Why U.S. Immigration Matters for the Global Advancement of Science

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Research agenda: The Economics of Lost Talent

The world may miss out on breakthrough science and innovation if talented individuals do not receive appropriate support to develop their abilities.

1. Invisible Geniuses AER:Insights 2020

2. This paper (IMF/IZA WP)

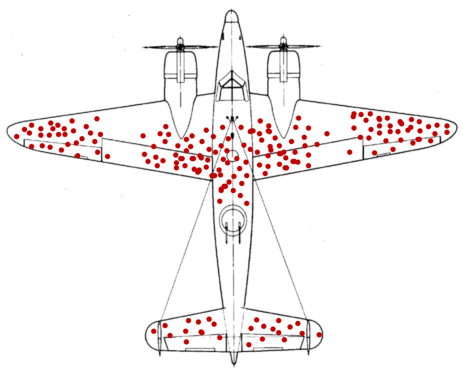
The immigrants behind the COVID-19 vaccines

How does immigration affect science and innovation *globally*?

- Literature investigating the effect of immigration on innovation in host countries (especially the U.S.)
  - Stephan & Levin (2001), Hunt & Gauthier-Loiselle (2010), Borjas & Doran (2012), Stuen, Mobarak & Maskus (2012), Gaule (2013), Moser, Voena & Waldinger (2014), Ganguli (2017), Doran & Yoon (2018), Moser & San (2020), Cristelli & Lissoni (2021)
- **Much less attention on how immigration affect science and innovation *globally***

Empirical challenges

- We want to observe migrants to different countries, and stayers
- We don't want to sample on success, i.e. we need to find people with great potential irrespective of whether they eventually make it
- Previous studies on migration patterns of highly cited scientists (Weinberg (2011), Hunter, Oswald & Charlton (2009))



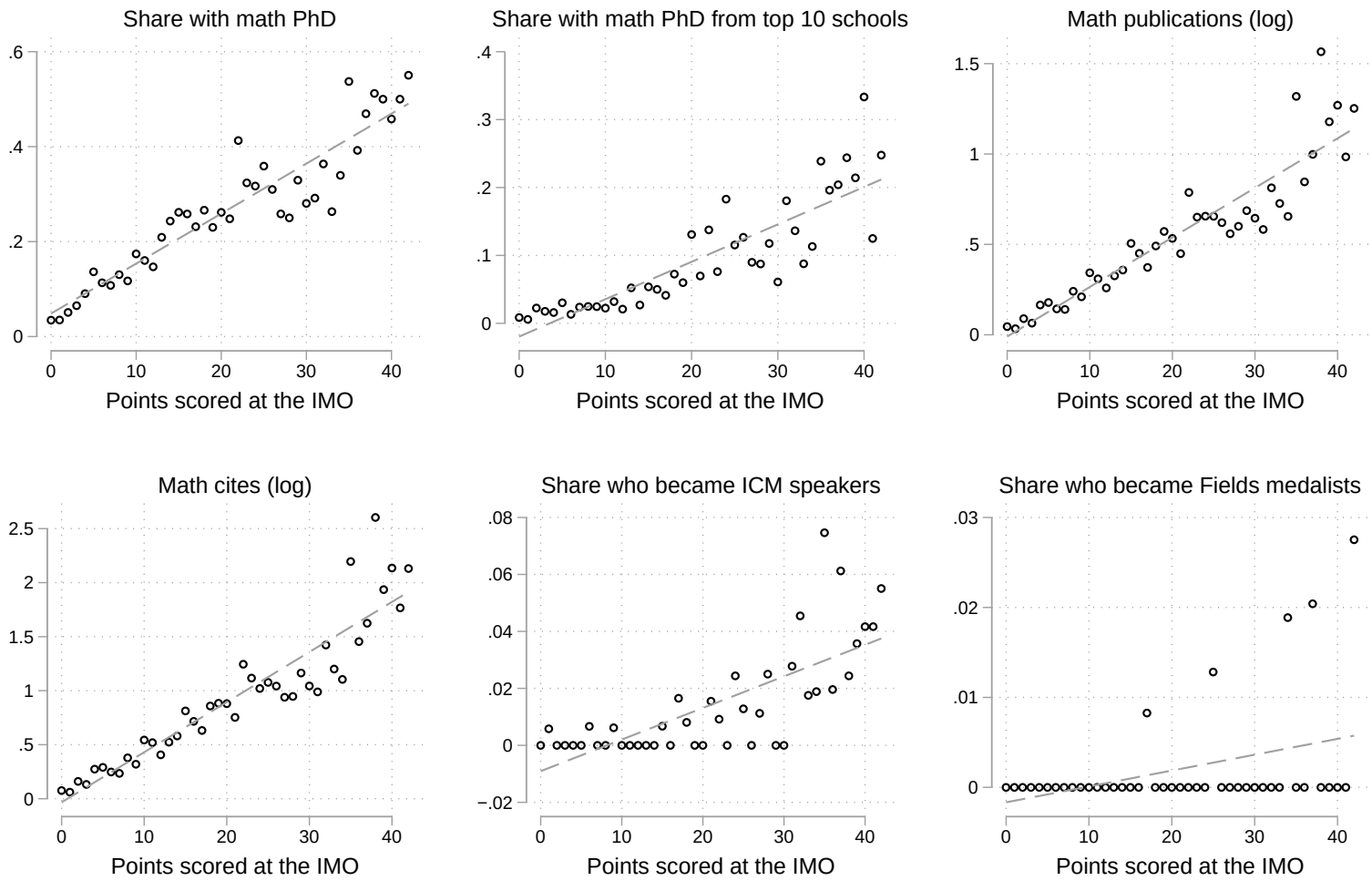
Talented youth: the International Mathematical Olympiad (IMO)

2019 Olympiad Q1

Let $\mathbb{Z}$ be the set of integers.
Determine all functions $f: \mathbb{Z} \to \mathbb{Z}$ such that, for all integers a and b,

$$f(2a) + 2f(b) = f(f(a+b))$$

IMO scores predict subsequent career achievement



Source: Agarwal & Gaule - AER Insights (2020)

Novel data sources on talented youth

- Data on IMO medalists (1981-2000, n=2,200) and *points scored* (measure of math ability)
- Matched to their math publication counts; and speakers at the International Congress of Mathematicians; manually collected data on current occupations and locations
- Original survey of approx. 500 recent IMO participants with measures of aspirations, info on universities applied to and series of hypothetical choices for university offers

Results preview

- A few countries, and the U.S. in particular, excel at *nurturing* talent
- Many talented individuals would like to migrate but are prevented to do so by financing constraints
- Reducing financial barriers to immigration could increase the global scientific output of future cohorts by more than 50%

Outline

Nurturing talent: the migration productivity premium

Attracting talent: dreams and reality

Implications for global science

Migration and productivity

$$Productivity_{iot} = \beta\, Migrant_{iot} + \eta_i + \zeta_t + \gamma_o + \varepsilon_{iot} \qquad (1)$$

- Poisson regressions
- *Productivity* is math publications or cites; speaker at the Int'l Congress of Mathematicians
- η_i, ζ_t and γ_o are IMO points fixed effects, cohort fixed effects and country of origin fixed effects

	(1)	(2)	(3)	(4)
	Cites-weighted math publications		Becoming speaker at the Int. Congress Mathematicians	
Migrant	1.445***		0.033***	
	(0.218)		(0.009)	
Migrant to the U.S.		1.653***		0.052***
		(0.216)		(0.013)
Migrant to the U.K.		1.020***		0.007
		(0.368)		(0.018)
Migrant to other countries		1.158***		0.010
		(0.294)		(0.010)
IMO points FE	Yes	Yes	Yes	Yes
Country of origin FE	Yes	Yes	Yes	Yes
Cohort FE	Yes	Yes	Yes	Yes
Observations	2,195	2,195	2,272	2,272

Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Magnitudes: $exp(1.653) - 1 \approx 4.2$; $exp(1.020) - 1 \approx 1.8$

	(1) Cites-weighted math publications	(2) Becoming speaker at the Int. Congress Mathematicians
From developing country	-1.150***	-0.014***
	(0.218)	(0.005)
Migrant	1.321***	0.039**
	(0.254)	(0.016)
Migrant x From developing country	0.298	-0.013
	(0.356)	(0.018)
IMO points FE	Yes	Yes
Cohort FE	Yes	Yes
Observations	2272	2272

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Interpreting the coefficient on migrant

- β compares the productivity of migrants and non-migrants for individuals with *similar math talent (IMO score)* using variation in migration across the score distribution (e.g. due to idiosyncratic preferences or constraints)
- IMO score is an objective measure of ability and highly relevant for admission to US undergrad programs (interviews about admissions at MIT)
- Could still be selection on unobservables correlated with migrating and math productivity (e.g. motivation) - *but they would have to play a large role to explain the entire effect*

Estimates from related literature

- Fulbright scholars who have to leave the U.S. produce 35%-44% less output than matched students from the same program Kahn & MacGarvie (2016)
- Indian nationals working in a large multinational IT firm who win the H1B lottery have 3x higher salaries relative to losers Clemens (2013)

Intensive and extensive margins

- We can further look at occupational choices of medalists:
  - Conditional on being in an academic career, are migrants more productive?
  - Are migrants more likely to go into academic careers in math (vs. IT or finance)?
- There is an effect on the extensive margin for migration in general but it is primarily the intensive margin playing a role in the U.S. premium

Intensive margin: conditional on entering academia

	(1)	(2)	(3)	(4)
	Cites-weighted math publications		Becoming speaker at the Int. Congress Mathematicians	
Migrant	1.053***		0.074***	
	(0.231)		(0.026)	
Migrant to the U.S.		1.329***		0.129***
		(0.250)		(0.036)
Migrant to the U.K.		-0.021		0.027
		(0.359)		(0.038)
Migrant to other countries		0.569*		0.002
		(0.310)		(0.022)
IMO points FE	Yes	Yes	Yes	Yes
Country of origin FE	Yes	Yes	Yes	Yes
Cohort FE	Yes	Yes	Yes	Yes
Observations	527	527	548	548

Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Extensive margin: likelihood of entering academia

	(1) Academia (math)	(2) Academia (not math)	(3) Finance	(4) IT
Migrant to the U.S.	0.208***	0.157***	0.038***	0.202***
	(0.028)	(0.024)	(0.014)	(0.025)
Migrant to the U.K.	0.264***	0.116**	0.257***	-0.012
	(0.066)	(0.053)	(0.059)	(0.025)
Migrant to other countries	0.281***	0.171***	0.038**	0.099***
	(0.036)	(0.032)	(0.019)	(0.027)
IMO points FE	Yes	Yes	Yes	Yes
Country of origin FE	Yes	Yes	Yes	Yes
Cohort FE	Yes	Yes	Yes	Yes
Observations	2,272	2,272	2,272	2,272
Mean of D.V.	0.241	0.125	0.045	0.093

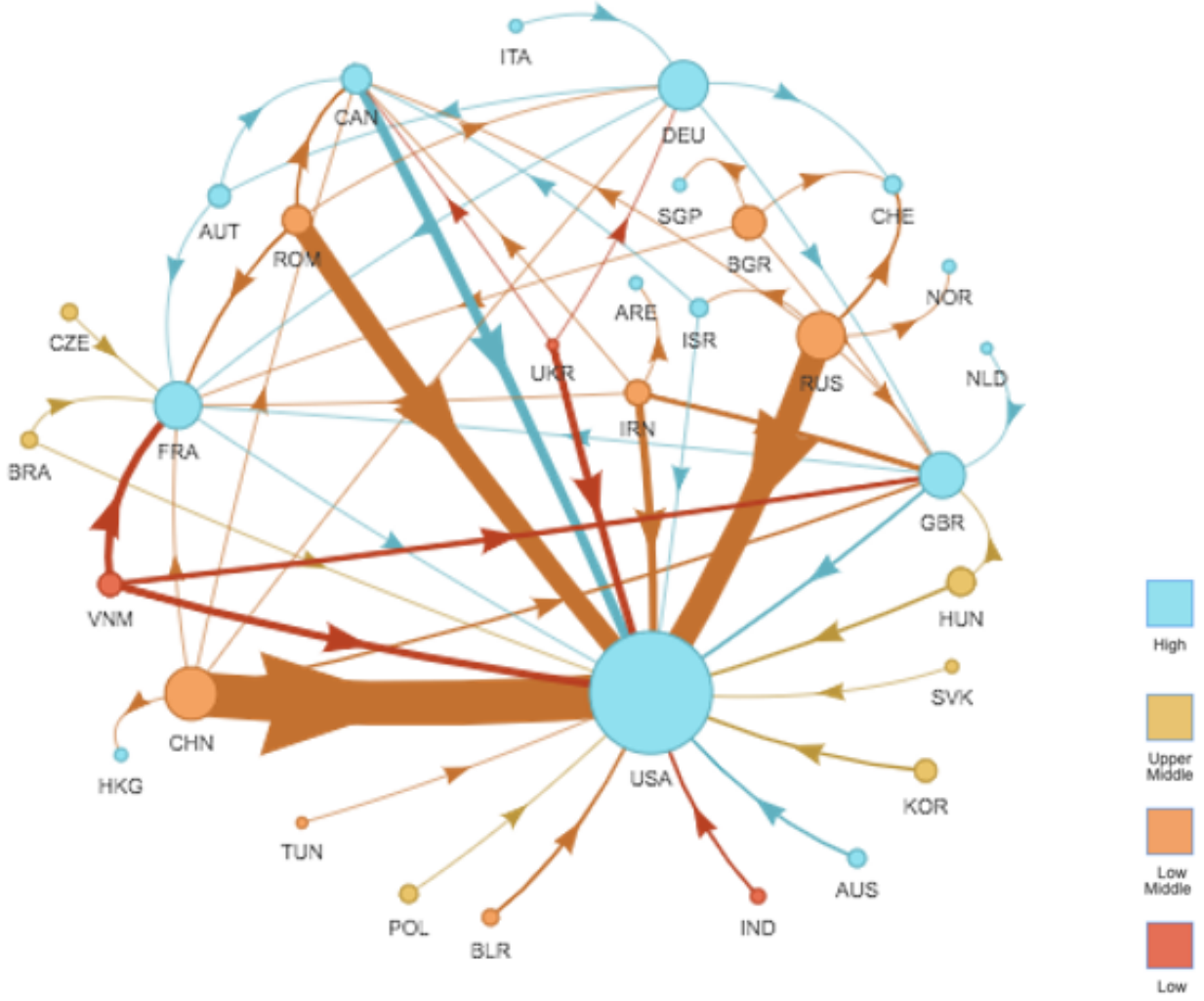
Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Outline

If you are currently living in a third-world country, leave the country for your undergraduate degree. The level of the universities is very poor and won't satisfy your thirst for knowledge.

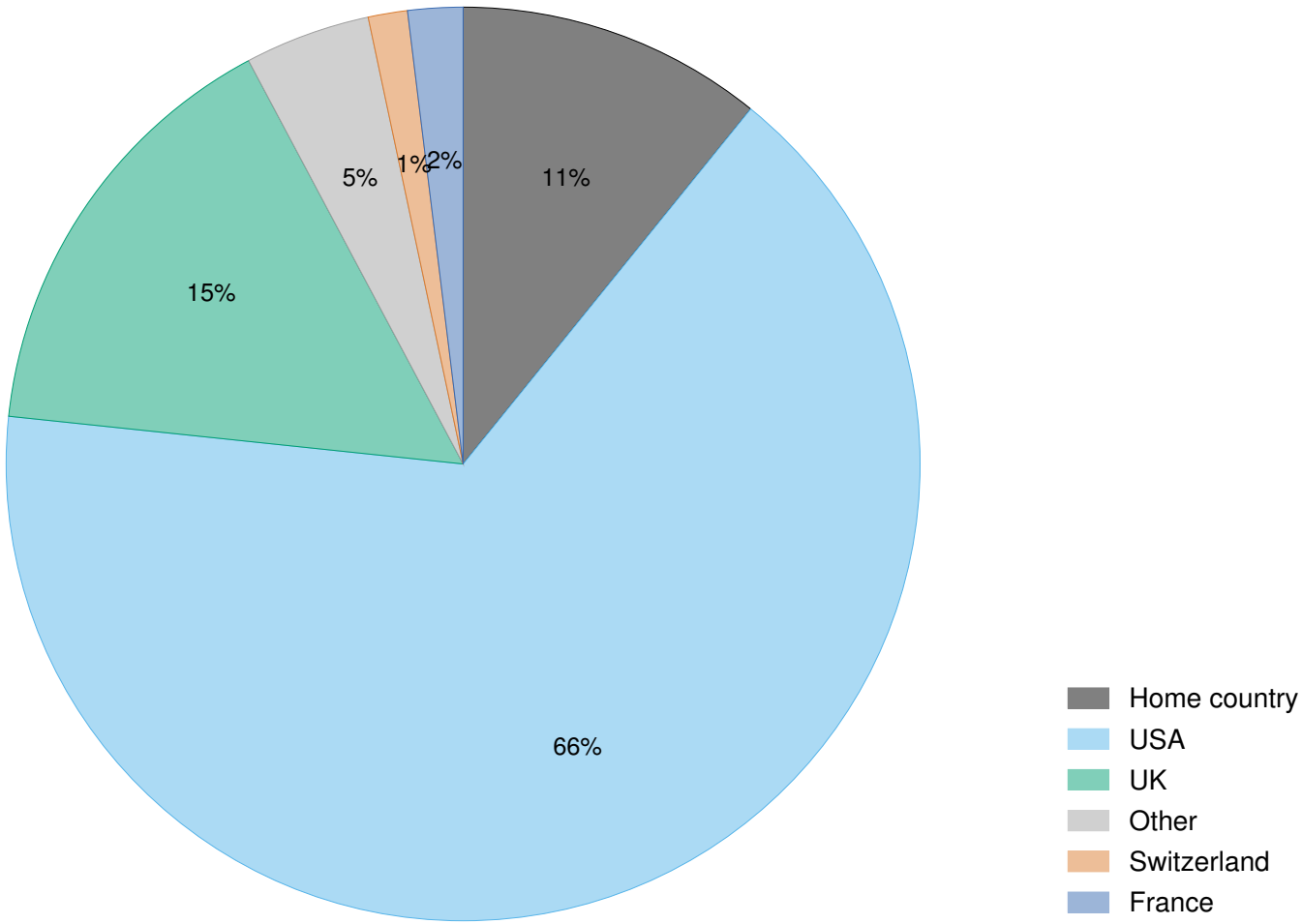
Advice from a former IMO participant

Migration flows among IMO gold medalists



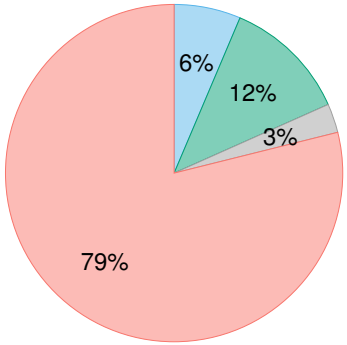
If you could have studied anywhere for your undergraduate degree, where would you have wanted to study?

Figure: Dream destination, developing country participants

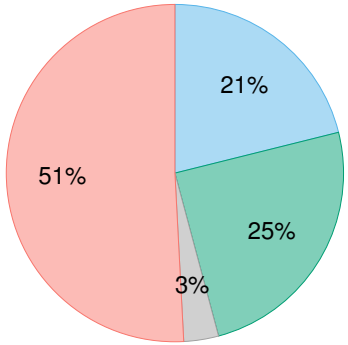


Studying abroad: dreams and reality

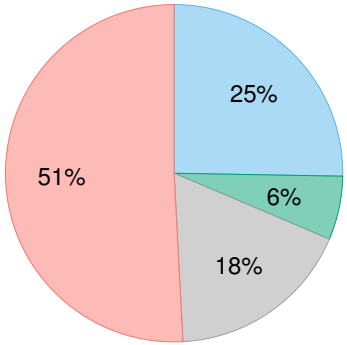
a: Advanced countries: actual



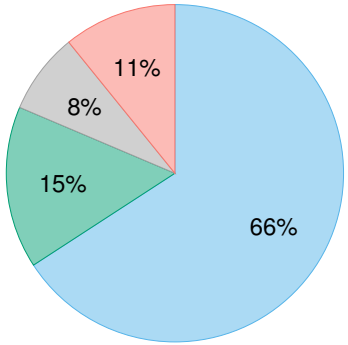
c: Advanced countries: dream



b: Developing countries: actual



d: Developing countries: dream

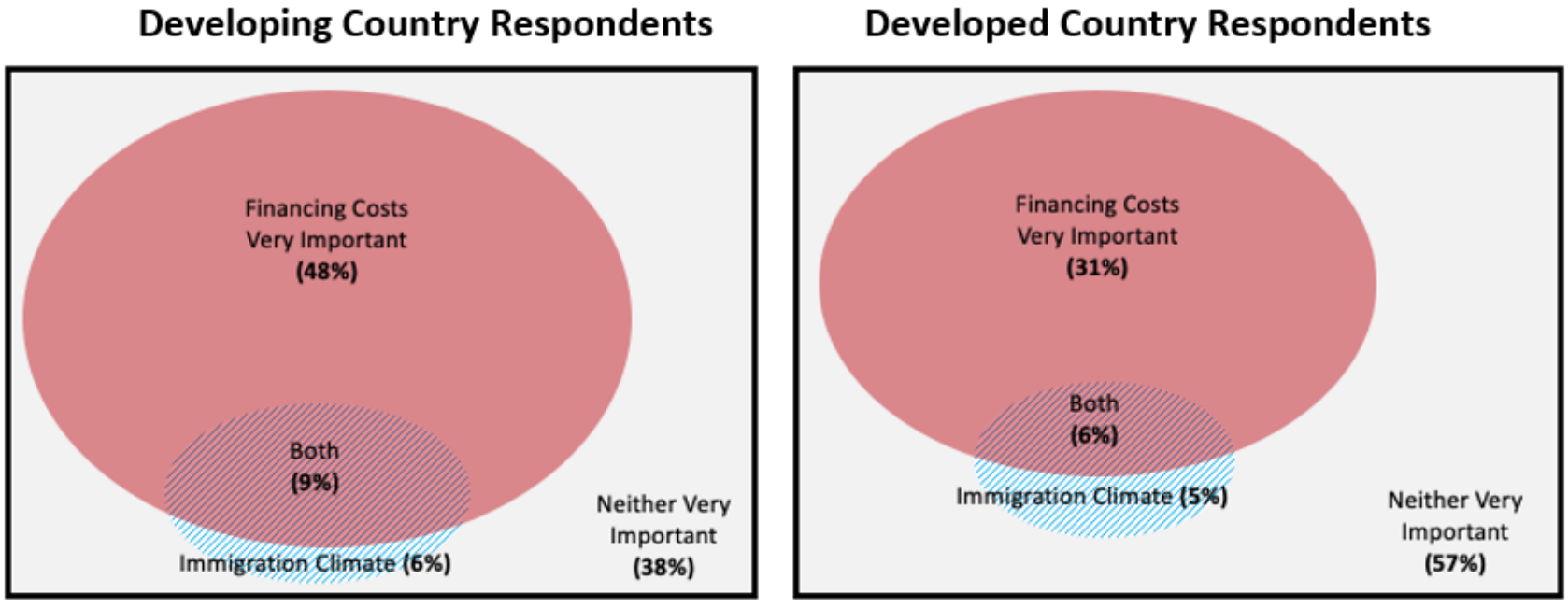


USA UK Other countries Origin country

Constraints to migrating

- Interviews suggested that financing constraints are an important barrier
- Key margin is students not even applying to U.S. undergrad programs
- In our survey we set out to understand the role of these constraints

Why did you not apply to U.S. universities?



Share of Respondents Citing Financial Costs or Immigration Climate as 'Very Important' Reason for Not Applying to US Institutions

Hypothetical choice questions

Q31 Suppose you had the choice between these two admission offers. Which one would you choose

College admission offer #1
University: Stanford University
Location: Stanford, USA
Financial support: No financial support

College admission offer #2
University: New York University
Location: New York, USA
Financial support: Full financial support

	Prefer left (1)	Indifferent (2)	Prefer right (3)
Which offer do you prefer? (1)	○	○	○

Developing country respondents are 25 percentage points more likely to choose the funded option in this type of hypothetical questions

Outline

Why does migration matter for the global advancement of science?

- Migration enables talented individuals to develop their potential: migrants are twice more productive than stayers
- Many talented individuals move abroad, but many others want to move but are prevented to do so by financing constraints
- Putting these two components together, we can quantify the impact of reducing barriers for talented youth

A thought experiment

How much more knowledge could be produced if all could study in their preferred location?

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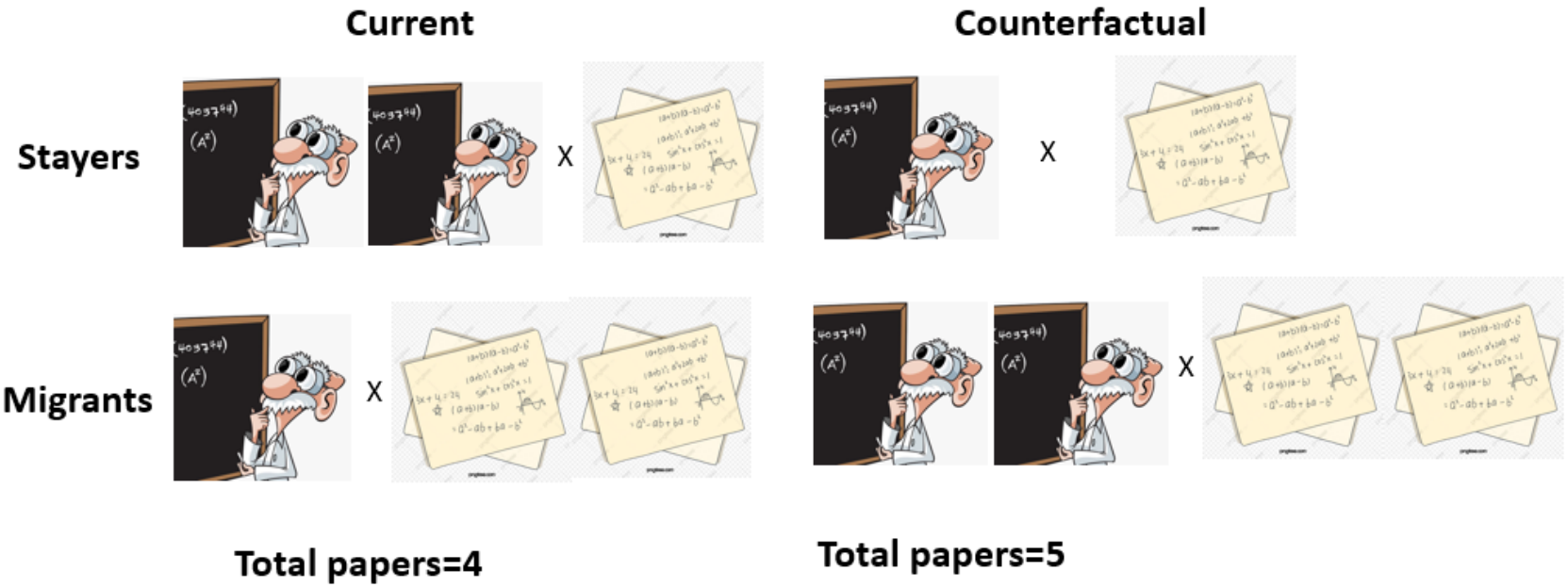
- The following calculation will assume that the productivity differences among stayers and migrants to different countries can be interpreted causally
- We do not consider (positive) knowledge spillovers to other individuals
- Or (negative) crowding out effects

A thought experiment - simplified version

- Migrants are about twice as productive as stayers
- Currently 1/3 of IMO participants migrate, this would jump to 2/3 if all could study in their preferred location



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- *If all who want to study in their preferred country could do so*, the share of migrants to the U.S. would jump to 42% (share of stayers down to 33%, share of migrants to the U.K. up to 20%, migrants to other countries down to 6%).

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- Productivity regressions suggest that compared to stayers, migrants to the U.S. are 4.2 times more productive, migrant to the U.K. are 1.8 times and migrants to other countries are 2.2 times more productive.

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- Productivity regressions suggest that compared to stayers, migrants to the U.S. are 4.2 times more productive, migrant to the U.K. are 1.8 times and migrants to other countries are 2.2 times more productive.
- **Total output would be 54% higher**
  [(0.33*1+0.42*4.2+0.2*1.8+0.06*2.2) / (0.67*1+0.15*4.2+ 0.09*1.8 +0.1*2.2)]

Beyond mathematics

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- Nikolai Durov, gold medalist at the 1998 IMO is the cofounder of VK (the Russian facebook) and Telegram
- Soham Mazumdar, silver medalist at the 1997 IMO, is the co-founder of Rubrik, a cloud data management company with 2000 employees

Policy implications

- Allowing talent from around the world the chance to nurture their talent by moving abroad could help accelerate science and innovation
- An opportunity to attract top talent through scholarships for highly talented individuals

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- An opportunity for philanthropic investment?
- We have recently been approached by Effective Giving, a philanthropy advisory group