Finding Young Einsteins: Olympiads and STEM Talent Discovery

Ruchir Agarwal, Patrick Gaule, and Yuyan Jiang*

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Abstract

Early identification and support for young talent can accelerate progress in science and technology, yet there is limited evidence on how to discover such talent. This paper examines whether the International Science Olympiads—global competitions featuring around 1,000 top high school students—can serve as effective tools for STEM talent discovery. Our findings reveal: (1) Olympiad medalists, though few, account for 5% of major science prize winners, increasing to 13% for math-specific awards; (2) Olympiad medalists are 10 times more likely to win major science prizes than undergraduates from the top 10 global universities, with over half of the top 500 Olympiad performers earning PhDs; (3) among Olympiad medalists, International Mathematical Olympiad (IMO) participants and gold medalists show the highest success rates, with roughly one in 50 IMO gold medalists winning a major science prize—40 times the rate of an MIT undergraduate. Overall, Olympiads, and especially the IMO, can be powerful tools for identifying future STEM innovators early on.

Keywords: Talent, Innovation, Universities, Scientific Knowledge Production

*Agarwal: Columbia University and Global Talent Fund. Gaule: University of Bristol and Global Talent Fund (corresponding author, patrick.gaule@bristol.ac.uk). Jiang: University of Cambridge. Acknowledgments: We gratefully acknowledge financial support from Founders' Pledge, Polynera, and Shaffer. We thank Archana Tiwari and Nisha Binu for research assistance, Deivis Angeli for comments, and Chris Peterson, Jeanette Lacoss, and Imre Leader for their insights on talent discovery. All errors remain our own.

1 Introduction

Young Albert Einstein struggled in school. One of his school teachers in Munich declared, "You will never amount to anything."[1] He left school without a diploma and later failed the entrance exam to the Swiss Federal Institute of Technology. Yet this seemingly difficult student would go on to revolutionize our understanding of the universe. While Einstein eventually succeeded, many future Einsteins may sit unrecognized in today's classrooms. This raises a fundamental question: Can we develop reliable ways to identify exceptional talent early—and ensure they receive the support they need?

Talented individuals often drive progress in science and technology. Yet our current systems may fail to identify many potential innovators. Current policies tend to support scientists or innovators only after they have proven themselves, missing crucial early opportunities. Grants, fellowships, and incentives are common for those already established in the field. Far less emphasis is placed on finding and nurturing young, untapped potential. This focus risks missing future innovators at a formative stage when support could matter most.

So, how can we improve at identifying exceptional talent early? The International Science Olympiads offer one promising avenue. These prestigious global competitions challenge and recognize high school students' abilities across key scientific disciplines. Each Olympiad focuses on a specific field—e.g., mathematics, physics, chemistry, informatics, or biology—allowing students to demonstrate their skills on a global stage. Unlike traditional metrics such as grades or test scores, the Olympiads emphasize creative thinking and advanced problem-solving abilities.

Olympiad alumni stories are compelling. Guido van Rossum, an International Mathematical Olympiad (IMO) bronze medalist, created the Python programming language. OpenAI's found-

[1]The physicist and science historian Martin Klein (1965) attributes this quote to Einstein's Greek teacher at Munich's Luitpold Gymnasium. In his article "Einstein and Some Civilized Discontents" in *Physics Today* (January 1965), Klein observed, "It is sobering to think that no teacher had sensed his potentialities," suggesting that traditional schooling often fails to recognize exceptional talent.

ing team includes Greg Brockman, Wojciech Zaremba, and John Schulman—all Olympiad participants. Vitalik Buterin, who won bronze at the International Informatics Olympiad, went on to create Ethereum. Grigori Perelman, an IMO gold medalist, solved the century-old Poincaré conjecture. Yet despite these examples, there has been little systematic analysis of how Olympiad performance predicts future achievements.

This paper aims to fill that gap. We examine how success in International Science Olympiads relates to long-term achievement in STEM. One challenge is the limited data that connects early academic success to later career outcomes, especially beyond college. Labor force surveys provide little information on early accomplishments. This makes it hard to track the path from youth excellence to professional achievements. Both exceptional youth performance and notable STEM career success are rare, adding complexity to the study.

We address these challenges by using publicly available competition results. We combine Olympiad data with other public sources, like Ph.D. repositories and lists of major scientific award winners. These include the Fields Medal, ACM Turing Award, and Nobel Prizes. This approach allows us to track Olympiad participants and see if they become leaders in science or mathematics. We focus on the first five Olympiads: mathematics, physics, chemistry, informatics, and biology. We refer to these as the International Science Olympiads.

We present three main results**:**

1. **Frontier Science**: Although Olympiad medalists number only in the hundreds each year, they account for 5% of major science prize winners (such as Fields Medals), with this share rising to 13% for math-specific awards.

2. **Exceptional Success Rate**: Medalists from the five major Olympiads are 10 times more likely to win major science prizes than undergraduate alumni from the world's top ten universities.

Notably, over half of the top 500 Olympiad performers go on to earn PhDs, compared with just 1% in the U.S. population and 0.2% worldwide.

3. **Predictive Power of Math and Gold Medals**: Among Olympiad medalists, those from the International Mathematical Olympiad (IMO) and higher-level achievers are more likely to win major science awards. IMO gold medalists (around 50 each year) achieve these awards at 70 times the rate of graduates from the top 10 global universities. Remarkably, about one in 50 IMO gold medalists secures a major science prize—40 times the rate of an MIT undergraduate.

Our findings indicate that high school competitions, particularly the International Science Olympiads, are an effective way to identify promising STEM talent at an early age. Mathematics competitions, in particular, are strong predictors of future success. A policy implication of these findings is that Olympiad results could be used more extensively to allocate scholarships and other forms of early support.

While Olympiads are valuable tools for discovering STEM talent, there are important questions that remain. Why do mathematics competitions seem to be especially predictive of STEM excellence? Does excelling in high school competitions have a causal impact on later scientific achievements? More systematic evidence is also needed to understand how other signals of early ability, such as grades and entrance exam scores, relate to long-term STEM success. Exploring these questions could deepen our understanding of how to better identify and nurture young talent.

1.1 Related Literature

This paper contributes to the discussion on policies that support science and innovation (Freeman & Van Reenen, 2009; Stepan, 2010; Bloom, Van Reenen & Williams, 2019), with a focus on expanding the supply of scientists (Freeman, 1975; Shu, 2015; Toivanen & Väänänen, 2016; Bell et al., 2019a, 2019b; Agarwal & Gaule, 2020)[2]. A crucial policy tool in this context is financial support for young talent. Although studies have examined the impact of funding at the doctoral or postdoctoral levels (Freeman, 2005; Kahn & MacGarvie, 2011; Jacob & Lefgren, 2011; Graddy-Reed, Lanahan & D'Agostino, 2021), few have explored how to effectively target these scholarships. This paper proposes a strategy for identifying and supporting high-potential young individuals likely to advance the knowledge frontier.

Our work builds on insights from Aghion et al. (2017), who found that IQ in early adulthood, measured through an army entrance test, correlates with inventive output. Being in the top 10% of the IQ distribution increases the probability of inventing by 2-3 percentage points, compared to an average of 1%. Although their focus was not on identifying future scientists, their findings imply that early aptitude tests could help identify those with significant potential. Our study extends this by showing that participation in high school competitions, such as the International Science Olympiads, provides an even more actionable signal of future scientific success.

Agarwal & Gaule (2020) track the careers of IMO medalists and find that those from developing countries are less likely to engage in knowledge production. A notable result is that IMO gold medalists are 50 times more likely to win the Fields Medal than Ph.D. graduates from the top 10 universities. While this finding highlights the exceptional potential of IMO participants—consistent with our paper—it is based solely on the Fields Medal and lacks comparisons with other Olympiads[3]. Our research expands on this by including participants from various Olympiads and examining their long-term achievements across multiple STEM fields and major scientific awards, underscoring the broader predictive power of early competition success.

Agarwal et al. (2023) show that IMO medalists are more productive when they migrate to the

[2] While the literature has often focused on pull incentives, such as competitive salaries (Freeman, 1975; Shu, 2015) or tax policies (Bell et al., 2019a), recent studies have taken a broader view, considering factors like educational access (Toivanen & Väänänen, 2016), exposure to innovation (Bell et al., 2019a, 2019b), and beliefs (Ganguli, Gaule & Vuletic, 2022).

[3] One issue with the Fields Medal is that its eligibility is restricted to individuals 40 years of age or younger, which may favor those who show early promise—similar to high school competitions.

U.S. They also find that financial constraints prevent many from studying in their preferred destinations, such as the U.S. or U.K. This underscores the importance of scholarships and targeted financial support. Our findings align with this, demonstrating that high school competitions can serve as practical tools for identifying individuals who would benefit most from such support.

The paper is organized as follows: Section 2 provides background on the International Science Olympiads. Section 3 outlines our data collection and methodology, and Section 4 presents the results. Section 5 discusses policy implications, limitations, and future research directions.

2 The International Science Olympiads

The International Science Olympiads are prestigious competitions designed to challenge and recognize high school students' skills in mathematics and the natural sciences. Each Olympiad focuses on a specific discipline, offering students the opportunity to demonstrate their abilities on a global stage. These competitions cover key scientific areas, including mathematics, physics, chemistry, informatics, and biology.

Which Olympiads: This paper focuses on the first five Olympiads established: the International Mathematical Olympiad (IMO), launched in 1959; the International Physics Olympiad (1967); the International Chemistry Olympiad (1968); the International Olympiad in Informatics (1989); and the International Biology Olympiad (1990). Although other Olympiads in fields such as astronomy, geography, and linguistics have since been introduced, we limit our focus to the original five. While the Olympiads differ somewhat in team size, exam format, and participant limits, they share many common features. Additional details on each Olympiad are provided in the appendix.

Participation Growth Over Time: Figure 1 illustrates the growth in participants across the Olympiads, as well as the number of countries involved in at least one Olympiad over time. Starting from modest beginnings, the total number of participants across all Olympiads grew slowly through the 1960s, 1970s, and the first half of the 1980s. By 1985, around 345 participants from 38 countries were involved across all Olympiads. The 1990s saw significant growth, with the number of participants reaching 1,000 by 1996. Growth continued more gradually thereafter, with 1,800 participants across all five Olympiads by 2022. This increase reflects factors such as the creation of new Olympiads (biology and informatics in the early 1990s) and an expansion in participating countries.

Selection Process: Students who reach the international level undergo a rigorous, multi-stage selection process, often involving multiple regional and national competitions. In the U.S., for example, students who perform in the top percentiles of the American Mathematics Competitions are invited to the American Invitational Mathematics Examination. The top 500 scorers from this exam then qualify for the USA Mathematical Olympiad, and further evaluations, including training camps, are used to select the final team of six students to represent the U.S. at the IMO.[4] Although each Olympiad has a team element with national team rankings, students compete individually and receive personal recognition for their performance.

Variation in National Reach: The reach and impact of national competitions, including those that feed into the International Olympiads, vary significantly by country and subject. For instance, in Brazil, approximately 18 million students—90% of the school-age population—participate in OBMEP, Brazil's national Olympiad for public schools. In other countries and subjects, participation may be limited to smaller groups of enthusiasts. Nevertheless, most countries organize competitive selection processes that involve thousands of students, narrowing down to a handful of representatives for the international stage.

[4] In the U.S., for instance, students scoring in the top percentiles of the (free-to-enter) American Mathematics Competitions are invited to the American Invitational Mathematics Examination. The top 500 scorers then qualify for the USA Mathematical Olympiad. Test results and training camps are used to select the team of six students that the U.S. sends to the International Mathematical Olympiad.

3 Data

A key challenge in studying how early achievements—such as high school competition results—predict career outcomes is the absence of comprehensive, longitudinal data. Ideally, we would track large cohorts of students from high school through their careers, examining which individuals go on to make contributions in science and engineering and linking these contributions to observable characteristics like grades or competition results. However, privacy laws and record linkage limitations make constructing such data challenging.

We developed an original dataset to provide insight into both the early achievements and long-term career outcomes of Olympiad medalists and scientific prize winners. Our data collection leverages publicly available information, including the individual results publicly announced by the International Science Olympiads. Using Olympiad websites, we constructed a database of all past participants in the five Olympiads over the period from 1959 to 2022. Accounting for multiple participations, our database includes 37,244 individuals from 141 countries.

Scientific Prize Winners: To examine long-term scientific contributions, we focused on major scientific prizes. Prizes are an attractive measure of contribution to science, as they are awarded following careful selection procedures and reflect the recognition of scientists by their community. We constructed a list of 126 awards (and their recipients) across mathematics, physics, chemistry, computer science, biology, and engineering.[5] The Nobel Prize is naturally included in this list, along with the Wolf Prizes, the Abel Prize, and many others.

Our data includes 2,125 prize winners who have won one or more prizes from 2010 to 2023. We identified these winners and matched them to their Olympiad participation records.[6] We also col-

[5]After careful consideration and cross-validation, we selected these awards based on their daily views on the corresponding Wikipedia pages. In doing so, we follow the approach of Ma & Uzzi (2023) in their systematic study of scientific prizes.

[6]While we need to address name disambiguation issues, matching the two datasets is relatively straightforward because we know both the population of International Science Olympiad participants and the population of prize winners.

lected information on the universities where prize recipients obtained their undergraduate degrees. This allows us to compare Olympiad medalists with graduates from top universities in terms of their likelihood of winning scientific awards.

Doctoral Education: To assess who becomes a professional scientist, we used Ph.D. attainment as a proxy. Given the cost of collecting this type of data, we focused on a subsample of 500 individuals, including the top 100 performers from each of the five major International Science Olympiads in 2000. We collected information on these individuals using multiple sources and matched their profiles to Olympiad participants.[7] For comparison, we also calculated the percentage of individuals earning Ph.D. degrees in the 1982 birth cohort in representative countries from different income groups. This comparison provides a baseline to assess if Olympiad participants pursue Ph.D.s at rates higher than their peers across different types of countries.

4 Results

This section examines the career outcomes and scientific contributions of International Science Olympiad participants by addressing three core questions: (1) How much do Olympiad medalists contribute to major scientific achievements? (2) How likely are top Olympiad performers to become leading scientists? (3) Which Science Olympiads, based on discipline and medal level, are most predictive of significant scientific breakthroughs?

4.1 How Much Do Olympiad Medalists Contribute to Major Scientific Achievements?

We are particularly interested in understanding the extent to which Olympiad prize winners contribute to advancing the knowledge frontier. To measure this empirically, we use a custom-built

[7] The sources we use include, but are not limited to, Wikipedia, Google Scholar, ORCID, Open Access Theses and Dissertations (OATD), ProQuest Dissertations & Theses Global (PQDT), ResearchGate, LinkedIn, Facebook, university and institute websites, and local news.

database of scientific prize winners (see data and methods section). Overall, we find that 5% (107 out of 2,124) of scientific prizes awarded in our sample have been won by participants from one of the five International Science Olympiads. Two pieces of context are useful to put this number in perspective. First, the popularity of the Olympiads is a relatively new phenomenon, and scientific achievements naturally lag high-school age results by quite a few years. Second, the number of individuals participating in the international Olympiads is in the hundreds (or low thousands in recent years).

(Insert Figure 2 about here)

Distinguishing between the competitions reveals that International Mathematical Olympiad (IMO) participants won the lion's share (82%) of the awards won by Olympiad participants (Figure 2). This reflects the success of IMO participants in winning mathematics awards (12.6% of mathematics prizes have been won by IMO participants). However, IMO participants have also been successful in winning prizes outside mathematics – winning 11 prizes, more than the total number of prizes won by International Olympiad in Informatics (IOI) or International Physics Olympiad (IPhO) participants in any field (10 and 9 respectively). We could not find any awards won by participants from the biology Olympiad and only 1 from the chemistry Olympiad participants.

4.2 How Likely Are Top Olympiad Performers to Become Leading Scientists?

We next examine the extent to which top Olympiad scorers become professional scientists or mathematicians, as proxied by obtaining a doctoral degree. This analysis is based on following the top 100 scorers in each of the five major Olympiads, as described in the data section. As shown in Figure 3, panels A and B, 58% of Olympiad top scorers obtain doctoral degrees, rising to 64% in rich countries. For comparison, only around 1% of the general population gets doctoral degrees in the US or in the OECD at large, and less than 0.2% worldwide. Olympiad top scorers are thus at least 50 times more likely to get a PhD than a member of the general population.

(Insert Figure 3 about here)

Being an Olympiad top scorer is an excellent predictor of getting a PhD not just in rich countries but also in poorer ones, where obtaining a PhD is an even rarer outcome. Around 59% of top Olympiad scorers in upper-middle-income countries (panel B) and 53% in low and lower-middle-income countries (panel C) get a PhD degree. For comparison, only 0.28% of Brazilians and 0.08% of Indians get PhD degrees.

While not our main focus, we note that the share of Olympiad participants getting a PhD degree tends to be lower in poorer countries. In low and lower-middle-income countries, 53% of Olympiad top scorers get PhDs compared to 59% in upper-middle-income countries and 64% in high-income countries. This is consistent with Agarwal & Gaule's (2020) finding that IMO participants from developing countries are less likely to become knowledge producers. However, our results here are noisier since we focus on a single cohort of participants.

We observe some differences across Olympiad types in the extent to which being a top scorer correlates with getting a doctoral degree. A higher share of top scorers in mathematics, physics, and chemistry Olympiads get doctoral degrees (65%, 66%, and 66% respectively), compared to biology and informatics (48% and 46%). We discuss possible reasons for these differences in the discussion section.

4.3 Which Science Olympiads Are Most Predictive of Future Breakthroughs?

We complement the evidence on the number of awards won by considering the ratio of awards to the number of individuals participating in each competition. We compute these numbers separately for all five competitions and medal categories (gold, silver, and bronze). For comparison, we also consider the number of awards won by undergraduate alumni from 10 leading global universities relative to their total alumni numbers.

(Insert Figure 4 about here)

Figure 4 displays the share of alumni winning scientific prizes for both leading global universities and International Science Olympiads. Among leading global universities, Caltech alumni are the most successful, with one in 862 going on to win a major scientific prize, followed by Harvard and MIT.

Alumni from certain International Science Olympiads win at a much higher rate. Among IMO gold medalists, one in 56 goes on to win a major scientific prize, compared to one in roughly 150 for IMO silver medalists or IOI bronze medalists. IMO medalists become scientific prize winners at thirty times the rate of undergraduate alumni from the world's top ten universities (seventy-five times for IMO gold medalists). Not all Olympiad medals are equally predictive: in biology and chemistry, we can hardly find any examples of Olympiad alumni winning major scientific prizes, and correspondingly the share of alumni winning prizes is zero (except for chemistry gold).

(Insert Table 1 about here)

Table 1 analyzes the propensity of winning a scientific prize for Olympiad medalists and undergraduate alumni from top 10 universities in a regression format.[8] Medalists from one of the five international Olympiads are around 10 times more likely to win a scientific prize than undergraduate alumni from 10 leading global universities (column 1). However, this masks substantial heterogeneity across medal categories and Olympiads. Gold medalists in any Olympiad are 26 times more

[8]These regressions are run on the union of the set of Olympiad medallists (n=21,243) and the set of undergrad alumni from 10 leading global universities (n=813,481). The dependent variable is an indicator for winning one or major scientific prizes. The variables of interest are indicator variables for different types of medals in one of the International Science Olympiads. The omitted category/reference is undergraduate alumni from 10 leading global universities. To facilitate the interpretation of coefficients, the dependent variable is rescaled by a factor 1/0.000241 so that its mean is 1 for the undergraduate alumni from 10 leading global universities.

likely to win a major scientific prize than undergraduate alumni, compared to 4.5 times for bronze medalists. Moreover, IMO and IOI medals are strongly associated with winning prizes whereas International Chemistry Olympiad (IChO) and International Biology Olympiad (IBO) medals are not (column 3). When distinguishing both medals and Olympiad categories, an IMO gold is associated with a 70x higher chance of winning a scientific prize, followed by IMO Silver (24x) and IOI Gold (17x).

The results suggest that while medaling in an Olympiad is not necessarily predictive of winning a subsequent scientific award, winning a gold medal and/or medaling in a mathematics competition is strongly predictive of winning a subsequent scientific award.

5 Discussion

Surprisingly little evidence exists on whether and how we might identify, at an early stage, individuals with exceptional potential to advance the knowledge frontier. This paper has examined the role of high school competitions as a tool for discovering such individuals. Our findings show that excellence in Olympiads is a strong predictor of earning a doctoral degree and receiving scientific awards for impactful contributions in science and mathematics. While Olympiad performance correlates with engagement in a scientific career across disciplines—mathematics, physics, informatics, biology, and chemistry—it is most predictive in mathematics, with some disciplines, such as chemistry and biology, showing weaker links to future scientific awards.

Traditionally, science and technology policies focus on supporting those who have already established scientific careers, through grants, fellowships, prizes, or similar forms of support. However, there is growing recognition of the importance of expanding the pool of individuals who enter scientific careers by intervening earlier. Some policymakers may seek to address underrepresentation in STEM fields, while others may be motivated by efficiency considerations, such as improving the quality and size of the STEM workforce. Early interventions, when well-targeted, hold promise for both broadening participation and enhancing efficiency, especially when such interventions are expensive on a per-individual basis. By using Olympiads as an identification tool, policymakers and institutions can direct early resources to individuals with the strongest potential, helping to allocate competitive university placements, fellowships, or even structured exposure to STEM careers and innovation environments.

Some studies suggest that interventions exposing young talent to high-level scientific or innovation-focused environments can encourage careers in these fields (Cohodes, Ho & Robles 2024). Yet, such programs can be costly on a per-student basis, limiting the scale at which they can be implemented. Programs like summer sessions at prestigious institutions (e.g., MIT) involve high logistical costs, especially if they require travel, accommodation, and tailored mentoring for each student. Identifying exceptional talent through Olympiads offers a way to narrow the selection to those with a demonstrated aptitude for STEM, making such "exposure-to-innovation" interventions more targeted and cost-effective. By focusing resources on high-potential students, we maximize the impact and efficiency of these initiatives, potentially increasing the likelihood of nurturing future innovators and scientific leaders.

While competitions appear to be useful for identifying young individuals with strong potential in STEM, they have certain limitations. First, some gifted individuals may be less inclined toward competition and thus might avoid Olympiads altogether. For example, women have historically been underrepresented in these competitions.[9] Second, access to Olympiads varies widely, with talented students in some regions lacking opportunities due to limited awareness, financial constraints, or lack of access to competitions. In some developing regions, such as parts of Africa, competition reach is limited, and in other countries, participation fees may pose a barrier. Third, preparing for

[9] Historically, less than 10 percent of participants in the IMO have been women. There may be ways to make competitions more inclusive and appealing to women, such as through female-only competitions. Ultimately, however, Olympiads are competitions that may be unappealing to certain individuals and groups.

Olympiads requires a significant time commitment, which may come at the expense of other academic pursuits or personal enrichment activities.

These limitations may put a premium on investing in Olympiad infrastructure and mathematics to broaden and deepen the talent pipeline. This could include establishing Olympiad programs in underserved countries, creating more inclusive formats, such as regional Olympiads or girls-only Olympiads (e.g., the European Girls' Mathematical Olympiad, or EGMO), and improving training (Calaway 2024, Ellison & Swanson 2016, Card & Giuliano 2024). Such investments would make competitions and mathematics more accessible and appealing, ensuring that more young talent has the opportunity to participate and excel. Additionally, it may be worthwhile to explore other technologies beyond competitions that could support early talent identification.

We conclude by noting a few open questions. One key question is why mathematics competitions, in particular, appear to be more predictive of individuals' ability to push the knowledge frontier. A simple explanation might be that knowledge production in fields outside of mathematics is more reliant on external factors, such as access to physical resources or even luck. However, this explanation is not consistent with the fact that individuals who excel in mathematics competitions often go on to win scientific prizes in diverse fields beyond mathematics. Another possibility is that the types of problems presented in mathematics competitions are better suited to capturing certain dimensions of intelligence and problem-solving abilities that correlate strongly with scientific excellence. A third, more practical, explanation is that mathematics competitions reach a larger pool of participants, as they have established longer traditions, are more widely accessible, and require minimal resources beyond pen and paper. This larger pool may result in stronger talent being identified among mathematics Olympiad medalists. Further research to explore these hypotheses would help clarify why mathematics competitions are more effective at identifying future leaders in science.

A second question is whether the relationship between high school competition success and later scientific achievement reflects more than mere correlation. On one hand, developing advanced problem-solving skills as a teenager could directly enhance one's ability to contribute to knowledge production later in life. On the other hand, success in competitions may encourage young people to continue pursuing science, either by building their confidence or by granting access to new opportunities, such as scholarships to top universities.[10] While our study has focused on high school competition results as predictors of future scientific success, establishing a causal link would provide additional justification for policymakers to support the development and expansion of such competitions.

Finally, much remains to be learned about other forms of talent identification, both in isolation and in comparison to competitions. High school students often go through various assessments, such as standardized exit exams or university entrance exams, but the extent to which these scores predict long-term excellence is unclear. Similarly, could extracurricular activities—such as chess, music, or summer research projects—serve as indicators of high potential? Further research into these various identification methods is essential for ensuring that exceptional talent is recognized and nurtured. By advancing our understanding of how to identify and develop young talent, we can better leverage human potential to drive progress in science, innovation, and economic growth.

[10] Using a regression discontinuity design with data from the Brazilian public mathematics Olympiad, Moreira (2019) finds that winning an honorable mention increases the confidence of not only the winners but also their school peers. Similarly, Agarwal & Gaule (2020), using a regression discontinuity design around IMO medal thresholds, do not find that earning a higher medal at the IMO increases the likelihood of pursuing a Ph.D. Even less evidence exists on the value of training for the IMO and similar competitions.

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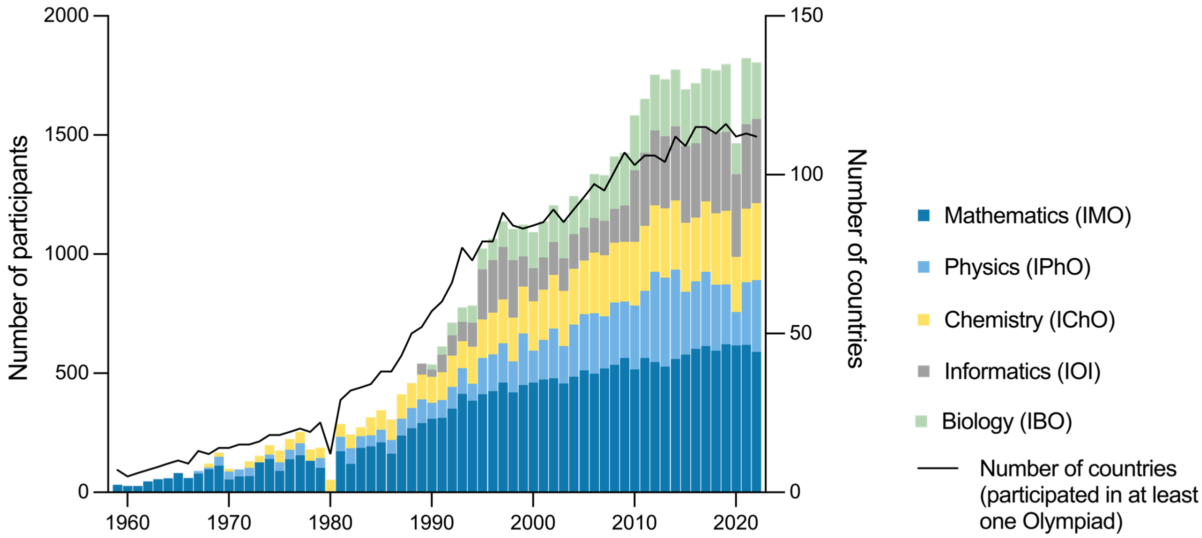
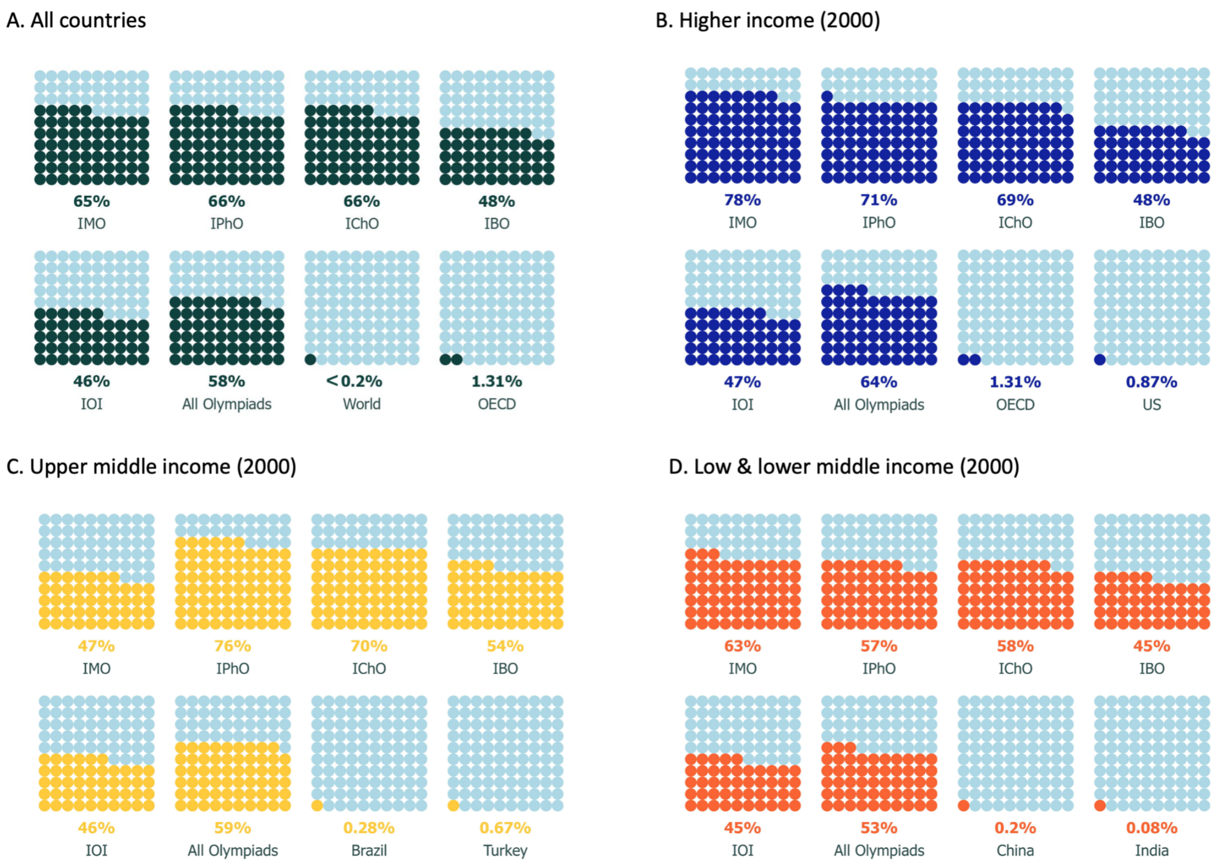
Tables and Figures

Figure 1: Participation in the International Science Olympiads



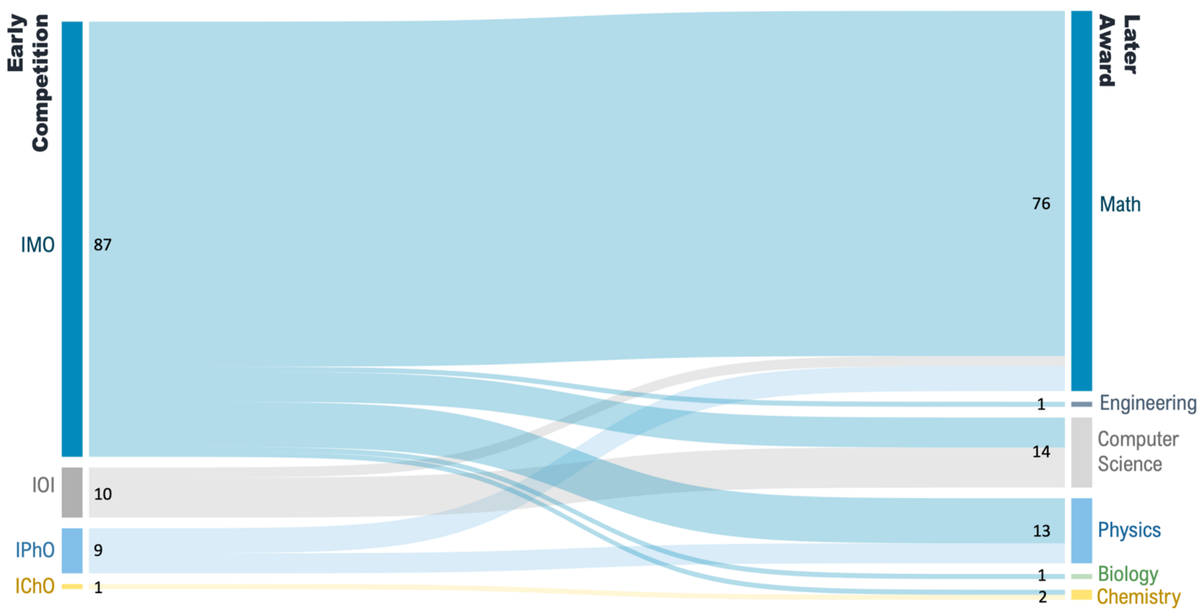
Notes: This Figure includes data for all participants and participating countries of the five major International Science Olympiads (IMO, IPhO, IChO, IOI, and IBO) from 1959 to 2022. The stacked bars show the number of participants in each Olympiad and the line shows the number of countries that participated in at least one Olympiad.

Figure 2: Obtaining a Doctoral Degree



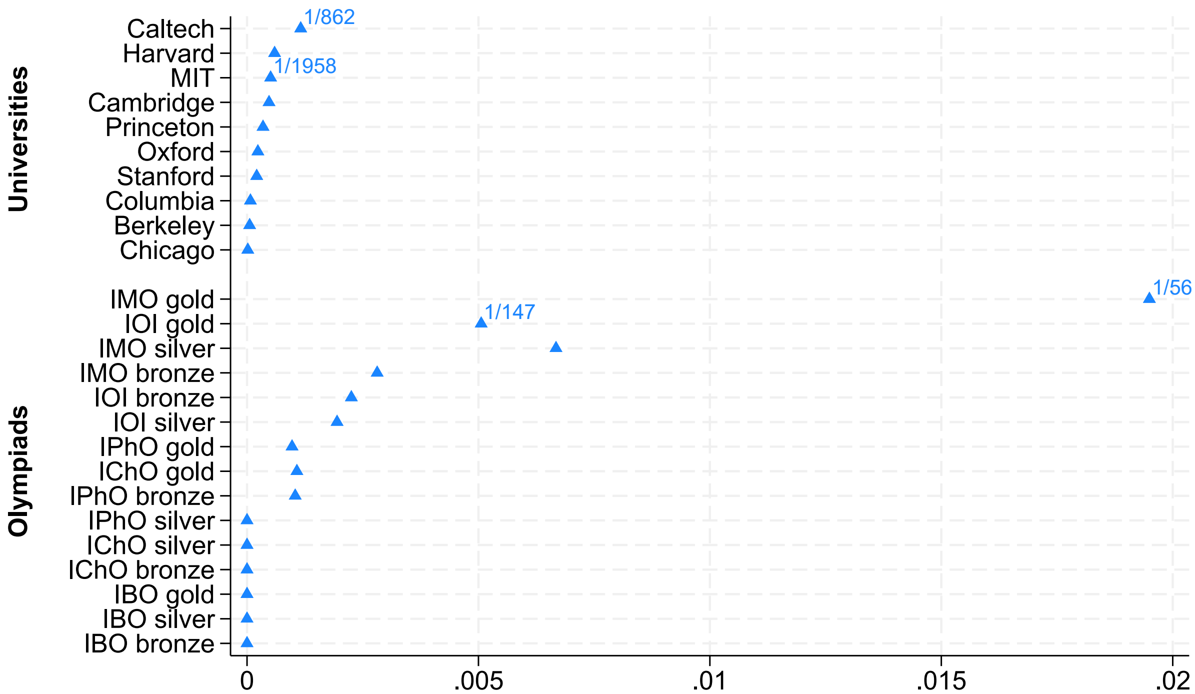
Notes: This Figure tracks the education of the top 100 scorers in each of five major Olympiads (held in 2000), with the general populations as comparison groups.

Figure 3: Scientific Prizes won by International Science Olympiads Alumni



Notes: The Figure shows the number of scientific prizes won between 2010 and 2023 by alumni from the major International Science Olympiads. The width of each band represents the number of prizes won by alumni from a given Olympiad in a specific discipline. The numbers in parentheses on the left represent the total number of prizes (across all disciplines) won by alumni from each Olympiad. The numbers in parentheses on the right represent the total number of prizes won in each discipline by alumni from any of the five Olympiads. The International Biology Olympiad (IBO) is not shown on the graph as no scientific prizes were won IBO alumni in our data.

Figure 4: Share of Alumni Winning Scientific Prizes



Notes: This Figure was constructed by (1) computing the number of scientific prize winners (awarded between 2010 and 2023) who are alumni from 10 leading global universities or one of the major international science Olympiads (distinguished by Olympiad and medal category); (2) computing the number of undergraduate students (enrolling between 1980 and 2009) and the number of Olympiad alumni (participating between 1980 and 2003) within each Olympiad and medal category; and (3) taking the ratio between the numbers from (1) and (2).

Table 1: Propensity to Win a Scientific Prize

	(1) Overall		(2) Medal Types		(3) Olympiads		(4) Both	
Any medal	10.33***	(0.50)						
Gold Medal			26.64***	(1.10)				
Silver Medal			8.39***	(0.86)				
Bronze Medal			4.50***	(0.73)				
IMO medal					29.94***	(0.92)		
IOI medal					10.25***	(1.33)		
IPhO medal					1.90*	(1.11)		
IChO medal					-0.10	(1.10)		
IBO medal					0.01	(1.15)		
IMO Gold							69.94***	(2.13)
IMO Silver							23.95***	(1.52)
IMO Bronze							9.06***	(1.23)
IOI Gold							17.16***	(3.07)
IOI Silver							4.29**	(2.18)
IOI Bronze							6.16***	(1.78)
IPhO Gold							3.00	(2.27)
IPhO Silver							-1.63	(1.91)
IPhO Bronze							2.84*	(1.56)
IChO Gold							3.71	(2.39)
IChO Silver							-1.16	(1.79)
IChO Bronze							-1.03	(1.47)
IBO Gold							-0.91	(3.02)
IBO Silver							-0.89	(2.19)
IBO Bronze							-0.95	(1.78)
Obs.	834,724		834,724		834,724		834,724	
R2	0.0005		0.0009		0.0013		0.0023	
Mean of DV (raw)	0.000241		0.000241		0.000241		0.000241	
Mean of DV (adj)	1		1		1		1	

Notes: These regressions are run on the union of the set of Olympiad medalists (n=21,243) and the set of undergraduate alumni from 10 leading global universities (n=813,481). The dependent variable is an indicator for winning one or more major scientific prizes. The variables of interest are indicator variables for different types of medal in one of the International Science Olympiads. The omitted category/reference is undergraduate alumni from the 10 leading global universities. To facilitate the interpretation of coefficients, the dependent variable is rescaled by a factor of 1/0.000241 so that its mean is 1 for the undergraduate alumni from 10 leading global universities. Standard errors are in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

A Further Background on the International Science Olympiads

The International Science Olympiads are a series of prestigious international competitions held annually for high-school students. They cover a wide range of scientific disciplines and aim to challenge and recognize exceptional young minds in various scientific fields. These Olympiads typically include formal sciences (e.g., mathematics and computer science), natural sciences (e.g., physics, chemistry, and biology), and sometimes social sciences as well. During the Science Olympiads, teams of students representing different countries compete against each other through rigorous exams and practical problem-solving tasks. The competitions are organized at the national level first, and the top-performing students from each country then advance to the international stage. In this paper, we mainly focus on five well-recognized International Science Olympiads in mathematics, physics, chemistry, computer science, and biology.

A.1 IMO

The International Mathematical Olympiad (IMO) is the World Championship Mathematics Competition for High School students and has been held annually in a different country since 1959. It started in East European countries and has gradually expanded to over 100 countries. A participating country may send a team of up to six students under the age of 20 and not enrolled in a tertiary institution. In the competition, there are six problems worth seven points each for a maximum total score of 42 points. The problems cover a variety of secondary school mathematics topics, such as geometry, number theory, algebra, and combinatorics, with no prior knowledge of higher mathematics required. Competitions are held over two consecutive days, during which contestants must solve three problems in four-and-a-half hours. Prizes are awarded to approximately half of the top-scoring contestants, with gold, silver, and bronze medals distributed roughly 1:2:3.

A.2 IPhO

Inspired by the IMO, the first International Physics Olympiad (IPhO), which is the World Championship Physics Competition for High School students, was held in Poland in 1967. It has gradually expanded to over 80 countries. Each national delegation is made up of at most secondary school students. The main aim of IPhO is to test the highest level of knowledge, critical thinking, problem solving, right practices of presentation and analysis, and hands-on skills in theoretical and experimental physics. The competition consists of two examinations, one theoretical examination lasts 5 hours and consists of three questions and one practical examination may consist of one or two experimental tasks which together last five hours. Gold, silver, and bronze medals are rewarded to the top 8%, 25%, and 50% of participants and an honorable mention or better is awarded to the top 67%.

A.3 IChO

The International Chemistry Olympiad (IChO) is a prestigious international chemistry competition for high school students. The first IChO was held in 1968, and it has gradually expanded to over 80 countries. Every year, each national team competes with up to 4 students. In the competition, a five-hour laboratory practical exam and a five-hour written theoretical examination are held on separate days to assess participants' knowledge and skills in chemistry. A gold medal is awarded to the top 12% of students, a silver medal to the next 22%, a bronze medal to the next 32%, and an honorable mention is awarded to the top 10% of participants who did not receive a medal.

A.4 IOI

The International Olympiad in Informatics (IOI), an annual competitive programming competition, is one of the International Science Olympiads for secondary school students. The first IOI was held in 1989 in Bulgaria to stimulate interest in informatics (computing science) and information technology. It now has more than 80 countries participating every year. Each participating country can send up to four students to take part in the contest. Students are typically given three problems to solve in C++ in five hours on each competition day. All problems from both competition days are summed up separately for each individual, and medals are awarded based on their relative total scores. The top half of the participants are awarded medals, with a ratio of approximately 1:2:3 for gold, silver, and bronze.

A.5 IBO

The International Biology Olympiad (IBO) is a biological competition for pre-university students under the age 20, and is one of the most well-known International Science Olympiads. The first IBO was held in Czechoslovakia in 1990 and it has gradually expanded to include more than 70 participating countries. Every year, participating countries send the four winners of their National Biology Olympiad to the IBO and the participants cannot compete more than two times in the competition. During IBO, students have to participate in Theoretical Exams (50%) and Practical Exams (50%). The Theoretical Exams include approximately 100 questions, which cover topics including cell biology, plant anatomy and physiology, animal anatomy and physiology, ethology, genetics and evolution, ecology, and biosystematics. The practicals usually consist of three to four laboratories, with content domains announced approximately six to twelve months before the IBO. By conducting experiments and analyzing data in the lab, students practice biological skills. The competitors are ranked based on their equally weighted scores for the theoretical and practical tasks according to the t-score of individual theoretical and practical tasks. The top 60% of participants are awarded medals, with a ratio of approximately 1:2:3 for gold, silver, and bronze, and the top 25% of non-medalists are awarded a certificate of merit.

B Constructing The Doctoral Education Database

We focused on a subsample of 500 individuals, comprising the top 100 participants from the five Olympiads in 2000. To link their profiles to competition participants and chess players, we used various sources and applied the following matching criteria:

1. We checked if the individual's CV or profile mentioned their participation in Olympiads.
2. For those who began university studies between 2000 and 2003 or obtained a PhD between 2008 and 2015, majoring in STEM or Economics (Finance), and had a relatively unique name (not yielding over 1,000 results on Linkedin), we considered a potential match.
3. We ensured that the profile photo corresponded to the official photo taken during the competitions.

Profiles were matched to Olympiad participants if they satisfied any of the above criteria (i, ii, or iii). As a proxy for medium-term outcomes in science, we utilized the attainment of a doctoral degree, which includes degrees like Doctor of Philosophy (PhD), Juris Doctor (JD), and Doctor of Public Health (DrPH). Individuals without a matched online profile or lacking educational information on their profile were coded as having no doctorate degree

Countries or regions in our sample were categorized into four income groups—low-, lower-middle-, upper-middle-, and high-income groups—based on their GNI per capita in 2000, calculated using the World Bank Atlas methods. Due to the limited number of Olympiad participants and chess players in the low- and lower-middle-income groups, we combined these two groups into one, resulting in three income groups for comparison. We considered the US and 26 OECD countries as representatives of the high-income group, Brazil and Turkey for the upper-middle-income group, and China and India for the low- and lower-middle-income group.

In our analysis, we made the assumption that individuals typically obtain their doctoral degree around age 28. We then calculated the probability of obtaining a doctoral degree among those born in 1982 for representative countries from different income groups. To calculate the chance of obtaining a doctoral degree, we divided the number of people who obtained a doctoral degree in 2010 by the total number of births in 1982 for each respective country. The results of these calculations are presented in Table S1, along with the relevant sources for each country's data. In the US, a large share of PhD graduates are international students. In the US, a large share of PhD graduates are international students. Thus, for the US, we use the number of US citizens obtained a doctoral degree instead of the number of doctoral graduates in the country. For India, we did not find the number of doctoral graduates for the year 2010, so we used the data for the academic year 2011-12 instead.

B.1 Constructing the Prize Recipients Database

Apart from studying who gets a PhD degree, we were also interested in the extent to which Olympiad medalists make groundbreaking achievements in science. To measure groundbreaking achievement, we compiled a list of scientific prizes.

List of prizes. The selection of these prizes was based on their daily views on the corresponding Wikipedia page, using Pageviews Analysis as a reference. We included an award in the list if its corresponding Wikipedia page had an average of no less than 5 daily views (2 for early or mid-career awards) from 1st July 2015 to 31st October 2022. Additionally, these awards needed to have more than 10 recipients since their establishment and should be international, intercontinental, or eligible for individuals working in the UK or US. Due to the limited history of IOI and IBO, we restricted the awards to early and mid-career awards in Computer Science and Biology. Our analysis has resulted in a list of 124 later scientific awards selected from seven fields, including Mathematics, Physics, Chemistry, Computer Science, Biology, Engineering, and Economics, based on these criteria.

List of prize winners. After selecting the awards, we collected information about the award winners from 2010 to 2023. The list of later award winners was obtained from the official websites of the prizes and awards in November 2022. Only prizes or awards awarded in or before November 2022 were included in our sample, and any prizes or awards awarded after that date were not considered in the analysis. Our data includes 2,124 awards made to 1,744 distinct individuals from 2010 to 2023.

Data collection for prize winners. For each prize winner, we manually collected data on educational history, including undergraduate degree institution and year. We also coded whether they participated in the International Science Olympiads and their results.

Alumni from leading global universities. To establish a group to compare Olympiad medalists with, we first defined a list of 10 leading global universities.[11] We then used public source to collect information on the number of undergraduate students enrolling in each of these universities across all majors.

[11]Based on the 2022 Academic Ranking of World Universities (ARWU), we selected the following top 10 universities are: Harvard University, Stanford University, University of Cambridge, University of California, Berkeley, Massachusetts Institute of Technology (MIT), Princeton University, University of Oxford, Columbia University, California Institute of Technology (Caltech), and University of Chicago. See http://www.shanghairanking.com/rankings/arwu/2022 for more information.