received the LA prior to their Nobel win, while in chemistry and medicine-physiology the percentages are 8% and 13%, respectively. A percentage of 15% of the economics laureates had received the JBCM before they were conferred with a Nobel Prize.

The summary data presented in Table 3 also indicate that the average number of citations, which the laureates' most impactful publications had received at the year of their Nobel award is 1454, with economists having the highest average number of citations (2449) and chemists the lowest (961). In terms of the existence of backlogs of potential laureates in the Nobel categories, chemists' professional association seems to have the largest number of potential "Nobel Prize candidates" with 141,872, whereas the economists' professional association is the less populated, with an average number of memberships of 24,728.

These statistics provide a foundation for an investigation of the Nobel Prize waiting period. This means to advance the literature by examining variables, which may be empirically associated with shortening or prolonging the time lag between major scientific discoveries and Nobel Price bestowals. As described in the subsequent sections, this is achieved by comparing Nobel laureates across time and disciplines. Any evidence suggesting that any of the attributes discussed above correlate with the probability of receiving the award sooner rather than later are formally investigated.

Econometric framework

The current section describes the econometric methodology used to investigate the time lag between the publication of a pioneering scientific work and the recognition of its author with the conferment of a Nobel Prize. Given the information provided in the previous sections, the variable of interest (referred to hereafter as "Nobel Prize delay") is examined both separately for each Nobel Prize discipline as well as for the total data set (i.e., including all Nobel Prize sciences).

Nobel prize delay model. The framework for examining the time lag between the publication of a pioneering scientific work and its conferment with a Nobel Prize is expressed as follows:

$$\begin{aligned}\text{NobelDelay}_{tij} = {} & \alpha_0 + \alpha_1 t + \alpha_2 \text{Citations}_{tij} + \alpha_3 \text{Precursor}_{tij} + \alpha_4 \text{PhDAge}_{tij} \\ & + \alpha_5 \text{Shared}_{ti} + \alpha_6 \text{Memberships}_{ti} + \alpha_7 \text{Gender}_{tij} + \varphi' C_{ij} + u_{tij}\end{aligned} \quad (1)$$

In the above, NobelDelay_{tij} is the log number of years elapsed between the publication of a major scientific discovery and the recognition of its author with the conferment of a Nobel Prize, t is a linear trend,[15] Citations_{tij} is the log number of citations the specific publication has at the time of the Nobel Price announcement, Precursor_{tij} is a dummy variable equal to 1 if the laureate is a recipient of a John Bates Clark Medal or a Lasker Award, PhDAge_{tij} is the log of the age of the laureate at the time of their Ph.D/MD obtainment, Shared_{ti} is a dummy variable equal to 1 if in the specific year and discipline the Nobel Prize is shared among 2 or 3 scientists, Memberships_{ti} is the rate of growth of membership numbers in the related professional association (i.e., a proxy for the backlog of potential laureates in the specific discipline),[16] $Gender_{tij}$ is a dummy variable equal to 1 if the laureate is a woman, $Scandinavia_{tij}$ takes the value of 1 when the Nobel-related work was conducted in a Scandinavian country (Denmark, Norway, or Sweden), C_{ij} are a series of dummy variables for all Nobel Prize disciplines except economics (namely chemistry, medicine, and physics) and u_{tij} is the error term.

Regarding the model parameters, the coefficients of the variables Citations_{tij}, Precursor_{tij}, Scandinavia_{tij}, and Shared_{ti} are expected to be negative, since the Nobel Prize Committee might expedite its decision to confer the Nobel Prize (and thus make laureates' waiting period shorter) when the impact of the pioneering scientists' work (Citations_{tij}) is greater,[17] or when they have already acquired an award widely recognized as a Nobel Prize precursor (Precursor_{tij}). A negative sign in the coefficient of $Shared_{ti}$ reflects cases when the members of the Nobel Prize Committee might decide to "cut down" the accumulated backlog of deserving candidates by simply awarding more than one award per year. In contrast, the backlog variable (Memberships_{ti}) is expected to have a positive coefficient, since the faster the number of notable candidates for the Nobel Prize grows, the longer it would take for the Nobel Prize Committee to confer the award to some of them. The coefficient of Scandinavia_{tij} is expected to be negative, since Nobel Prize nominators include professors from Scandinavian countries. Research conducted in Scandinavia may therefore become known faster, and thus result in an earlier Nobel Prize.

Owing to evidence of a growing time lag between pioneering work and Nobel Prize recognition (Becattini et al., 2014), the coefficient of the trend (t) is expected to be positive. The PhDAge_{tij} coefficient can be either positive (if an early career breakthrough contributes in making the laureates' waiting period shorter) or negative (if the Nobel Prize Committee tends to leave the work of young scientists to mature—or be empirically proven—before granting them the honor of the Nobel award). No a priori assumptions are made about the relation between gender and the Nobel Prize waiting period, while the vector of determinants, denoted by (C_{ij}), is included to capture any lingering effects between economists and natural scientists, with the former used as the reference group (i.e., the omitted category).

Econometric concerns. The current study uses a panel data set with multiple entities (i.e., Nobel Prize disciplines), each of them having repeat measurements at different periods of time. Since using panel data models without a proper consideration of their relevance may lead to invalid empirical results (Baltagi, 2005), the present paper applies several tests in order to select the most appropriate model to be used. For example, the presence of

Table 5 Investigating the relationship between certain variables and the period between the publication of Nobel laureates' prize-winning work and the conferment of a Nobel Prize.

	Economics (1)	Chemistry (2)	Medicine (3)	Physics (4)	All sciences (5)
Linear trend	−0.001	0.022***	0.023***	0.032***	0.022***
Citations	−0.007	−0.096*	−0.119***	−0.181***	−0.133***
Precursor Award	−0.234***	−0.865***	−0.026	1.101	−0.164*
Age at Ph.D/MD	0.174	0.304	−0.038	−0.801	−0.104
Shared Nobel Prize	−0.117**	−0.356***	−0.138*	−0.203*	−0.251***
Memberships	−1.694	3.789	—	2.637	—
Gender	−0.405**	−0.165	0.103	0.545	0.069
Chemistry	—	—	—	—	−0.479***
Medicine	—	—	—	—	−0.351***
Physics	—	—	—	—	−0.463***
Intercept	3.115***	0.812	1.790**	3.808**	2.707***
Number of obs.	78	125	148	150	505
R-squared	0.297	0.323	0.273	0.222	0.296
Breusch-Pagan test	1.000	1.000	1.000	1.000	1.000
F-test	0.059	0.618	0.205	0.116	0.000
Hausman test	0.068	0.615	0.207	0.120	0.000
Modified Wald test	0.998	0.328	0.959	0.182	0.000
Wooldridge's test	0.086	0.438	0.316	0.229	0.299
Ramsey RESET test	0.812	0.096	0.716	0.901	0.017

Table 5 presents results from calculating Eq. (1) for samples identified by column. The dependent variable is the number of years elapsed between the publication of a major scientific breakthrough and the recognition of its author with the conferment of a Nobel medal. The lower panels of the table report results from several diagnostic tests. Breusch-Pagan and *F*-test examine the presence of random and fixed effects, respectively, while Hausman test helps to decide among the two. The Modified Wald test examines the presence of group-wise heteroscedasticity, Wooldridge's test inspects for serial correlation and Ramsey RESET test checks the overall model specification. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

random effects is being tested with the Breusch-Pagan (1980) LM test, while the presence of fixed effects is examined via a traditional F-test for linear restrictions. When the presence of both fixed and random effects is evident, then a Hausman (1978) test is usually performed.[18]

Since the presence of either serial or cross-sectional correlation in such models may lead to biased estimates, Wooldridge's autocorrelation tests are also performed, while the presence of heteroscedasticity is examined by running Modified Wald tests. Overall model specification is investigated via the application of Ramsey RESET tests. Yet another concern, when estimating panel data models- is potential non-stationarity, since the presence of unit roots in the variables may lead to spurious regressions. Therefore, Fisher-type (Choi, 2001) panel data unit root tests are also performed.

Empirical findings

The first step in the current estimations is to examine the stationarity of the continuous variables involved. As indicated in Table 4, the null of the unit root is rejected for all variables. Then, in order to efficiently investigate the "Nobel Prize delay", Eq. (1) is calculated separately for each Nobel Prize discipline *and* for the total sample (i.e., including all four Nobel Prize categories together). Owing to concerns for model misspecification (described in brief in the previous section), several diagnostic tests are being performed. The findings from the estimation of Eq. (1) are presented in the following section, the outcome from the robustness checks is presented in the subsequent section, and the implication of the empirical results is discussed in the section after that.

Model estimates. The empirical findings are presented in Table 5. Diagnostic tests are performed for all calculations. The results presented in the lower panels of Table 5 indicate that for the models calculated at each Nobel Prize category separately (columns 1 to 4), the presence of neither random or fixed effects is detected, therefore the models may be safely estimated as pooled OLS regressions. There is no evidence of heteroscedasticity, serial correlation, or model misspecification.

The estimates presented in the upper panel of Table 5 indicate that the time between scientific discoveries and Nobel awards is increasing in the natural sciences, with an annual rate ranging between 2.2% in chemistry and 3.1% in physics. There is no evidence for such an annual increase in the case of economics. The number of citations of the laureates' most prominent work seems to be positively correlated with a shorter than average time lag, but only in the natural sciences. An increase in citations by 1%, is associated with a decrease in the time lag between work and recognition by 0.09% in chemistry, 0.12% in medicine, and 0.16% in physics. Early career recognition is also significant, since being a winner of an accolade widely regarded as a Nobel Prize precursor is associated with a decrease of the Nobel waiting period by 19.5% in the case of economics and 55.9% in the case of chemistry.[19] Obtaining such an honor (i.e., winning a Lasker Award), does not seem to be correlated with reduced Nobel waiting time in the case of medicine, while in physics the related coefficient is positive.

The empirical results in Table 5 also suggest that laureates who share the Nobel Prize tend to receive the honor sooner compared to scientists who receive an unshared award, but only in the disciplines of economics and chemistry. Specifically, the waiting time of laureates who receive a shared Nobel is 11% lower than those who receive an unshared award in the case of economists, and 31% lower in the case of chemists.

As stated previously, this outcome is a likely reflection of the increasing pool of potential Nobel candidates, which may urge the Nobel Prize Committee members to take advantage of the option to split the award between up to three winners in a particular year. This is also evidenced by the fact that the parameter estimate of the laureate backlog variable is positive and significant in chemistry and physics (suggesting that the increasing number of scientists contributes in making the Nobel waiting period longer in those disciplines). According to Baffes and Vamvakidis (2011), the "shared prize" effect may also reflect

Table 6 Robustness checks of the estimation results.

	IID standard errors (1)	White standard errors (2)	Clustered standard errors (3)	FGLS standard errors (4)	PCSE standard errors (5)
Time trend	0.022***	0.022***	0.022***	0.017***	0.022***
Citations	−0.129***	−0.129***	−0.133***	−0.098***	−0.123***
Precursor award	−0.156*	−0.156*	−0.156	−0.147**	−0.160**
Age at Ph.D/MD	−0.148	−0.148	−0.148	−0.028	−0.173
Shared Nobel Prize	−0.257***	−0.257***	−0.257***	−0.254***	−0.286***
Gender	0.061	0.061	0.061	−0.119	0.061
Scandinavia	0.281*	0.281*	0.281*	0.346***	0.296**
Chemistry	−0.463***	−0.463***	−0.463***	−0.479***	−0.458***
Medicine	−0.346***	−0.346***	−0.346***	−0.378**	−0.326***
Physics	−0.449***	−0.449***	−0.449***	−0.476***	−0.439***
Intercept	2.816***	2.816***	2.816***	2.692***	2.886***
Number of obs.	505	505	505	505	505
R-squared	0.301	0.301	0.301	—	0.359

Table 6 presents calculations of Eq. (1) in five different cases of model specification. In column (1) the error term is assumed to be identically and independently distributed (IID), while in column (2) is assumed that the error term is heteroscedastic and, therefore, the model is estimated with White robust standard errors. In column (3) the error is assumed both heteroscedastic and serially correlated, whereas the model is calculated with clustered standard errors. In columns (4) and (5) is assumed the simultaneous presence of heteroscedasticity, serial and cross-sectional correlation and the estimations are made using feasible generalized least squares (FGLS) and panel-corrected standard errors (PCSE), respectively. Notice that columns (1–3) are almost identical to column (5) of Table 5. *** denotes significance at 1%, ** at 5%, and * at 10%.

a rising trend of collaboration in research, as discussed in Adams et al. (2005) and Sutter and Kocher (2004).

The results in Table 5 also indicate that obtaining doctoral degrees earlier seems to reduce the Nobel waiting period slightly, since the related parameter has a negative sign. However, the results are statistically significant only in the cases of chemistry and physics. With regard to the effect of the gender of the laureates, there is evidence of such influence only in the case of economists. The particular result should be viewed with some precaution, though, since the only two female laureates in the field include Esther Duflo, who is also the youngest person ever to receive the Nobel Prize in Economics. Conducting Nobel-related research in a Scandinavian country yields a positive, although not always statistically significant estimate. This result is both surprising and hard to explain with the available information.

The last column of Table 5 reports empirical findings from using the whole sample (i.e., data for all Nobel Prize laureates combined). The reference group (i.e., the group against which the effects of the explanatory variables are compared with) consists of the Nobel laureates in economics. It should be reiterated at this point that the sample does not include laureates who did not obtain a doctoral degree and those for whom the timing and the number of citations of their most prominent work was impossible to determine. The sample is also limited to the years for which the two precursor prizes (JBCM and LA) have been awarded, therefore only observations for the year 1945 and after are included in the calculations. Membership data for medical researchers (AMA) are not available, therefore the related variable is excluded from the calculations.

The statistical tests presented in the lower panels of Table 5 indicate that Eq. (1) may be econometrically specified as a panel data model with fixed (group) effects. To correct any heteroscedasticity of the error term, the calculations are derived using robust (White) standard errors. There is no evidence of serial correlation, but the Ramsey test indicates model misspecification. Therefore, Eq. (1) is also calculated using different specifications and empirical methods to examine the robustness of the calculations (see the next section for a discussion of the related findings).

The results in Table 5 indicate that the time gap between the publication of a major scientific work and the conferment of its author with the Nobel Prize increases at an annual rate of 2.2%. An increase in the number of citations by 1% is associated with a decrease in the time lag between work and recognition by 0.13%, while being a holder of a precursor award is associated with a decrease in the Nobel Prize waiting period by 14.4%. The length of time between pioneering work and recognition tends to be 22.7% lower for laureates who receive a shared Nobel award, while there are no statistically significant effects from either the laureates' gender or the age at which they receive their doctoral degrees. What is most remarkable in the empirical results in Table 5 is that the length of time between the publication of a major scientific work and its author's recognition with the Nobel Prize varies significantly across disciplines. Nobel laureates in chemistry have a waiting period that is 37.1% less than Nobel laureates in economics, while in medicine and physics the corresponding waiting periods are 30% and 36.2% shorter, respectively.

Robustness checks. Equation (1) is also calculated using different specifications of the error term, in order to examine the robustness of the calculations. More specifically, the general (all sciences) model is re-calculated with the assumption that the error term is either: (i) identically and independently distributed, (ii) heteroscedastic, (iii) heteroscedastic and serially correlated, and (iv)–(v) heteroscedastic, serially and cross-sectionally correlated. The empirical findings from these alternative specifications are summarized in Table 6. The results are quite similar to those in Table 5 in terms of sign and significance. Thus, the estimates in the previous sections are robust to alternative model specifications.

Discussion of findings. The previous sections examine variables that may be associated with the variation observed in years elapsed between a major scientific discovery and the recognition of its originator with the Nobel Prize. This is achieved by applying regression models with the "Nobel Prize Delay" as the dependent variable and the selected variables as the regressors. As it is observed, nearly all covariates are statistically significant and are exhibiting the anticipated signs (with the notable exception of Scandinavian affiliation).

Summarizing the results, the calculations suggest that the time lag between reporting a scientific discovery worthy of a Nobel Prize and the awarding of the medal increases over the years, in

the natural sciences. As this interval becomes higher, so the average age at which laureates are awarded the prize goes up. Since the Nobel Prize cannot be awarded posthumously, this lag threatens to undermine the stature and prestige of the awards (Fortunato, 2014) by constituting the recognition of ground-breaking research impossible due to the death of its authors. Becattini et al. (2014) attribute this increase of the Nobel waiting period to a decrease in the frequency of ground-breaking discoveries, which motivates the Nobel Prize Committees to dig deeper and deeper to the past each year to find worthy winners in their fields. The impact of the laureates' prize-winning work, proxied by the number of citations, seems to be associated with a moderation of this growing time lag (see, also, Gingras and Wallace, 2010).

Given the number of studies delving into the power of early career performance in predicting Nobel Prize winners (see, e.g., Inhaber and Przednowek, 1976), the finding that accolades widely perceived as Nobel Prize precursors seem to correlate with a shorter Nobel Prize waiting period does not come as a surprise. The present study employs the JBCM and the LA as such measures, but the fact that many awards associated with future Nobel Prize winners exist (see Chan et al., 2014) leaves room for future studies to investigate this correlation in more detail.

No relationship was found between the age at which laureates receive their doctoral degree and the time lag between their notable work and their Nobel Prize conferment (in the all Nobel categories sample). This is not unexpected, given the low degree of variation that the specific variable indicates in Table 3.

The calculations from the present study indicate that, in the disciplines of economics and chemistry, laureates who share the Nobel Prize tend to receive it sooner than scientists who receive an unshared award. Since no more than two discoveries can be awarded the Nobel Prize at the same time, and the number of scientists in each respective field increases in each year (see, e.g., Iwami et al., 2014), this result may possibly reflect efforts made from the Nobel Prize Committees to cut down the accumulated backlog of award-worthy candidates for the Nobel Prize by jointly awarding scientists with breakthroughs in similar or related research fields.[20]

There is no discernible correlation between the gender of the laureates with the length of time they have to wait for their Nobel award. This may indicate either that there is not such correlation, or that there are not enough data points in the sample for a correlation to become discernible due to the under-representation of women in the Nobel laureates' population (see, e.g., Lunnemann et al., 2019). It can be argued at this point that, since the sample size of women laureates is too small, any statistical test may not be generalizable.

With regard to differences across Nobel Prize disciplines, the calculations of the present study indicate that the time lag between reporting a scientific discovery worthy of a Nobel Prize and the conferment of the medal is longest in economics. The waiting period is lowest for chemistry, followed by physics and medicine-physiology. The existence of substantial differences across the Nobel Prize disciplines is consistent with previous empirical evidence (see, e.g., Van Dalen, 1999). Chan and Torgler (2013) attribute such differences to the codification process in each discipline. According to their argument, important discoveries in physics and chemistry are more easily codified and defined than in physiology or medicine, so their merits are more swiftly recognized.

An explanation for the notably longer time lag in the case of economics may lie in the fact that the prize only began to be awarded in that discipline in 1969. The backlog of potential laureates is therefore substantially bigger. Since the prize cannot be awarded posthumously, the Nobel Prize Committee may be prioritizing giving the award to older scientists to prevent them from not being recognized before they pass away, rather than awarding it to younger eminent researchers. This suggests that variables that the present paper does not control for, such as the laureates' age, may considerably affect the amount of time elapsed between the award-winning work and the call from Sweden. However, as previously described, the use of such a variable would create endogeneity concerns.

Another plausible explanation for the time lag may be that the Nobel Committee does not tend to award the prize to the same subfield in consecutive years. So, if there is a research team in economics who have published similar work with the previous year's laureate(s), they may have to wait for a considerable amount of time until an award to research in their subfield can once again be awarded.[21]

Yet another explanation for the larger gap in economics might be the fact that the Nobel Committees tend to award scientific discoveries after they are sufficiently verified via a lengthy period of testing. Economic theories take considerably longer to be empirically proven than, for instance, medical science breakthroughs, therefore the award in economics also takes a longer period from the point of publication to be granted.

It should be noted at this point that a major limitation of the current study is that it examines only scientists who have received the Nobel Prize, and not notable scholars who have come close to winning it but have not so far (as of 2020), or those who would have been awarded it if they had not passed away before their work was sufficiently recognized. However, extending the sample in such a manner would create the deeper technical problem of how to measure the time lag in the case of those brilliant individuals.

Another limitation is that the analysis does not contain any policy variables. If we believe that the Nobel Prize Committees attempt to spur more research in a certain direction, or to incentivise scientists to contribute to a specific line of inquiry, then it is rather ineffective to give the award decades after the initial discovery is made. From that perspective, the motivation exists to study the time lag with a view to formulating measures, which may hopefully shorten it. The current study, however, focuses more on explanatory rather than causal variables.

Conclusions

The time lag between reporting a scientific discovery worthy of a Nobel Prize and the awarding of the Nobel itself varies across time and disciplines. Furthermore, this time interval between reporting scientific breakthroughs and their recognition is significantly more extended in the field of economics. Given that the conferment of a Nobel Prize bestows substantial benefits to the laureates, to their affiliated institutions, and to academia as a whole (Merton, 1973), it becomes more and more essential to develop a more complete understanding of this aspect of the operation of the award system of science. The aim of the present study is to clarify this issue by examining variables, which are empirically associated with this Nobel Prize time delay across time and disciplines.

The findings indicate that the time between scientific discoveries and Nobel awards increases in the natural sciences, but not in economics. Factors such as bestowment of accolades widely regarded as Nobel Prize precursors and the number of citations of the laureates' most prominent publications seem to be associated with a moderation of this increase, suggesting that the Nobel Committee members might be influenced by such factors in their decisions. Scientists who share the Nobel Prize tend to receive it sooner than persons who receive an unshared award, but only in chemistry and economics, indicating that the Nobel Committees might be using their option to split the award as a way to reduce

the backlog of potential laureates in those fields. There are no significant differences in the specific sample between female and male laureates with regard to the time it takes for their work to be recognized by the Nobel Prize Committee. Also, the age at which laureates obtain their doctoral degree seems to matter, but only in the fields of chemistry and physics.

What is most notable is that the empirical findings suggest that the differences in the Nobel time lag across disciplines might be best explained by variables that the current study does not account for. One such possible explanation is the laureates' age, which was not included in the calculations due to endogeneity concerns. This suggests possible explanations for the longer Nobel Prize delay in the case of economics that include: (i) the existence of a substantially bigger backlog of potential laureates in comparison to other disciplines due to the later establishment of the award, (ii) the tendency of the Nobel Committee not to award the prize to the same subfield in consecutive years and (iii) the considerably longer period that economic theories require in order to be empirically proved, compared to the testing periods of discoveries in the natural sciences.

Data availability

The datasets generated and analyzed during the current study can be provided upon reasonable request.

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Notes

1 The Nobel Prize in Economic Sciences was established in 1968 by a donation from the Central Bank of Sweden to the Nobel Foundation, in order to recognize significant achievements in the field of economics. It was first awarded in 1969 to Ragnar Frisch (1895–1973) and Jan Tinbergen (1903–1994). Even if it is not one of the prizes that Alfred Nobel established in his will in 1895, it is administered and referred to along with the original Nobel Prizes by the Nobel Foundation. Its recipients are announced around the same time and they receive the award at the same ceremony as the laureates in the other five fields, namely Chemistry, Literature, Medicine-Physiology, Peace and Physics.

2 Weinberg and Galenson (2019), use two methods to identify the year(s) of the laureates' most cited work. The first method determines the years in which each laureate's citations are above a threshold (which is equal to the mean of each laureate's annual citations plus two standard deviations). In the second method, the authors identify the year in which the laureates made their single most important contribution—that is, the single year with the most citations for each laureate.

3 For example, Ye et al. (2013) provide statistical links between obtaining the Nobel Prize in Medicine-Physiology and accolades such as the Lasker Award and the Wolf Prize. Chan et al. (2018) demonstrate that recipients of the John Bates Clark Medal have increased chances to become Economics Nobel Laureates.

4 Nobel Prize winners are selected from lists nominated by "qualified nominators", a group that includes past Nobel Prize winners, Nobel Prize Committee members, various professors from Scandinavian countries, and other academics and scientists. The qualified nominators work within a nomination process that runs from September to February, with the selection process spanning February through early October. Although selection criteria disqualify deceased scholars, the academy may, and often does, select multiple winners (Mixon and Upadhyaya, 2014).

5 The data set contains citation records of prize-winning work of only 580 of the 700 Nobel winners examined. The reason for this is that many laureates published their work long before the prevailing referencing/citation system became widely applied and, thus, their publications indicate zero citations at the time of the Nobel award bestowment.

6 There are several studies delving into the potential of early career performance and recognition to lead to additional awards later in one's academic career. Seminal papers in the area include Cole and Cole (1967), Garfield and Malin (1968), Inhaber and Przednowek (1976), and Ashton and Oppenheim (1978), who examine the ability of early career performance to act as a predictor for Nobel Prize winners. For a summary and discussion of the awards correlated with the Nobel Prize, see Chan et al. (2014).

7 The JBCM was established in 1947 to award "American economists under the age of 40 judged to have made the most significant contribution to economic thought and knowledge". Despite the use of the word "American", economists of all nationalities are eligible for the JBCM, provided they are affiliated with an American institution at the time of the award. Based on the author's count, 13 JBCM winners have also gone on to win the Nobel Prize in Economics (as of 2020). JBCM is chosen over accolades such as the Frisch Medal (established in 1978) and an Econometric Society Fellowship (established in 1933) as a precursor of the Nobel Prize in economics, due to its higher explanatory power on the variable of interest.

8 The LA is granted to "living persons who have made major contributions to medical science or who have performed public service on behalf of medicine". It is selected as a Nobel Prize precursor due to its higher explanatory power on the variable of interest compared to other candidates, such as the Wolf Prize (established in 1978) and the Harvey Prize (established in 1972). Based on the author's count at the time of writing (2020), 89 LA winners have also gone on to win a Nobel Prize in either Medicine-Physiology, Chemistry or Physics. To account for the LA not being established until 1945, the sample used in the calculations carried out in subsequent sections is limited only to 1945–2019.

9 Information on the date and institution where the Nobel laureates obtained their Ph.D/MD is derived from either Encyclopaedia Britannica or Van Dalen (1999). An interesting peculiarity is that 33 scientists were awarded a Nobel Prize without ever obtaining a Ph.D or a MD, including 3 economists: John Hicks (Nobel Prize in Economics, 1972), James Meade (Nobel Prize in Economics, 1997), and Leonid Hurwicz (Nobel Prize in Economics, 2007).

10 There are also arguments that the academic age of the laureates does not really matter, since the early years of their careers are spent trying to establish themselves, and it is questionable whether much Nobel-worthy research is conducted in the first 5–10 years after their Ph.D. The data instead suggests that a certain number of years is needed in order to output Nobel-quality publications, and that academic age stops mattering beyond ~25 years (Van Dalen, 1999).

11 The same argument holds for using the age of the laureate in order to examine whether the Nobel Prize Committee members tend to expedite their decision to award the prize to potential recipients who are quite old and likely to pass away without receiving the award (since the Nobel Prize may not be awarded posthumously). Age of laureate at the time of the award, and time elapsed between the prize-winning publication and the award are also simultaneously determined. Therefore, they are endogenous, by definition.

12 The author is grateful to professor Louis Christofides of the University of Cyprus and the University of Guelph for suggesting the inclusion of the specific variable, and Rhonda Doyle (ACS), Pamela Stebbins (APS), Barbara H. Fiser, and Susan B. Houston (AEA) for data provision. Unfortunately, American Medical Association (AMA) membership numbers are not publicly available, therefore it is not possible to examine the extent to which the existence of a "backlog of potential Nobel Prize winners" affects the "waiting period" in the case of the Nobel Prize in Medicine-Physiology.

13 For example, economist Esther Duflo (Nobel Prize in Economics, 2019) is only the second woman to be named Nobel Prize recipient in her discipline, after Elinor Ostrom, who was awarded the Nobel Memorial Prize in Economic Sciences in 2009.

14 The present paper adopts the most commonly used definition of "Scandinavian countries", which refers to Denmark, Norway, and Sweden. A broader definition was also considered—including Finland and Iceland—which led to similar, if not identical, empirical results in all cases examined.

15 Since the dependent variable (Nobel Prize Delay) is expressed in a logged form, the time trend used in equation (1) is actually an exponential one, as in Becattini et al. (2014) and Fortunato (2014).

16 The memberships variable enters the equation as a rate of growth, because the panel data unit root tests indicate the log of the specific variable to be non-stationary in levels and stationary in the first differences. This also helps to circumvent multicollinearity concerns in the calculations, since the membership numbers are increasing over time and may therefore correlate with the trend. This is also reflected in Baffes and Vamvakidis (2011) and Polemis and Stengos (2022), where the trend is used as a proxy for the expanding pool of Nobel candidates, for the growing subfields of research and for the increasing life expectancy.

17 There is also the possibility for the coefficient of citation numbers to appear positive, since the longer the Nobel Committee waits before conferring the award on a candidate, the more the citations of their prominent work will grow. However, such (positive) correlation would be spurious.

18 Note that, since there can be up to three winners per year in each Nobel Prize category, the econometric model expressed by equation (1) may be actually viewed as a three dimensional (i.e., year, discipline, and laureate) panel data model. That means that the cohorts denoted by C_i in addition to Chemistry, Medicine and Physics, also include binary variables capturing the presence of a second or a third winner in the given year and discipline. For this reason, one cannot eliminate the probability that equation (1) may exhibit both fixed (discipline) and random (laureate) effects.

19 Since all the models employed in the present study have the general form of a semi-logarithmic regression, the effects of dummy variables are calculated according to

Halvorsen and Palmquist (1980), that is: exp(coef) −1, where coef denotes the corresponding coefficients estimated in the Table 5.

20 Since the related variable, as defined in the current study, does not distinguish between people who received the prize in the same year for independent work (in either related or unrelated contributions) from persons who received the prize in the same year by actually working together, there is no way to examine whether this result reflects the high productivity in Nobel laureate teamwork, as indicated in Hollis (2001) and Wuchty et al. (2007).

21 The hypotheses presented above were formulated following discussions with Professors Paula E. Stephan of Georgia State University and Terence Chong of the University of Melbourne.

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