

Economic Benefits and Losses from Foreign Science, Technology, Engineering, and Mathematics (STEM) Talent in the United States

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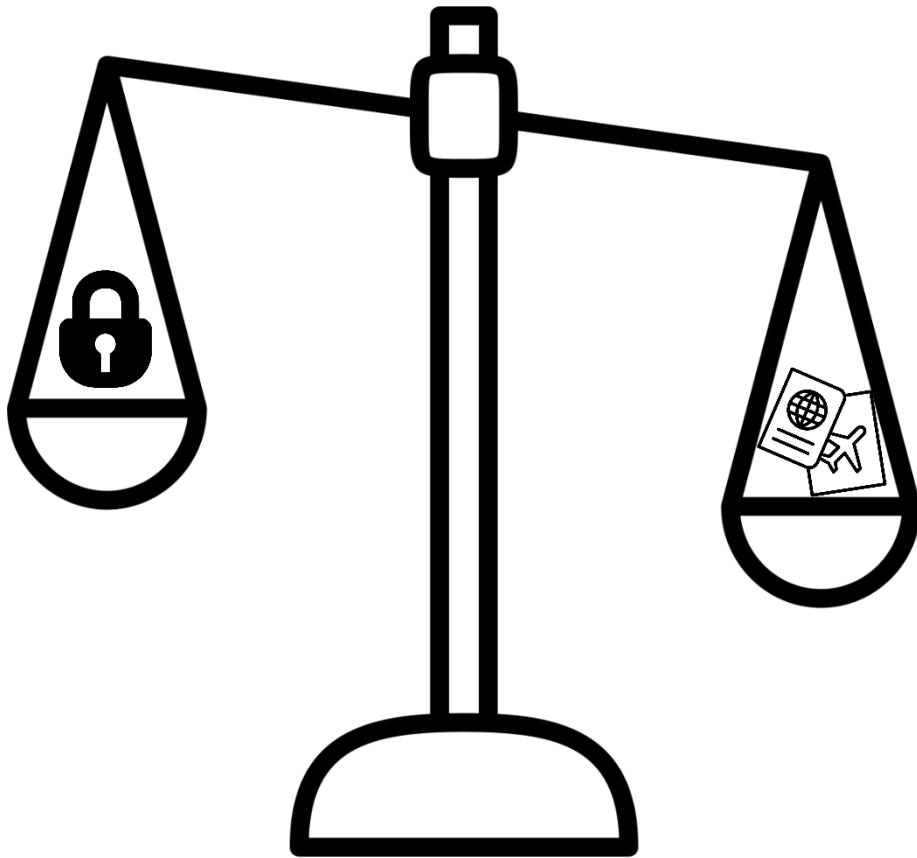
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STEM Workers are Important for U.S. Economic Growth



- Technological innovation key driver of economic growth
- STEM talent, particularly at PhD level, critical to technological innovation
- U.S. Government exploring policy options to increase supply of STEM talent, domestic and foreign, for U.S. workforce

Analysis Will Better Inform Discussions About STEM Immigration Policy



- Policymakers considering how to balance benefits associated with openness of U.S. scientific enterprises with the concerns that this openness could be exploited by foreign competitors
- Differing views about benefits and losses have driven debates about tightening or easing U.S. immigration and visitor policies
- OSTP asked STPI to estimate benefits and potential losses from foreign STEM talent

Study Questions



1. What is the role of foreign STEM talent in the U.S. STEM workforce?



2. How large are the economic benefits foreign STEM talent provides the United States?



3. How large are the potential economic losses foreign STEM talent might inflict on the United States?

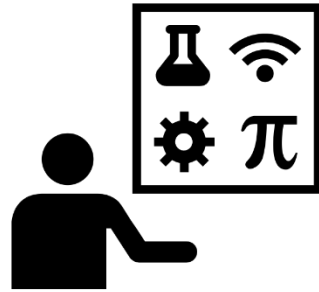


4. How do economic benefits compare with potential losses?

Role of Foreign STEM Talent in U.S. STEM Workforce

What is the STEM Workforce?

Who is Included in Foreign STEM Talent?



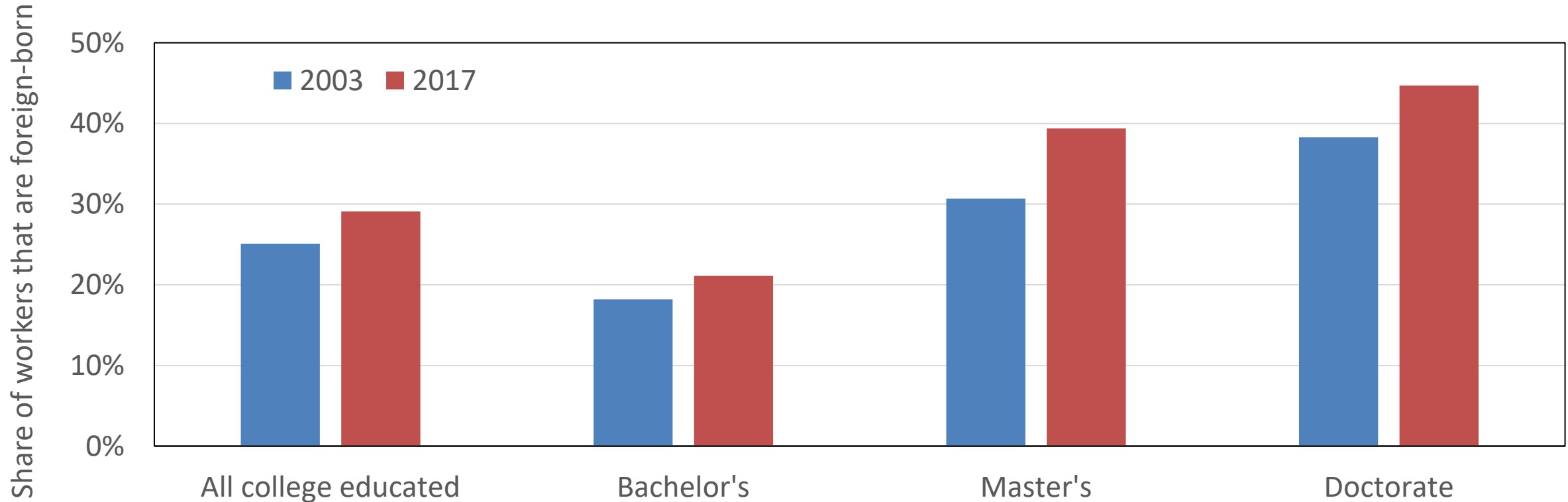
STEM workforce composed of:

- Computer and mathematical scientists
- Biological, agricultural, and environmental life scientists
- Physical scientists
- Social scientists
- Engineers
- Post-secondary STEM teachers

Foreign talent encompasses:

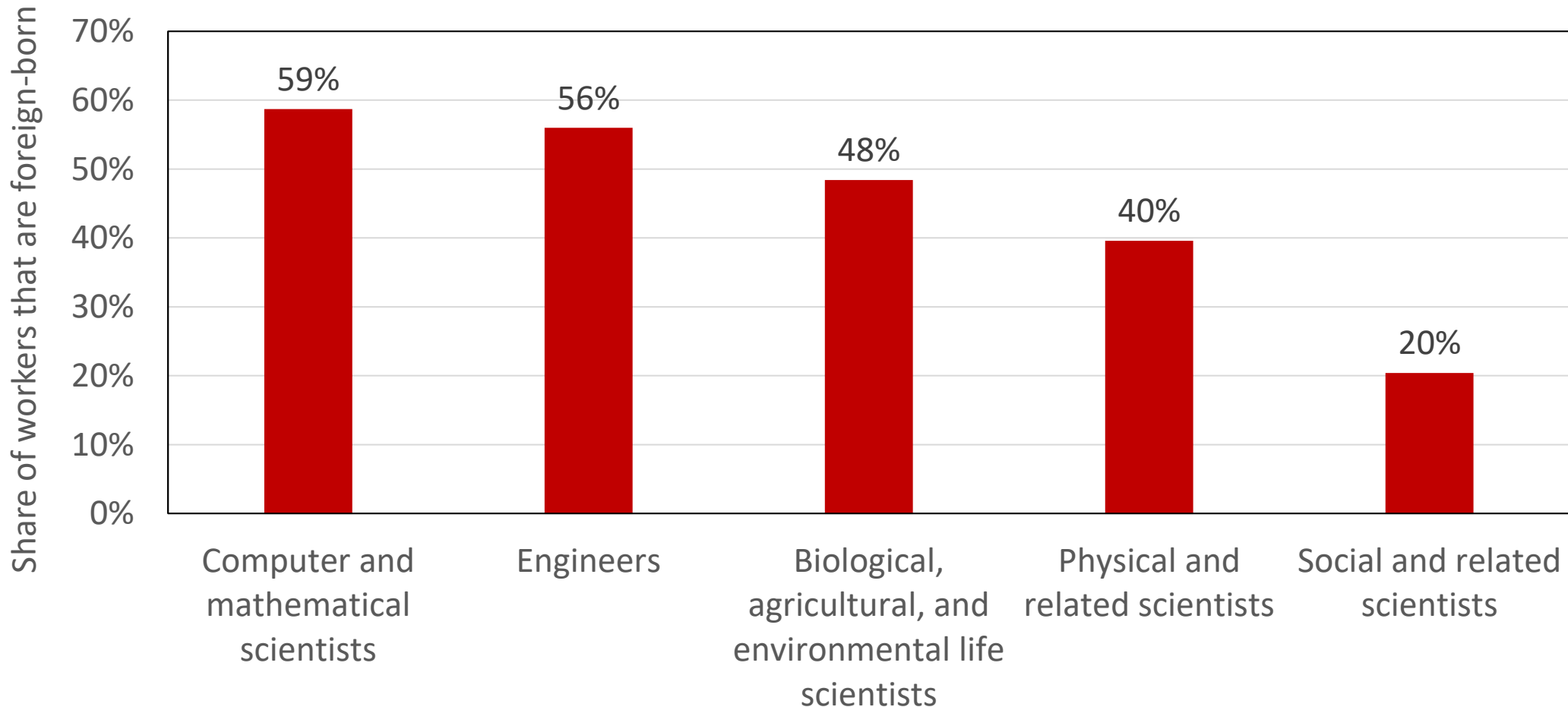
- Foreign-born individuals (includes naturalized citizens, permanent and temporary residents)
- Foreign nationals (i.e., non-U.S. citizens)

Foreign Talent Plays Large Role among STEM Workers at all Educational Levels



In 2017 about 45% of PhD-level STEM workers in the United States were foreign-born

Share of Foreign-Born PhD-Level Workers Varies by STEM Discipline



Source: NSB. *Science and Engineering Indicators 2020*.

Most Foreign-Born PhDs in U.S. Enter as Students; Become U.S. Citizens or Permanent Residents

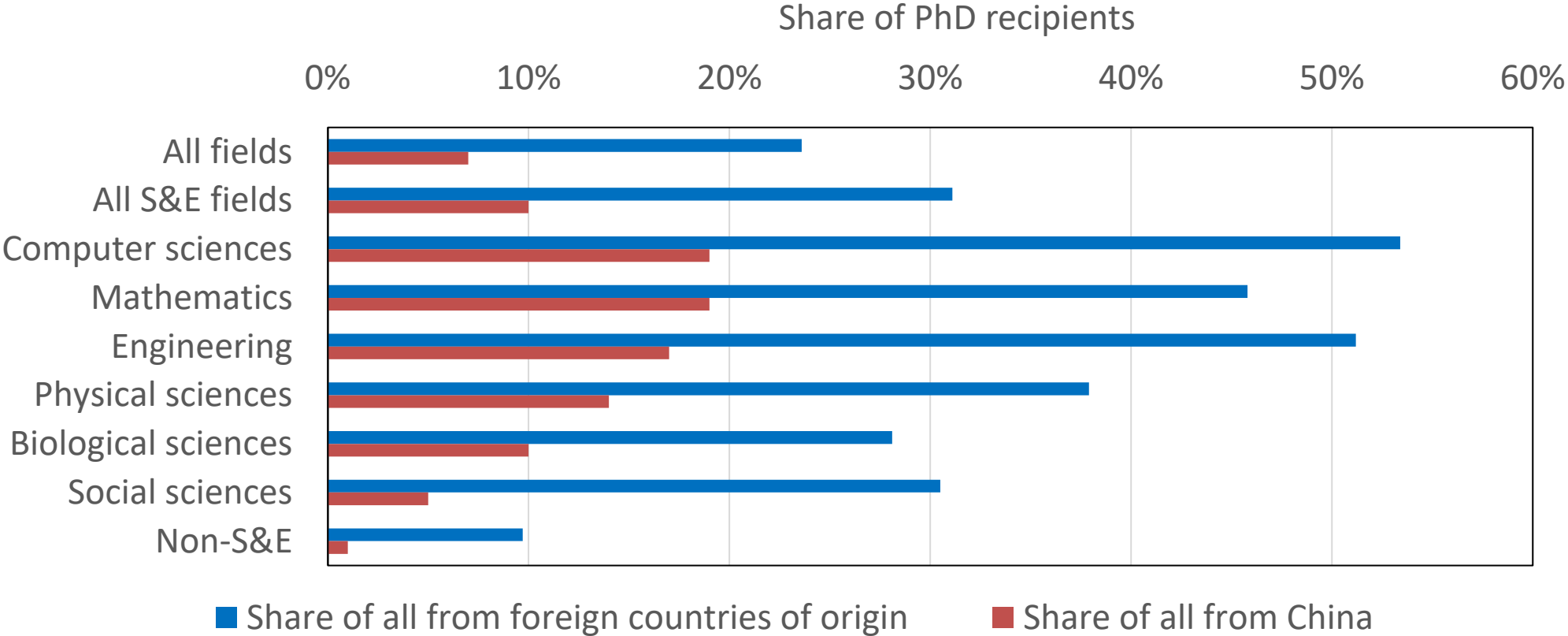


Of these PhD-level, foreign-born STEM workers:

- 25% are from China, and 15% from India
- 71% initially entered the United States on temporary resident visas for study or for training (i.e., for an undergraduate or graduate degree)
- By 2019,
 - 45% were naturalized U.S. citizens
 - 28% were permanent residents
 - 23% were temporary residents



Large Share of New Doctorates in Computer Science, Engineering, Mathematics Are Foreign Students



Between 2000-2017, a large share of U.S.-granted STEM PhDs were awarded to non-U.S. citizens, many of whom were from China.

Most Non-U.S. Citizen STEM PhD Recipients Stay in the United States to Work



	2011–13 Foreign Doctorate Recipients 5-year stay rate	2006–08 Foreign Doctorate Recipients 10-year stay rate
All temporary visa holders	71%	72%
China (including Hong Kong)	83%	90%

Non-U.S. citizens that received STEM PhDs in the U.S. and stay in the U.S. are:

- More likely to be employed by businesses or at an academic 4-year college/university than in other sectors
- More likely to be employed by businesses than their U.S. citizen/permanent resident counterparts
- Many eventually become U.S. citizens or permanent residents

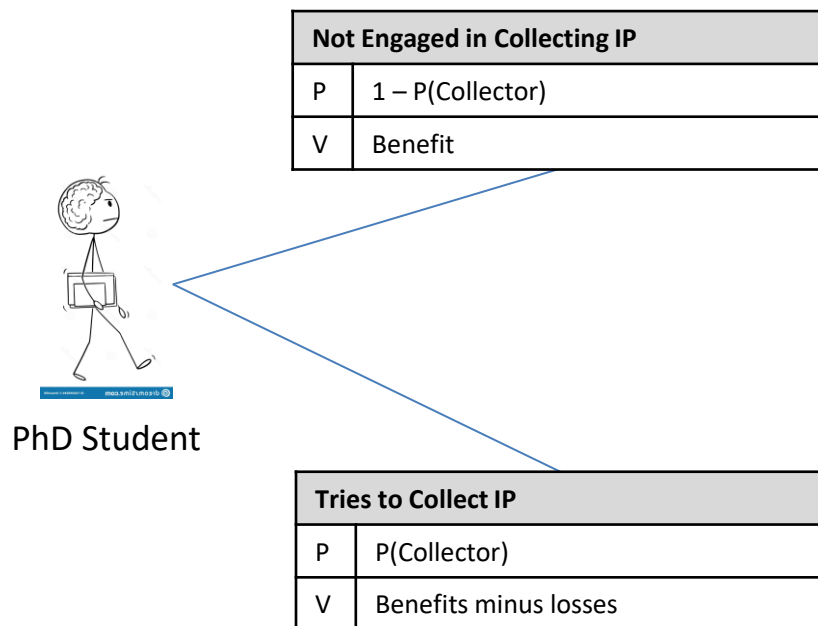
Source: NSB. 2019. Higher Education in Science and Engineering and STPI analysis of Okrent and Burke 2021

Comparison of Costs and Benefits: Methodology

STPI Divided Foreign STEM Talent into Six Groups; Calculated Benefits and Potential Losses for Each Group

- Ph.D. students
 - Students who are in the United States on student visas
 - Are assumed to study for 5 years; may stay for optional practical training; some obtain immigrant visas
- Foreign STEM workers
 - Anyone born outside the United States; can be permanent resident, citizen
 - Works in STEM field, does not necessarily have a STEM degree
- Post-doctoral students or visiting researchers not on immigrant visas
- Masters students on student visas
- Bachelors students on student visas
- Academic and business visitors

Event Trees Framework Used to Estimate Net Benefit or Loss for Different Groups of Talent

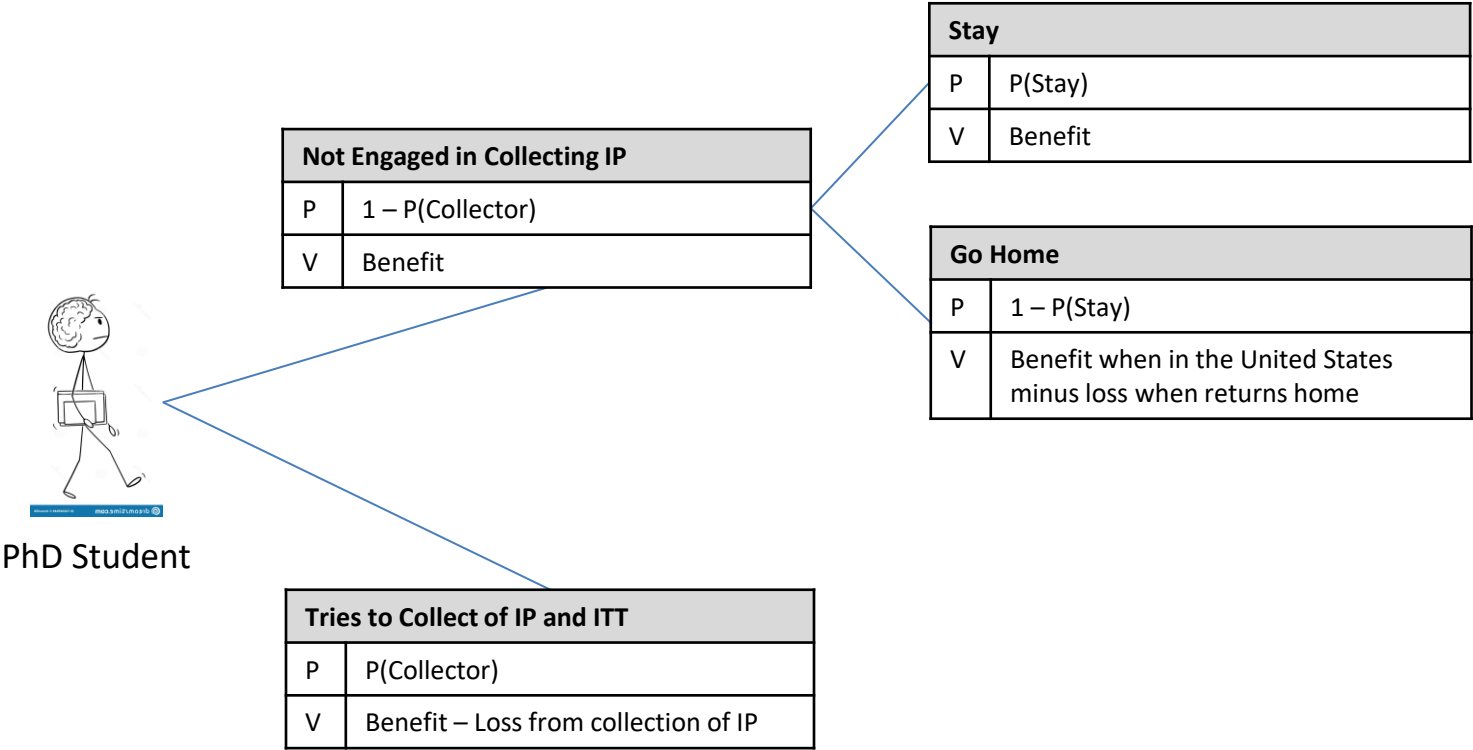
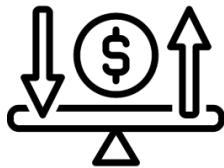


Acronyms:

- Probability (P)
- Value (V)
- Intellectual
- Property (IP)

Time 0. Admitted to USA.
Acquires knowledge and skills.

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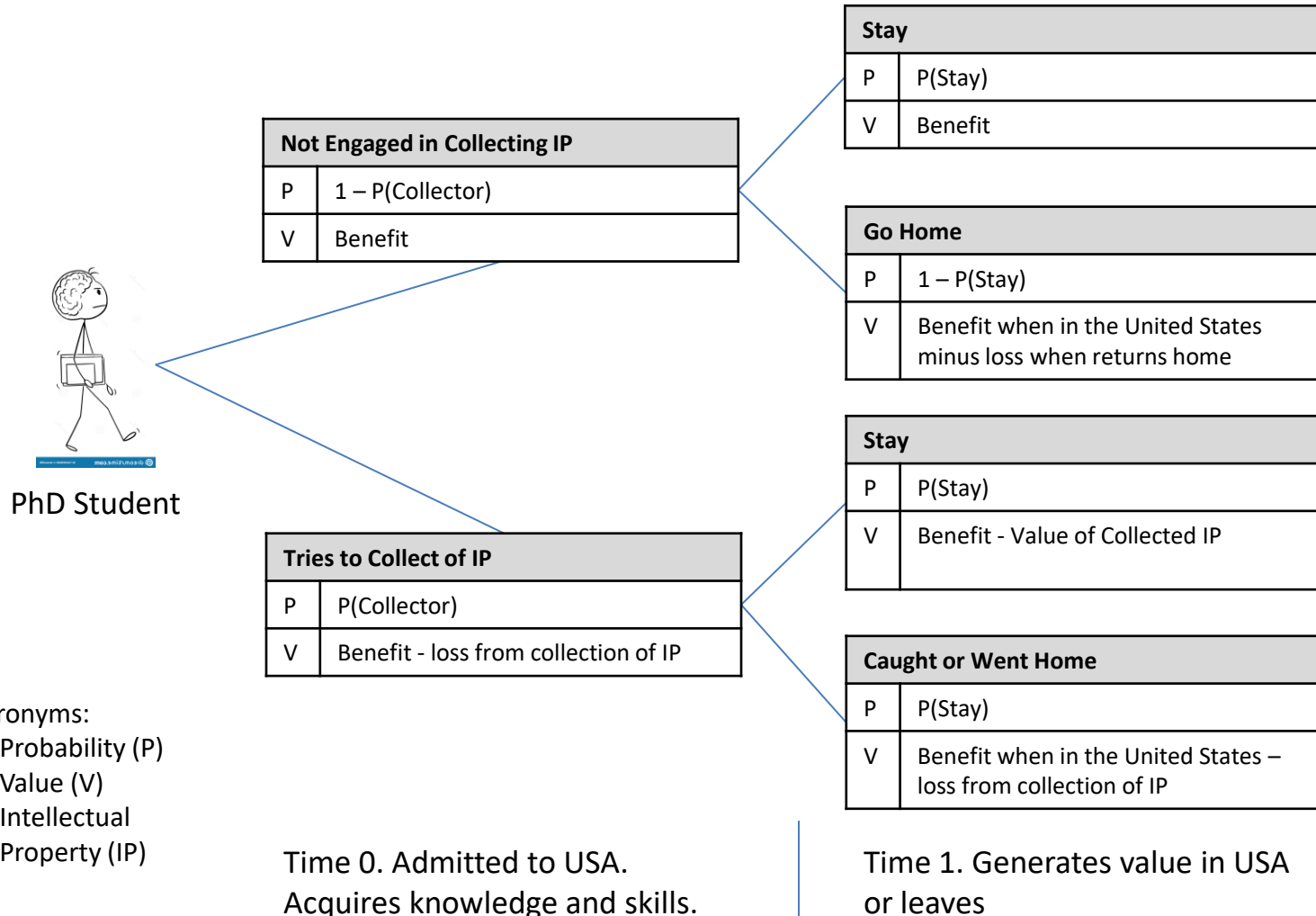
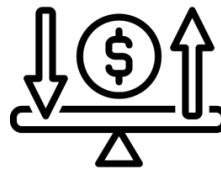


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or leaves

Event Trees as the Framework STPI Used to Estimate Net Benefit or Loss for Different Groups of Talent



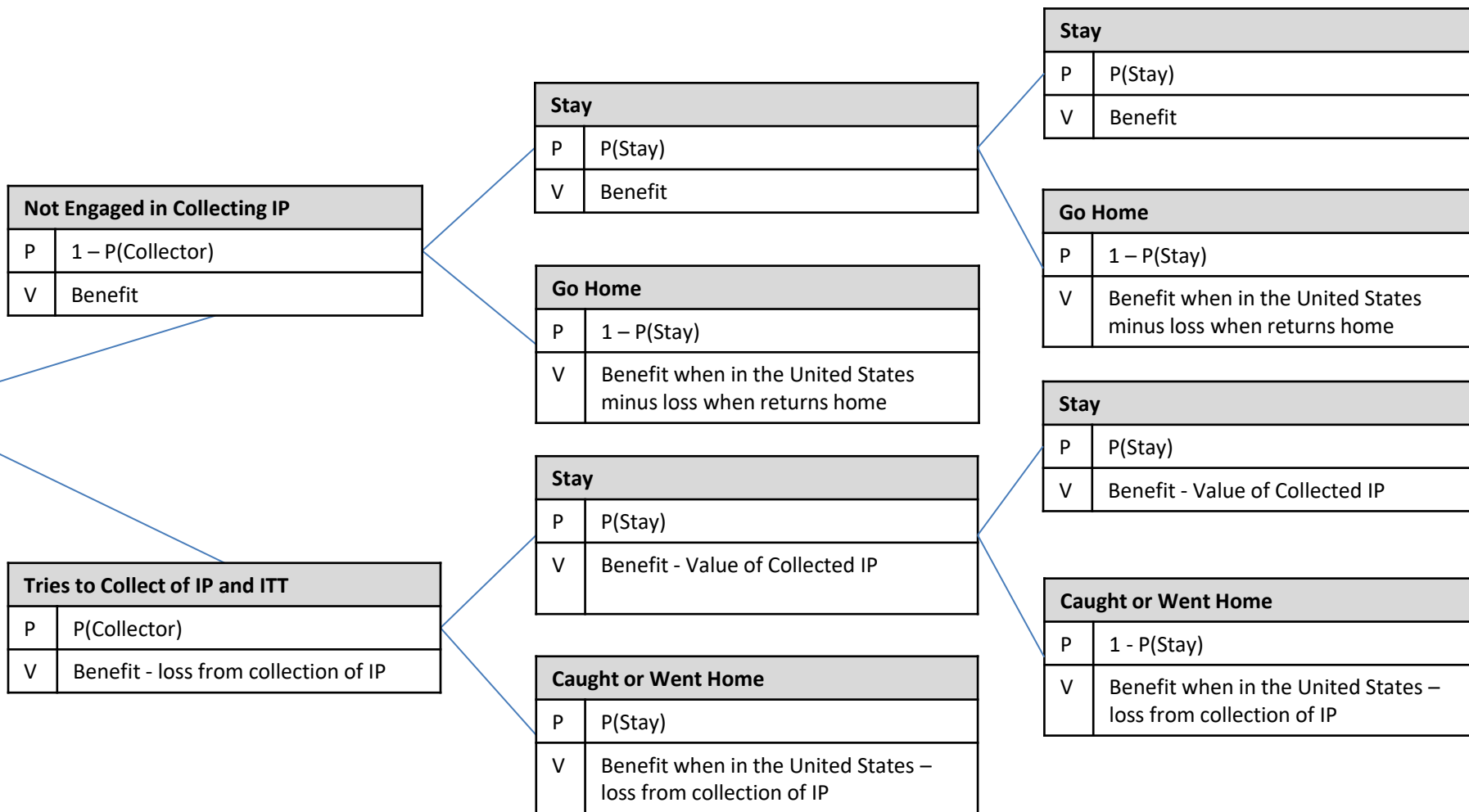
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Event Trees Framework Used to Estimate Net Benefit or Loss for Different Groups of Talent



PhD Student



Acronyms:

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Acquires knowledge and skills.

Time 1. Generates value in USA
or leaves

Time 2. Generates value in USA
or leaves

Estimating Benefits

STPI Calculated Four Types of Economic Benefits Provided by Foreign STEM Talent



1. Contributions to U.S. gross domestic product (GDP) from foreign-born STEM labor
2. Contributions to increases in total factor productivity
3. Contributions to GDP of high technology companies founded by foreign-born entrepreneurs
4. Payments by foreign students for tuition and living expenses while in the United States

Every Year Foreign-born STEM Workers Add 1.7% to 1.9% to U.S GDP through their Labor



- GDP = labor value-added plus returns to capital and land

*Contributions of foreign STEM workforce =
Value added per worker (\$139,605) x
Foreign born STEM workers (28.1% x 8.6 million STEM workers)*

- In 2019, we estimate foreign STEM workers generated \$367 billion to \$398 billion in value-added to U.S GDP

Source: Bureau of Labor Statistics (BLS). 2020. *Occupational and Employment Statistics*; Bureau of the Census. 2020. *American Community Survey*.

STPI Estimates Foreign STEM Talent Generated \$37 Billion Annually in Productivity Gains from 2000-2019



- Total factor productivity (TFP) = growth in GDP in addition to that from increases in labor or the capital stock
- From 2000 to 2019, TFP generated \$132 billion per year in additional GDP, 41% of average annual increases
- To estimate contribution of foreign STEM talent to increases in TFP, we assume
 - All increases in TFP are driven by innovation
 - U.S. STEM workforce generates all innovation in the U.S. economy
 - Contribution of foreign STEM talent to innovation (and growth in TFP) same as percentage of foreign nationals in STEM workforce

16% to 24% of Founders of U.S. High Technology Companies Have Been Foreign-Born



- In 2019, high technology companies generated 7.6% of U.S. GDP
- We estimate high tech companies with at least one foreign-born founder contributed an estimated 1.2% to 1.8% of GDP in 2019



Foreign Students Important Source of Tuition Revenues for Universities



- Total U.S. receipts from educational services, educational travel equaled \$42.6 billion in 2018
- Foreign STEM students are 51.3% of all foreign students
- Of total spending on educational services, travel, foreign STEM students estimated to have spent \$21.9 billion



Source: NSB. 2021. *Science and Engineering Indicators 2020*; BEA 2020.

Economic Contributions of Foreign STEM Talent to the United States Substantial



1. Foreign-born STEM workers add 1.7% to 1.9% annually to U.S GDP through their labor
2. Foreign STEM talent generated \$37 billion annually in productivity gains from 2000-2019
3. High tech companies with at least one foreign-born founder contribute an estimated 1.2% to 1.8% of GDP
4. Foreign STEM students estimated to have spent \$21.9 billion on total spending on educational services and travel

Estimating Losses

Foreign STEM Talent Inflicts Economic Costs through Theft of Intellectual Property (IP), Primarily Trade Secrets

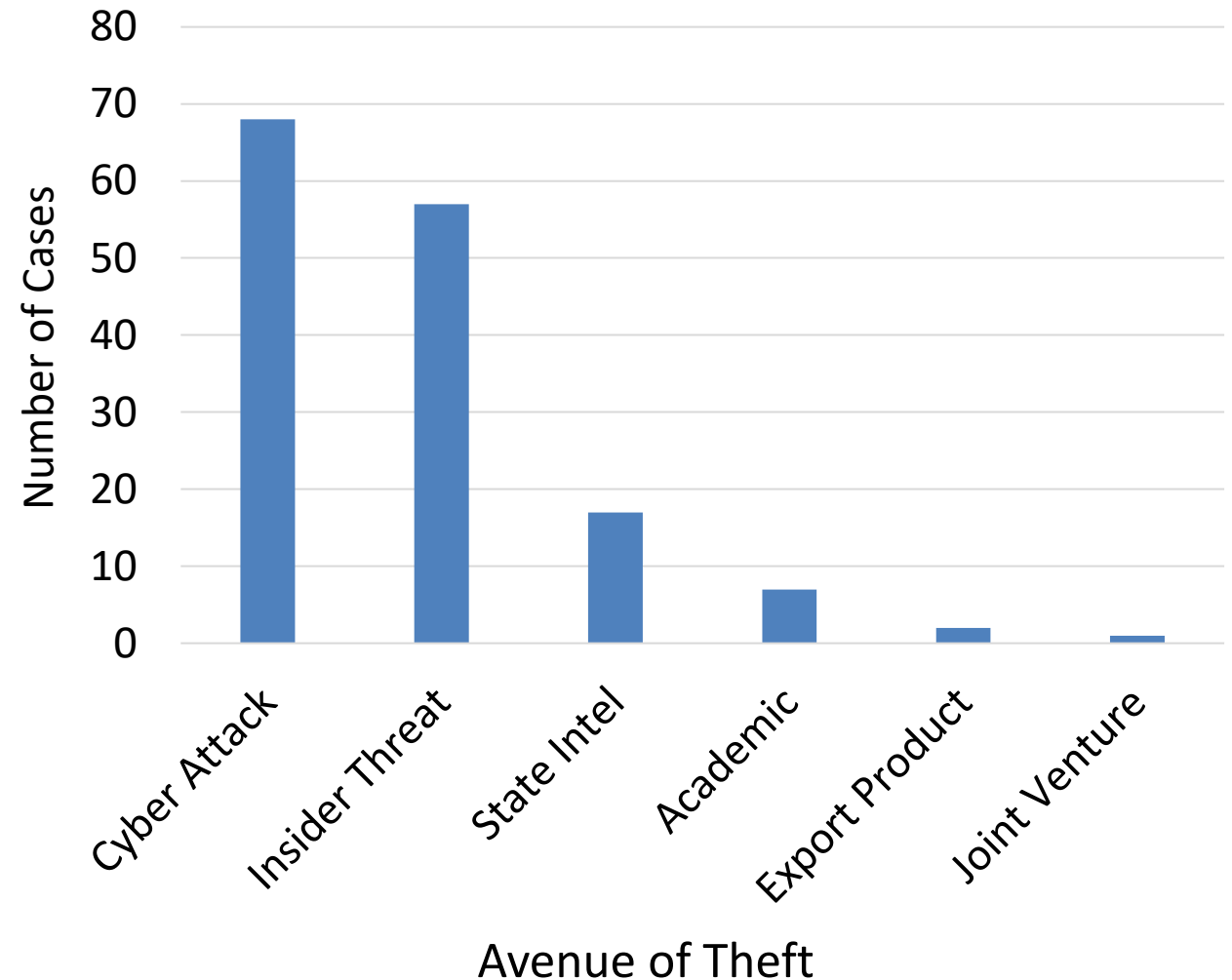


Misappropriation of IP	Likelihood Foreign Talent in U.S. Involved
Copyright infringement, primarily software	Tends to take place abroad
Illegal use of trademarks	Takes place abroad and in the U.S., but foreign STEM nationals not primary perpetrators
Patent infringement	Tends to take place abroad
Misappropriation of trade secrets	Foreign- and U.S.-born insiders have been convicted of stealing trade secrets

How Does China Conduct Economic Espionage, Steal Trade Secrets?



- Center of Strategic and International Studies (CSIS) identified 160 public cases of Chinese theft of trade secrets, espionage against United States since 2000
- STPI grouped cases according to avenue through which theft occurred: cyber attack, insiders, spies, academic exchanges, illegal exports, joint venture partners
- 57 attributed to insiders



Source: CSIS 2021

STPI Estimated Losses from Misappropriation of Trade Secrets Using Information from Lawsuits



- STPI focused on the 57 cases of insider threats
- Of these 57 cases, we found information on 17 for which the court reported values for alleged harm and restitution
 - Plaintiffs set values for alleged harm
 - Court-determined restitution

	Alleged Harm	Restitution
Maximum	\$1 billion	\$60 million
Minimum	\$700 thousand	\$114 thousand
Median	\$57.5 million	\$420 thousand

Range of losses from misappropriation of trade secrets set using median values

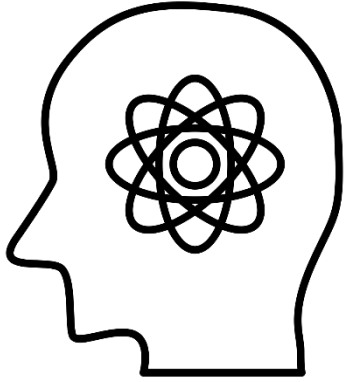
- Alleged harm—\$57.5 million
- Restitution—\$420,000

How Likely Is Foreign STEM Talent to Misappropriate Trade Secrets?



- We assume 0.1% of STEM students and workers born in China may be potential collectors, drawing on a statement by Director National Counterintelligence and Security Center
- Few reported cases of espionage, theft of trade secrets
 - 57 insider cases of espionage for China from CSIS database
 - 37 Chinese nationals on FBI “Wanted” list for these activities
- Based on data shown earlier, we estimate that ~122,000 STEM students and ~360,000 STEM workers born in China were in the U.S. in 2019
- Ratios of insider cases to these numbers very small, especially when cases are annualized

Intangible Technology Transfer (ITT) May Also Impose Economic Losses

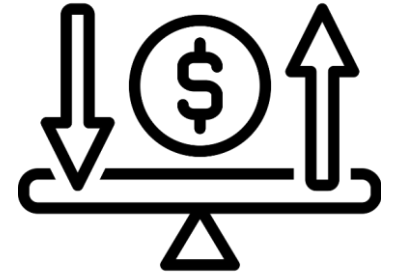


- Intangible technologies: knowledge about procedures, operations acquired from working or studying in specific environment
- ITT not illegal, comes about from working, studying in any organization
- Losses to the United States ensue if competing industry emerges in another country that leads to lost sales, jobs for U.S. industry

Difficult to Estimate Losses from ITT



- Hard to trace contributions of ITT to growth in competing industries
 - China's high speed rail and wind turbine industries developed through theft of technology from foreign joint venture partners
 - Growth in solar panel industry driven by Chinese subsidies
- STPI chose to estimate value of ITT based on China's willingness to pay STEM talent to return
 - \$110,000 to \$170,000 annual payments to STEM talent returnees
 - One-off investments in support—\$620,000 to \$2,400,000

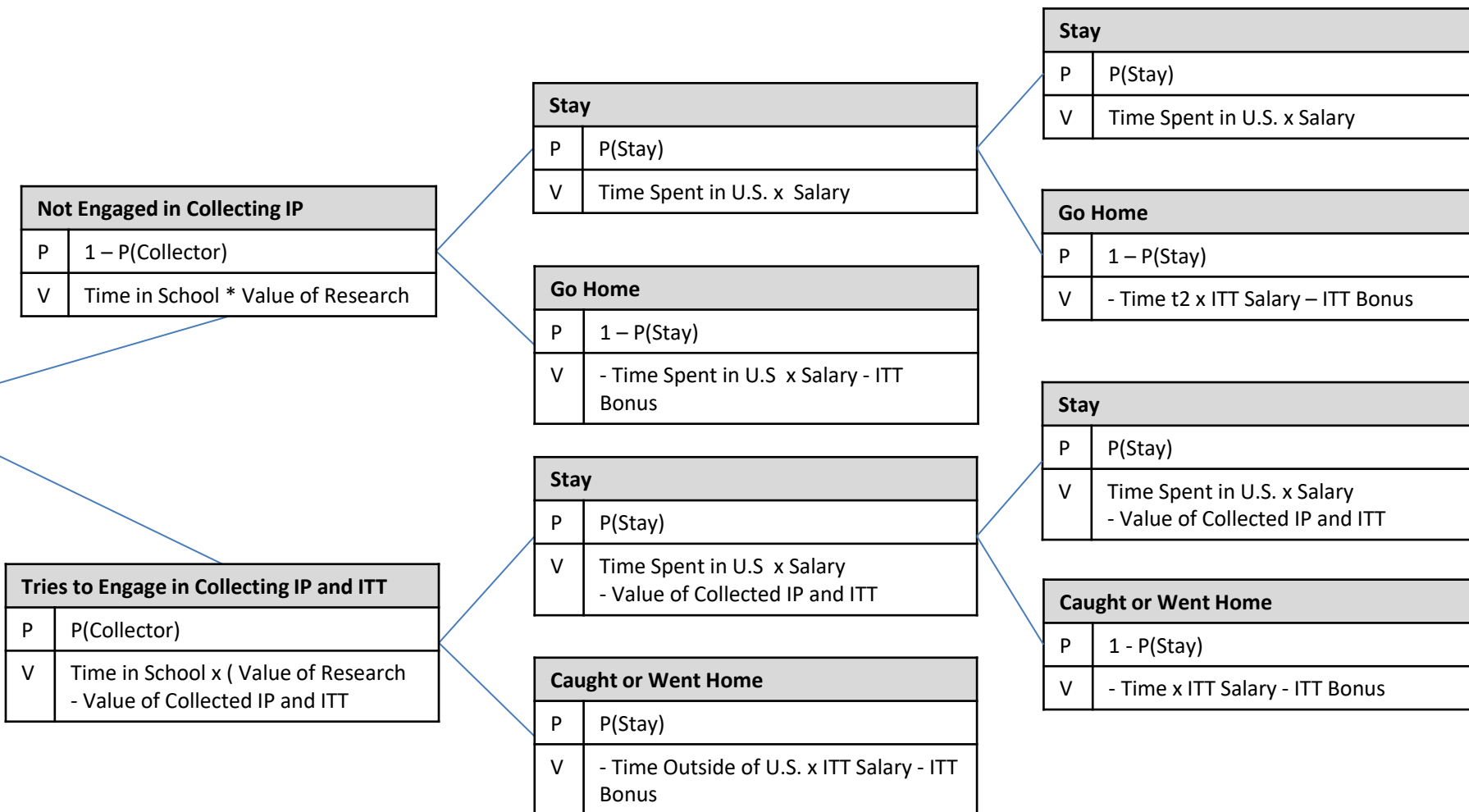


Net Benefits

STPI Used Event Trees to Estimate Net Benefit or Loss for Different Groups of Talent



PhD Student

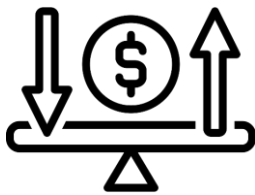


Time 0. Admitted to USA.
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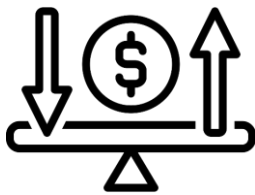
Time 2. Generates value in USA
or leaves

STPI Found Every Group of Foreign STEM Talent Makes Net Positive Contribution to U.S. Economy



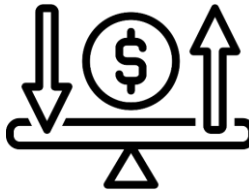
Group	Net Benefit Low	Net Benefit High	Time in USA
Ph.D. Student (Studying & Joining Workforce)	\$300,000	\$600,000	12 years

STPI Found Every Group of Foreign STEM Talent Makes Net Positive Contribution to U.S. Economy



Group	Net Benefit Low	Net Benefit High	Time in USA
Ph.D. Student (Studying & Joining Workforce)	\$300,000	\$600,000	12 years
STEM Worker	\$100,000	\$700,000	6 years

STPI Found Every Group of Foreign STEM Talent Makes Net Positive Contribution to U.S. Economy



Group	Net Benefit Low	Net Benefit High	Time in USA
Ph.D. Student (Studying & Joining Workforce)	\$300,000	\$600,000	12 years
STEM Worker	\$100,000	\$700,000	6 years
Post-Docs or Visiting Researcher	Same upside as STEM worker, less downside		
Bachelors Student	\$100,000	\$200,000	4 years
Masters Student	\$40,000	\$80,000	2 years
Short-term Visitor	\$3,000	\$3,000	~2 weeks

Summary

- Generated quantitative estimates of benefits and potential losses for different groups of foreign STEM talent in the United States
- Makes possible apples-to-apples comparisons for benefits and potential losses to the United States
- Using our event tree framework and estimates of benefits, losses, and probabilities, we found every group of foreign STEM talent makes net positive contribution to U.S. economy

Full Report can be found at: <https://www.ida.org/research-and-publications/publications/all/e/ec/economic-benefits-and-losses-from-foreign-stem-talent-in-the-united-states>

Backup Slides

Summary of Values Used in Expected Value Calculations

Metric	Category	Category		Periodicity
		Low	High	
Probability of Stay	Doctoral Students, Post-doctoral Fellows	83%	90%	
Probability of Non-Traditional Collector	All	0.1%	0.1%	
Value of Personnel				
Average Compensation of STEM Worker	Workers, Professors, Post-doctoral Fellows	\$139,605	\$139,605	Annual
Contribution to increases in GDP from TFP	Workers, Professors, Post-doctoral Fellows, Doctoral Students	\$12,225	\$13,568	Annual
Tuition, Room, and Board—Bachelor's	Bachelor's Students	\$37,390	\$48,290	Annual
Tuition, Room, and Board—Master's	Master's Students	\$19,050	\$41,990	Annual
Travel Expenses	Short-term Visitors	\$3,100	\$3,100	Per trip
Value of Misappropriated Trade Secrets	STEM Workers	\$420,000	\$57,500,000	Instance
Opportunity Cost of Academic Fraud	Professors	\$400,000	\$800,000	Annual
Intangible Technology Transfer				
Thousand Talents Salary	Doctoral Students (low only), Researchers, Workers	\$110,000	\$170,000	Annual
Thousand Talents Bonus	Doctoral Students (low only), Researchers, Workers	\$620,000	\$2,400,000	Instance

Breakeven Calculations (When Costs = Benefits): What Share of Foreign STEM Talent Is Collecting Information For this to be the Case?

Misappropriated Trade Secrets	Value ITT	P(Stay)	Expected Value	Breakeven P(NTC)
Low	Low	Low	\$604,162	79%
		High	\$699,950	89%
	High	Low	\$270,963	35%
		High	\$503,951	63%
High	Low	Low	\$499,706	0.57%
		High	\$591,498	0.64%
	High	Low	\$166,506	0.26%
		High	\$395,499	0.46%

For the high value for misappropriated trade secrets (\$57.5 million per instance), more than 0.3% of individuals would need to successfully steal a trade secret every year for the United States to suffer a net loss.

This is three time higher than our tentatively used value of 0.1%.