Breaking the Language Barriers? Machine Translation Technology and Analysts' Forecasts for Multinational Firms
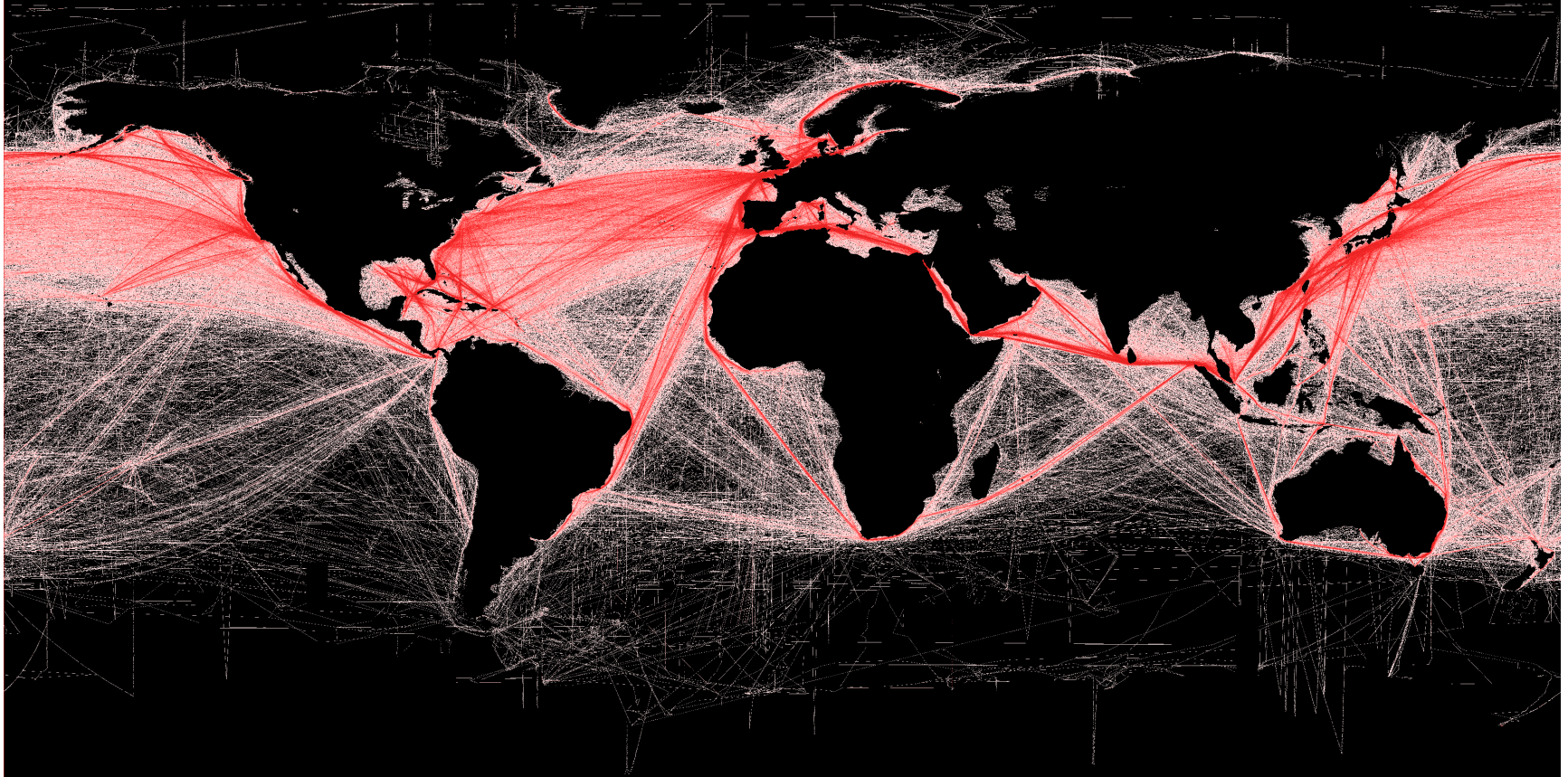
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Pengkai Lin

(Singapore Management University)

ABFER 11th Annual Conference

Global Shipping Routes

Information Problem Associated with Globalization

- **Global exposure of US firms**

  - Local sales, production, or imports from foreign countries

  - Exposure to local competition, economic factors, and policies

- **Such exposure complicates firms' information environment**

  - Information from foreign sources can be relevant
    (e.g., local firms' disclosures, media news, and government policies)

  - U.S. investors and analysts face language barriers when processing foreign information (e.g., Lundholm et al. 2018; Chan et al. 2005)

Translation Technology and Its Complementary Role

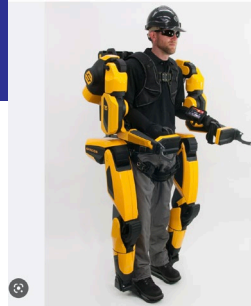Robotic Exoskeleton Amplifies Human Strength | Gardner Web

- **Machine translation technology**

  - Free translation tools (e.g., Google Translate) arguably reduce foreign information's processing costs

- **Complementary role of technology**

  - Substitution/competition effects from financial social media and FinTechs (e.g., Robo-Analysts) (Grennan and Michaely 2021; Jame et al. 2022)

  - Translation technology is non-financial in nature

- **Research question**

  - **Can machine translation technology improve analysts' forecasts for multinational firms in the U.S.?**

Research Design: Generalized DID

- **Time-series variation in availability of advance translation tools**

  - Google Translate's staggered support for translation of foreign languages

- **Cross-sectional variation in US firms' foreign exposure**

  - Subsidiaries operated across countries

- **Combining these two variations to define treatment group**

  - Firm-years with at least 10% of subsidiaries from countries with their most-commonly used language supported by Google Translate

Summary of Findings

- **Reduction in analysts' forecast errors for treatment group**

  ▪ Stronger for analysts with limited language skills or brokerage resources

- **Improvement in analysts' foreign information set and incorporation**

  ▪ More questions related to firms' foreign operations in conference calls

  ▪ More incorporation of foreign economic information (GDP growth)

- **Incremental information content of analysts' forecasts**

  ▪ Stronger market reaction to analyst forecast revisions and better stock liquidity

Contributions

- **Complementary role of technology in investment research industry**

  - Concurrent studies examine benefits of using AI or big data (e.g., Cao et al. 2023; Chi et al. 2022)

  - We examine a non-financial type of technology, publicly accessible to all

  - Such technology may especially benefits analysts with limited hard skills or resources, possibly closing performance gaps

- **Information processing costs in analyst research**

  - An important information processing cost associated with globalization

- **Cross-border Information frictions associated with language barriers** (e.g., Brochet et al. 2016; Lundholm et al. 2018)

  - Effectiveness of machine translation technology

Setting: Google Translate

- **Adopted statistical learning techniques to build translation models that revolutionized the industry since 2006**

  - Replaced historical rules-based approach (manually calibrated by linguists to define vocabularies and grammars)

> "For decades, machine translation was mostly useful if you were trying to be funny.
>
> **But in the last few years, as anyone using Google Translate […] can tell you, things have changed dramatically**. And all because of an effort begun in the 1980s to **remove humans from the equation**."

Konstantin Kakaes, February 21, 2011

The Washington Post
Democracy Dies in Darkness

Setting: Google Translate

- **Adopted statistical learning techniques to build translation models that revolutionized the industry**

  - Replaced historical rules-based approach

- **Comprehensive and timely language coverage**

  - 108 languages as of June 2020 (68 for Microsoft Translator)

  - Generally led Microsoft Translator by several months to several years

  - Better translation performance than other 30 products (Intento 2022)

- **Likely the most popular and widely used machine translation tool**

  - With more than 500 million users as of 2016
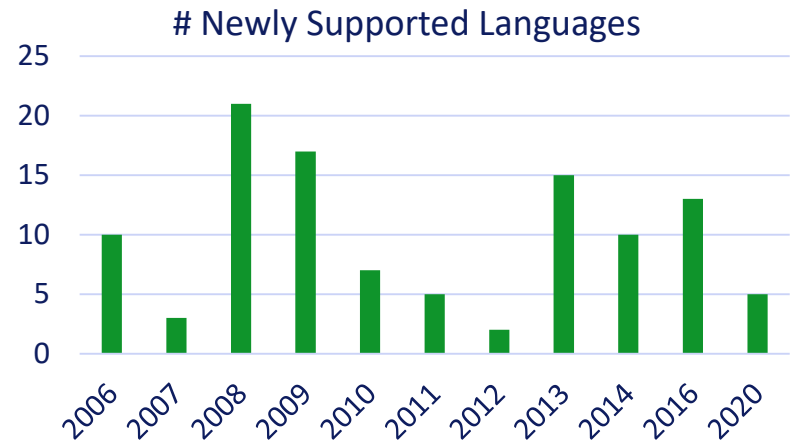
Staggered Rollout of Google Translate

- Identified new languages' launch dates using historical web pages of Google Translate on **The WayBack Machine**

Page on May 13, 2010

Page on May 14, 2010

Newly Supported Languages

- First batch in April 2006:
Arabic, Chinese (simplified), French, German, Italian, Japanese, Korean, Portuguese, and Spanish

What Explain Language Rollout Timeliness?

- Variation possibly exogenous to a US firm's geographic footprint

	(1)
Number of U.S. Subsidiaries / Population	-0.45
	(-0.31)
Language Distance Index	-0.96**
	(-2.55)
Log(Population)	0.27***
	(7.23)
Log(GDP Per Capita)	0.33***
	(8.26)
GDP Growth	-0.01
	(-1.28)
Number of Inbound Tourists / Population	0.01***
	(5.01)
Obs.	405
pseudo R^2	0.17

Use of Translation Tools

- **Web interface**

 - Supports typed-in text, documents, or web links

- **Browser extension**

  - Install in browser to access foreign websites in your preferred language

- **Translation need from analysts?**

  - Corporate disclosures by foreign firms (competitors, suppliers, etc.), local media news, government policies etc.

  - Help analysts access foreign information in a more **timely** and **cost-effective** way
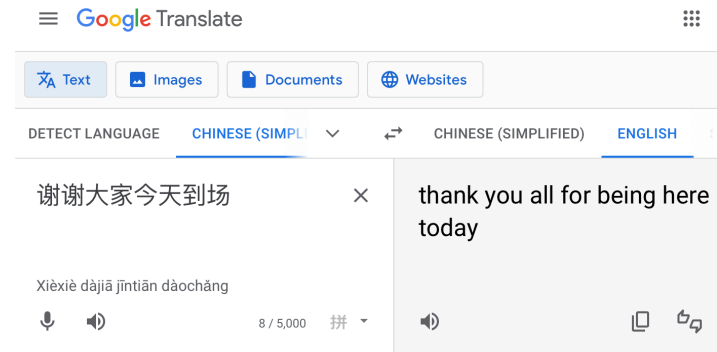
Alternative Translation Support

- **In-house translators**

  - Mainly responsible for translating product details and confidential documents

- **External translators**

  - Average translation rate of $180-250 per 1,000 words (GSA 2020) with slower turnaround (a few hours to a few days)

- **Internal translation engine**

  - BNP Paribas built one in 2022, which only supports 15 languages

Data and Sample

- Analysts' annual earnings forecasts from I/B/E/S

- Analyst full names collected from I/B/E/S, Capital IQ, LindedIn etc.

- Corporate subsidiaries and jurisdictions from Exhibit 21 of Form 10-K parsed by WRDS since 1997

- Other data: Compustat, CRSP, Thomson 13f filings, World Bank

- Include firms that are both headquartered and incorporated in the U.S.

- **Final main sample: 49,450 firm-years between FY 1998 and 2020**

Main Regression

$$Error_{i,t} = \beta_0 + \beta_1\ Translate_{i,t} + \beta_2\ Controls_{i,t} + Firm\ FE + Year\ FE + \varepsilon_{i,t},$$

- $Error_{i,t}$, error of consensus analyst forecast for firm *i* in year *t*

- $Translate_{i,t}$, indicator for treatment group

  ▪ Firm-years with at least 10% of subsidiaries in countries, where their most-commonly used language is supported by Google Translate in year *t*

  ▪ Control group

  – Same group of firms before rollout of Google Translate

  – Firms with less than 10% of subsidiaries affected

- Standard errors are clustered by firm

Main Results

	(1) Error (%)	(2) Error (%)	(3) Error (%)
Translate	-0.56***	-0.46***	-0.48***
	(-6.04)	(-2.99)	(-3.42)
Controls	No	No	Yes
Firm FE	No	Yes	Yes
Year FE	No	Yes	Yes
Obs.	49,450	49,450	49,450
Adjusted R^2	0.00	0.25	0.39

- Economic significance using Column 3
  - 6.5% of sample standard deviation

Parallel Trends
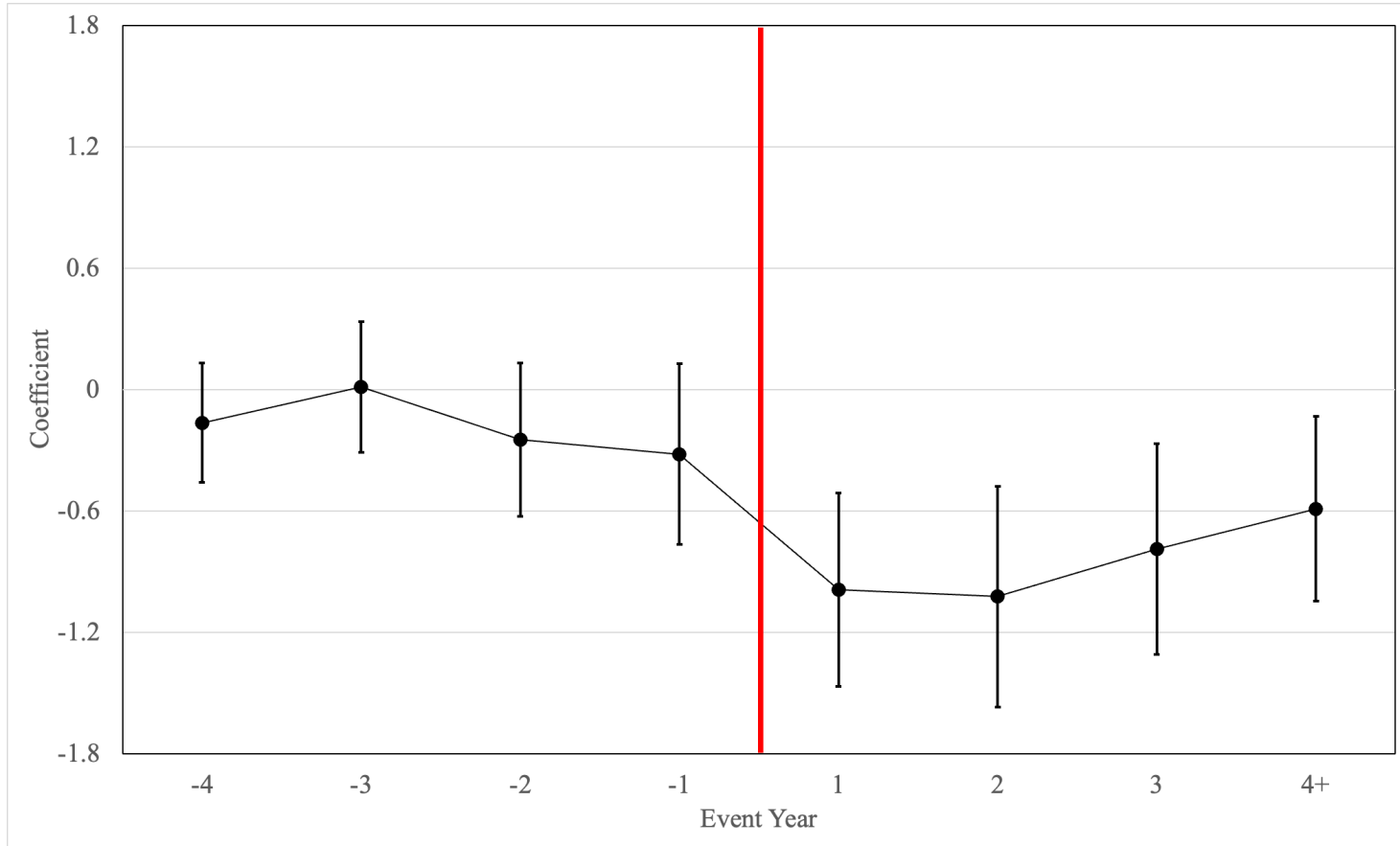
Robustness Tests

- **Alternative DID estimators (**De Chaisemartin and d'Haultfoeuille 2020; Borusyak et al. 2023; Callaway and Sant'Anna 2021; Baker et al. 2022)

- **Alternative treatment variables**

  - Using different cutoffs, continuous variable, geo segment sales as weight, Microsoft Translator rollout

- **Results not just driven by first batch of nine important languages**

- **Potential endogeneity in firms' foreign exposure**

  - Robust to using static subsidiary data from the first sample year

- **Potential real effect in firms' foreign operations**

  - No significant change in foreign subsidiary count

Cross-Sectional Tests at Analyst Level

- **Innate ability: Foreign language proficiency**

  - Infer most likely ethnicity based on analyst names using machine learning software (NamSor)

  - Assign most commonly-used language associated with the ethnicity

- **External resources: Foreign coverage resources from brokerage firms**

  - Colleagues serve as useful resources to analysts (e.g., Do and Zhang 2020; Hope and Su 2021; Huang, Lin, and Zang 2022)

  - Analysts can leverage foreign expertise of colleagues who cover foreign local firms

Cross-Sectional Tests at Analyst Level: Example

Meng Jiao · 3rd
Equity Research Analyst at Deutsche Bank

Analyst
Deutsche Bank · Full-time
Apr 2016 – Sep 2022 · 6 yrs 6 mos
Greater New York City Area

Followed **American Express** in 2019 with subsidiaries in China, Germany, Saudi Arabia etc.

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Followed American Express in 2019 with subsidiaries in China, Germany, Saudi Arabia etc.

- **Potential language proficiency**

  - Most likely ethnicity: Chinese

  - Assign Chinese as a language he might understand

  -> Separate out Chinese (*Proficient*)

- **Potential foreign coverage resources**

  - Deutsche Bank have other analysts covering local firms in China and Germany but not Saudi Arabia

  -> Separate out China and Germany (*Covered*)

Cross-Sectional Tests at Analyst Level

	(1) Error (%)	(2) Error (%)	(3) Error (%)	(4) Error (%)	(5) Error (%)	(6) Error (%)
Translate	-0.19***			-0.12*		
	(-2.72)			(-1.79)		
Translate (Non-Proficient)		-0.18***			-0.13**	
		(-2.64)			(-2.02)	
Translate (Proficient)		-0.03			0.04	
		(-0.56)			(0.43)	
Translate (Non-Covered)			-0.18***			-0.14***
			(-3.48)			(-2.65)
Translate (Covered)			-0.06			-0.04
			(-1.49)			(-0.84)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	No	No	No
Analyst FE	Yes	Yes	Yes	No	No	No
Analyst-Firm FE	No	No	No	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	524,078	496,978	524,078	478,226	459,297	478,226
Adjusted R^2	0.43	0.43	0.43	0.44	0.44	0.44
Coefficient Difference						
Non-Proficient **LESS** Proficient		-0.15**			-0.17*	
p-value		0.04			0.10	
Non-Covered **LESS** Covered			-0.12***			-0.10**
p-value			0.00			0.02

Gauging Analysts' Information Set

- Conference call questions reflect analysts' efforts and knowledge (Cen et al. 2022)

- Focus on questions that mention at least one of Supported countries

Q4, 2016, Apple's Earning Conference Call

"Tim, you'd mentioned in your prepared comments a little bit about **India**, and we've been doing a lot of work talking about the opportunity in India. And we get a lot of pushback talking about disposable income metrics and lots of things like that yet the population being so large. Can you talk a little bit about, do you see that India could, at some point, be as big of an opportunity as China?"

James D. Suva
(Citigroup)

Gauging Analysts' Information Set

▪ LDA Topic modeling to separate questions into three categories

1) **Firm specifics only**: profitability, financial details, business plans

2) **Related entities**: suppliers, partners, competitors, banks etc.

3) **Macro environment & policy**: currency risk, trade agreement, exports and tariffs, regional market conditions

	(1)	(2)	(3)	(4)
		Foreign Questions by Category		
	Foreign Question	Firm Specifics Only	Related Entities	Macro Environment & Policies
Translate	0.44***	0.03	0.05**	0.25**
	(3.01)	(0.93)	(2.02)	(2.32)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Obs.	26,032	26,004	26,004	26,004
Adjusted R^2	0.41	0.11	0.08	0.33

Analysts' Incorporation of Foreign Information

- Relation between forecast-implied ROA and weighted GDP growth across countries following Li et al. (2012)

	(1) ROA (%)	(2) Forecast-Implied ROA (%)	(3) Forecast-Implied ROA (%)
GDP Growth (Supported)	0.63***	0.30***	0.18*
	(4.70)	(3.85)	(1.67)
GDP Growth (Supported) × Translate			0.21*
			(1.92)
GDP Growth (Non-Supported)	0.30***	0.21***	0.27***
	(2.93)	(3.05)	(2.94)
GDP Growth (Non-Supported) × Translate			-0.14
			(-1.53)
Controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Obs.	23,897	23,897	23,897
Adjusted R^2	0.55	0.71	0.71

Market Reaction to Forecast Revisions

- **Incremental information content of analyst forecasts?**

  - Other market participants may also use Google Translate and have already incorporated more foreign information into stock prices

	(1) CAR (%)	(2) CAR (%)
Revision	0.71***	0.74***
	(29.07)	(25.33)
Translate	0.01	0.09
	(0.05)	(0.64)
Revision × Translate	0.24***	0.27***
	(4.82)	(4.53)
Controls	Yes	Yes
Firm FE	Yes	No
Analyst FE	Yes	No
Analyst-Firm FE	No	Yes
Year FE	Yes	Yes
Obs.	439,143	395,581
Adjusted R^2	0.10	0.07

Forecast Dispersion and Stock Liquidity

- **Lower analyst forecast dispersion**

  ▪ Reduced performance gaps across analysts

- **Higher stock liquidity**

  ▪ Improved firms' information environment

	(1) Dispersion (%)	(2) Liquidity
Translate	-0.42***	0.02**
	(-4.54)	(2.16)
Controls	Yes	Yes
Firm FE	Yes	Yes
Year FE	Yes	Yes
Obs.	45,958	47,751
Adjusted R^2	0.44	0.56

Conclusion

- **Findings**

  - **More accurate analyst forecasts for multinational firms after Google Translate's rollout**

    - Stronger for analysts with limited language skills or brokerage resources to process foreign information

    - Incremental information content to the market and improved firms' information environment
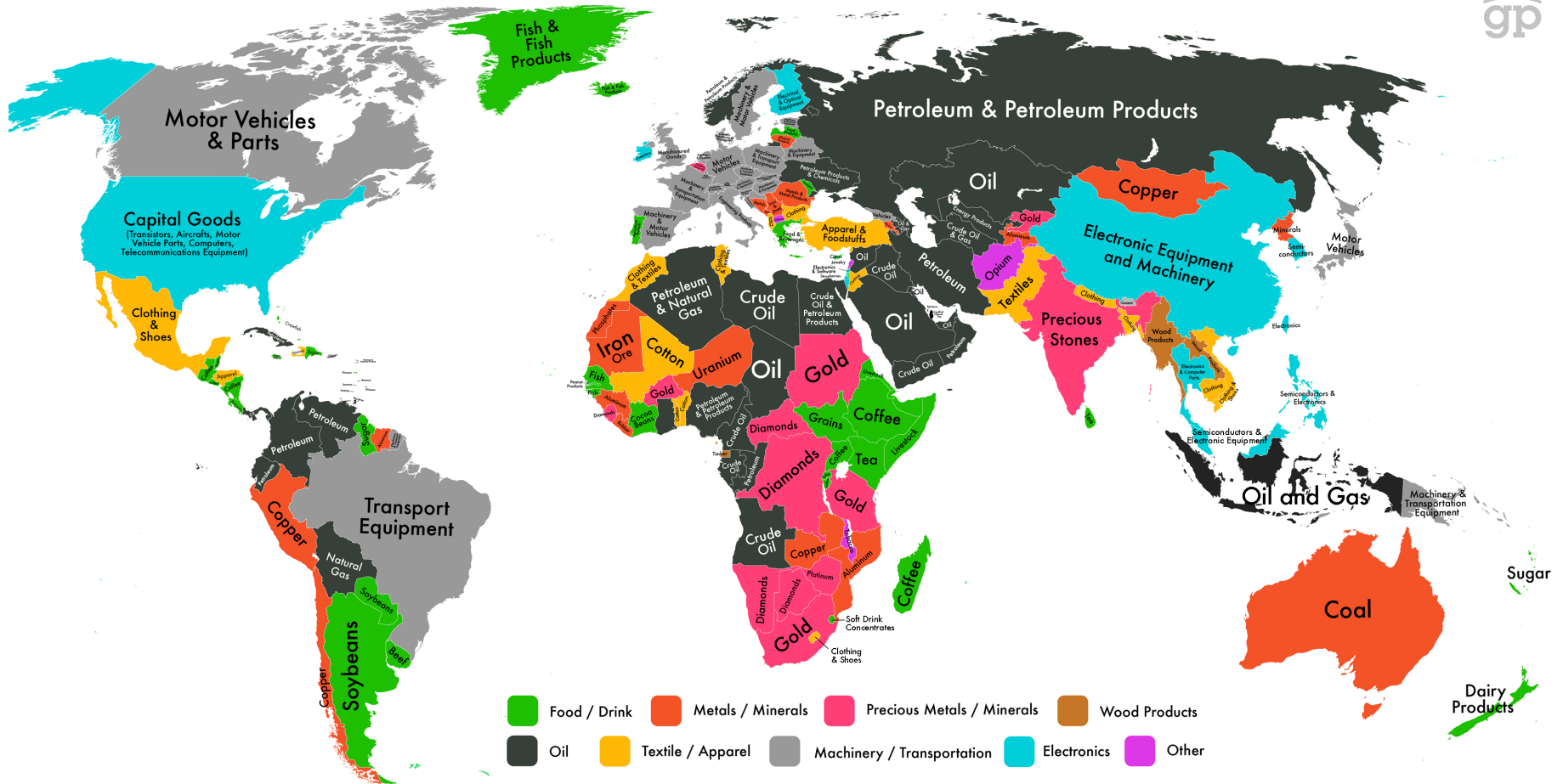
- **Contributions**

  - **Complementary role of technology** in investment research industry

  - Machine translation technology helps tackle **information problem associated with globalization**

Thank you!

ADDITIONAL SLIDES

Highest Valued Export by Country

Source: CIA Factbook; Simran Khosla/GlobalPost 2014

Related Literature: Multinational Firms

- **Information frictions facing analysts and investors**

  - Foreign exposure and increased information complexity (Reeb et al. 1998; Thomas 1999; Callen et al. 2005; Duru and Reeb 2002)

  - Foreign institutional differences (e.g., Bae et al. 2008)

- **Language barriers**

  - Underweighted portfolio allocation (Lundholm et al. 2018; Chan et al. 2005; Beugelsdijk and Frijns 2010)

  - Improved forecasts for analysts who understand foreign firms' local culture (Du et al. 2017) or same language as CEOs (Zhang 2022)

# Related Literature: Technological Innovations

- **Financial social media and FinTechs**

  - Incremental information content (Chen et al. 2014; Campbell et al. 2019; Jame et al. 2016; Coleman et al. 2022)

  - Wider reach to broad market participants (e.g., Farrell et al. 2022)

- **Relation between technology and human labor in financial research industry**

  - Reduced demand for traditional information sources (Grennan and Michaely 2021)

  - Intensified competition and discipline effects (Jame et al. 2022)

Rules-Based vs Statistical Learning Approach

- **Rules-based approach**

  ▪ Developed in early 1970s

  ▪ Requires full vocabulary and language rules defined by linguists

  ▪ Manual calibration and lack of adaptability

- **Statistical learning approach**

  ▪ Developed since 1980s and available as free online translation tool in early 2000s

  ▪ Feed computer large amount of text and apply statistical learning to pick up the most common matches between two languages

  ▪ Easy to adapt and self-evolving

Translation Performance

- Google Translate scored "best" provider in 65 out of 99 language-pair-domains evaluated by Intento (translation service provider) in 2022

- Second best performer (DeepL) is subscription-based

● Language pair, domain
Number of cases the provider got into "best"

35
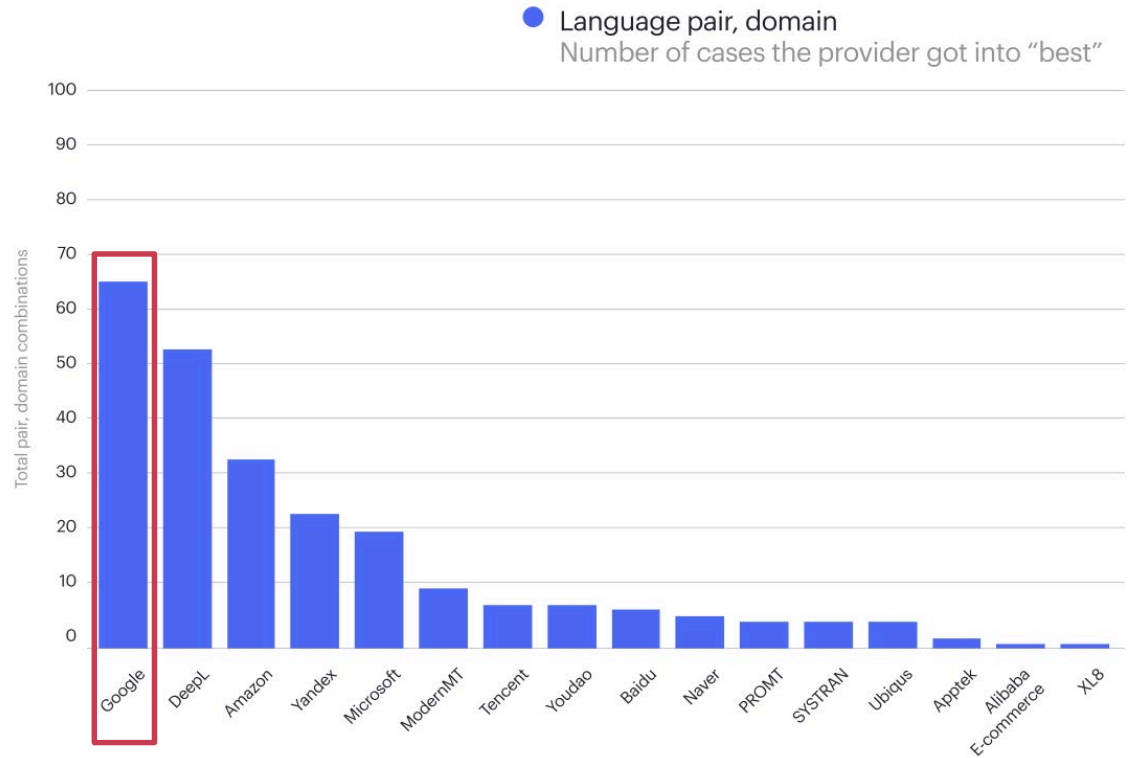
Use of Translation Tools: Anecdotal Evidence

- Here is where we consider ideas that others share, either voluntarily or according to law…We follow blogs, not only in English but also in German, French, Swedish, Norwegian and more (thank you, **Google Translate**) (Johnson 2016).

- [I]nvestors themselves can use technology effectively. It is quite common even for finance professionals to use tools like **Google Translate** to read financial statements and announcements of foreign issuers (Root 2020).

- Their [Credit Suisse] due diligence for their client is putting Bulgarian news articles into **Google Translate** and attempting to read them (Garrahan 2022).

Foreign Languages by Year

Year	Number	Languages
2006	10	Arabic, Chinese (Simplified), French, German, Italian, Japanese, Korean, Portuguese, Russian, Spanish
2007	3	Chinese (Traditional), Dutch, Greek
2008	21	Bulgarian, Catalan, Croatian, Czech, Danish, Finnish, Hebrew, Hindi, Indonesian, Latvian, Lithuanian, Norwegian, Polish, Romanian, Serbian, Slovak, Slovene, Swedish, Tagalog (Filipino), Ukrainian, Vietnamese
2009	17	Afrikaans, Albanian, Belarusian, Estonian, Galician, Hungarian, Icelandic, Irish, Macedonian, Malay, Maltese, Persian, Swahili, Thai, Turkish, Welsh, Yiddish
2010	7	Armenian, Azerbaijani, Basque, Georgian, Haitian Creole, Latin, Urdu
2011	5	Bengali, Gujarati, Kannada, Tamil, Telugu
2012	2	Esperanto, Lao
2013	15	Bosnian, Cebuano, Hausa, Hmong, Igbo, Javanese, Khmer, Maori, Marathi, Mongolian, Nepali, Punjabi, Somali, Yoruba, Zulu
2014	10	Burmese, Chichewa, Kazakh, Malagasy, Malayalam, Sesotho, Sinhala, Sundanese, Tajik, Uzbek
2016	13	Amharic, Corsican, Frisian, Hawaiian, Kurdish, Kyrgyz, Luxembourgish, Pashto, Samoan, Scots Gaelic, Shona, Sindhi, Xhosa
2020	5	Kinyarwanda, Odia, Tatar, Turkmen, Uyghur

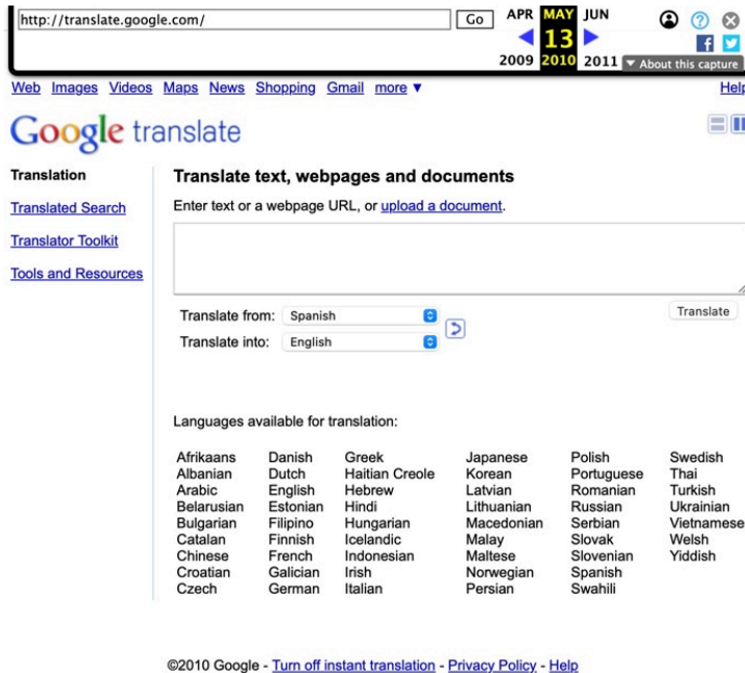# Countries/Regions with Major Language Supported by Google Translate

Year	Number	Countries/Regions
2006	84	Algeria, Angola, **Argentina**, **Austria**, Bahrain, Belarus, Benin, Bolivia, **Brazil**, Burkina Faso, Cabo Verde, Cameroon, Chad, **Chile**, **China**, **Colombia**, Costa Rica, Cuba, Democratic Republic of the Congo, Djibouti, Dominican Republic, Ecuador, **Egypt**, El Salvador, Equatorial Guinea, **France**, French Polynesia, Gabon, **Germany**, Guadeloupe, Guatemala, Guinea, Guinea-Bissau, Holy See, Honduras, Iraq, **Italy**, Ivory Coast, **Japan**, Jordan, Kazakhstan, Kuwait, Lebanon, Libya, Liechtenstein, Mali, Martinique, Mauritania, **Mexico**, Monaco, Morocco, Mozambique, New Caledonia, Nicaragua, Niger, North Korea, Oman, Palestine, Panama, Paraguay, Peru, **Portugal**, Puerto Rico, Qatar, Republic of the Congo, Reunion, **Russia**, Saint Pierre and Miquelon, Saint-Martin (French part), San Marino, Sao Tome and Principe, **Saudi Arabia**, Senegal, **South Korea**, **Spain**, Sudan, **Switzerland**, Syria, Togo, Tunisia, **United Arab Emirates**, Uruguay, **Venezuela**, Yemen
2007	8	**Belgium**, Cyprus, Greece, **Hong Kong**, Macao, **Netherlands**, Suriname, **Taiwan**
2008	22	Andorra, Bulgaria, Croatia, **Czech Republic**, **Denmark**, **Finland**, **India**, **Indonesia**, **Israel**, Latvia, Lithuania, Moldova, **Norway**, **Philippines**, **Poland**, **Romania**, Serbia, Slovakia, Slovenia, **Sweden**, Ukraine, **Vietnam**
2009	16	Afghanistan, Albania, Brunei, Cocos (Keeling) Islands, Estonia, Hungary, Iceland, **Iran**, Kenya, Macedonia, **Malaysia**, Malta, Tanzania, **Thailand**, **Turkey**, Uganda
2010	5	Armenia, Azerbaijan, Georgia, Haiti, **Pakistan**
2011	1	**Bangladesh**
2012	1	Laos
2013	6	Bosnia and Herzegovina, Cambodia, Mongolia, Nepal, Somalia, **South Africa**
2014	7	Lesotho, Madagascar, Malawi, Myanmar, Sri Lanka, Tajikistan, Uzbekistan
2016	4	Kyrgyzstan, Luxembourg, Samoa, Zimbabwe
2020	2	Rwanda, Turkmenistan
		Bold: Top 50 in nominal GDP (World Bank 2021)

Non-Supported Countries

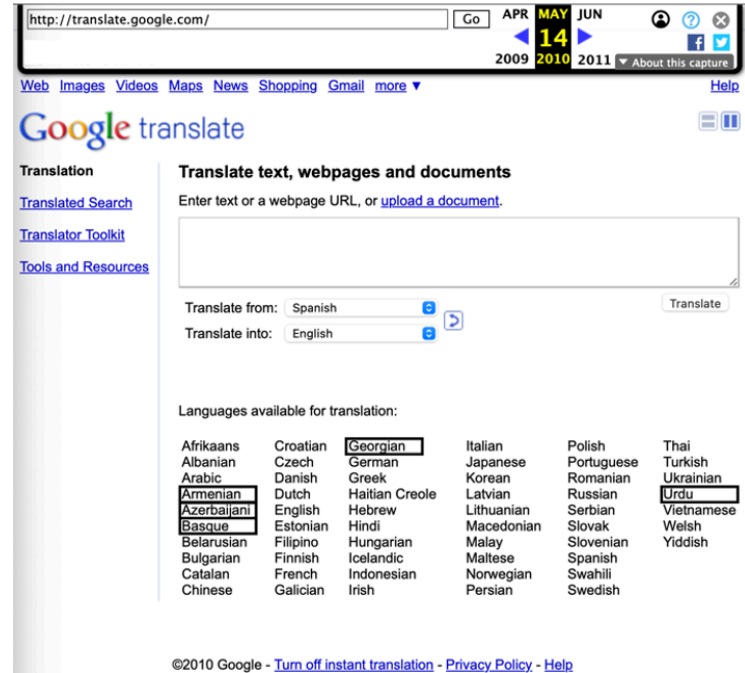| Year	Number	Countries/Regions
Non-Supported	24	Aruba, Bhutan, Burundi, Central African Republic, Comoros, Curaçao, Eritrea, Eswatini, Ethiopia, Faroe Islands, Fiji, Greenland, Maldives, Marshall Islands, Montenegro, Naur, Netherlands Antilles, Northern Mariana Islands, Palau, Papua New Guinea, Seychelles, Tonga, Tuvalu
English-Speaking	48	Anguilla, Antigua and Barbuda, **Australia**, Bahamas, Barbados, Belize, Bermuda, Botswana, British Virgin Islands, **Canada**, Cayman Islands, Cook Islands, Dominica, Falkland Islands (Malvinas), Gambia, Ghana, Gibraltar, Grenada, Guam, Guernsey, Guyana, **Ireland**, Isle of Man, Jamaica, Jersey, Kiribati, Liberia, Mauritius, Micronesia, Montserrat, Namibia, **New Zealand, Nigeria**, Pitcairn, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Sierra Leone, **Singapore**, Solomon Islands, South Georgia and the South Sandwich Islands, South Sudan, Trinidad and Tobago, Turks and Caicos Islands, **United Kingdom, United States of America**, "Virgin Islands, US", Zambia
		Bold: Top 50 in nominal GDP (World Bank 2021)

Identify Rollout Dates

- Two historical web pages on The Wayback Machine

Page on May 13, 2010   Page on May 14, 2010

Identify Treatment Firms

$$Translate\ Percentage_{i,t} = \frac{\sum_{s=1}^{N_{i,t-1}} Support_{i,s,t}}{N_{i,t-1}} \times 100\%$$

- Subsidiaries ($s = 1$ to $N_{i,t-1}$) for firm *i* in year *t-1* (lagged by one year)

- $Support_{i,s,t}$, indicator equal one

  - If subsidiary *s* is domiciled in a country where its most-commonly used language has been supported by Google Translate by the start of year *t*

- Treatment firms: $Translate\ Percentage_{i,t}$ >= 10%

- Control firms

  - Same group of firms before rollout of Google Translate

  - Other firms with less than 10% of subsidiaries located in Supported countries

Other Information Sources: Managers and Media

	Corporate Filings		Earnings Guidance		Media News	
	(1) 8-K Count	(2) 10-K Length	(3) Guidance Count	(4) Guidance Error	(5) WSJ etc. Count	(6) DJ Newswires Count
Translate	0.00	-0.01	**0.09***	-0.48	0.02	-0.03*
	(0.11)	(-1.27)	**(5.55)**	(-1.43)	(1.191)	(-1.85)
Control	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	49,450	49,395	49,450	15,462	43,874	43,874
Adjusted R^2	0.75	0.57	0.65	0.72	0.72	0.76

▪ **Possibly less subject to cross-border information frictions**

– Managers have access to rich foreign information through internal resources or local agents (e.g., Liu and Lu 2023)

– Media outlets tend to operate local branches in foreign countries

Analyst Coverage Decision

- **Substitution effect of Google Translate?**

  ▪ Expanded panel of firm-analyst-year data

  ▪ Coverage = 1 if an analyst provides forecast in that firm-year

	(1) Coverage	(2) Coverage
Translate	**-0.00**	**-0.01**
	(-0.93)	**(-1.05)**
Controls	Yes	Yes
Firm FE	Yes	No
Analyst FE	Yes	No
Analyst-Firm FE	No	Yes
Year FE	Yes	Yes
Obs.	1,048,369	1,031,188
Adjusted R^2	0.14	0.30

Robustness Tests

	Alternative Treatment Variables				Stacked DID
	(1)	(2)	(3)	(4)	(5)
	Error (%)	Error (%)	Error (%)	Error (%)	Error (%)
Treatment Variable	Percentage (%)	Indicator (> 0%)	Indicator (≥ 20%)	Indicator (Segment)	Indicator (≥ 10%)
Translate	-0.01***	-0.45***	-0.52***	-0.35**	-1.45***
	(-3.05)	(-2.99)	(-3.62)	(-2.29)	(-5.42)
Controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	No
Year FE	Yes	Yes	Yes	Yes	No
Cohort-Firm FE	No	No	No	No	Yes
Cohort-Year FE	No	No	No	No	Yes
Obs.	50,060	50,060	50,060	41,065	103,119
Adjusted R^2	0.39	0.39	0.39	0.40	0.43

Table 4

Return

Robustness: First Batch vs Others

- Average of *Translate Percentage:* 13.4%

  ▪ First batch: 8.2%

  ▪ Other batches: 5.2%

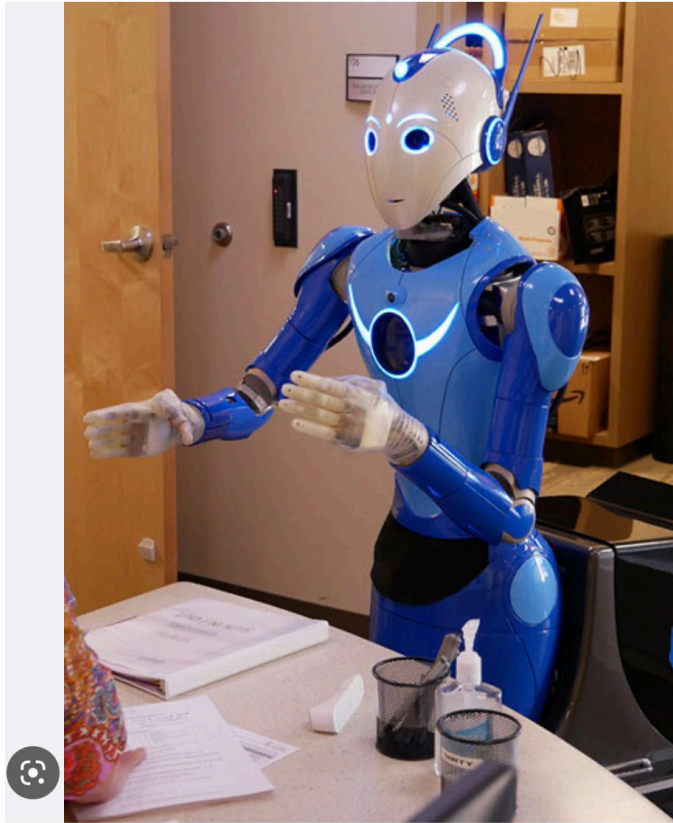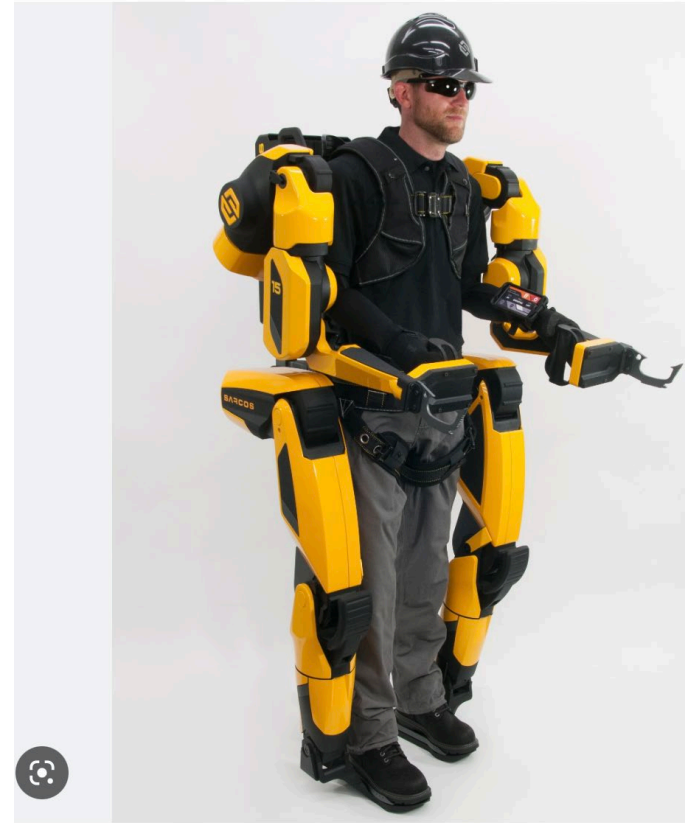- Results

	(1) Error (%)
Translate Percentage (First Batch)	**-0.007***
	(-1.77)
Translate Percentage (Other Batches)	**-0.011****
	(-2.07)
First Batch **LESS** Other Batches	0.004
p-value	0.6122
Controls	No
Firm FE	No
Year FE	No
Obs.	50,060
Adjusted R^2	0.00

Return

Substitution vs. Complementarity

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