

Large Language Models (LLMs) in Social Science Research

Part II

Joshua Cova and Luuk Schmitz

Max Planck Institute for the Study of Societies

2024-07-15

Welcome back!

- ▶ In Part 1, we introduced the **uses of LLM in social science research** and talked about **validation and performance metrics**.
- ▶ Any questions?

 Luuk Schmitz
@LuukSchmitz ...

Interested in what you can (and can't) do with large language models in social science research? I gave a workshop for beginners with my colleague Joshua Cova outlining use cases, validation, and model selection. You can find the slides here: drive.google.com/file/d/1pjtbll...

Large Language Models (LLMs) in Social Science Research
Session I: Introduction

Joshua Cova and Luuk Schmitz
Max Planck Institute for the Study of Societies
20-06-2024

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Today

- ▶ Open vs. closed-source models (Josh)
- ▶ Model selection (Josh)
- ▶ Deep-dive on how to use LLM in an applied setting (Luuk)

Reminder: Do you even need a large language model (LLM)?

- ▶ For many applications, it is sufficient to train your own classifier or use an already existing one (e.g. BERT)
 - ▶ Classification tasks & fine-tuning
 - ▶ Fine-tune classifier to your own use case, with a labelled data set. Research illustrates that it can often do better than LLMs in social science settings (Ziems et al. 2024).
 - ▶ LLM: text generation & translation
 - ▶ LLM ad hoc or experimental, you don't have labelled examples, classes might change; when you need more elaborate output than just the name of the different classes

Some terminology

- ▶ **Prompt engineering:** '*structuring an instruction that can be interpreted and understood by a generative AI model*'
- ▶ **Zero-shot vs. few-shot** → No labelled examples required vs. set of annotated examples (in-context learning)
- ▶ **Fine-tuning:** re-training the model on a specific dataset to increase task-specific performance
- ▶ **Model parameters:** the # of weights used during the training of the model
- ▶ **Temperature:** Increasing/decreasing deterministic/creative responses
- ▶ **Tokenization:** Divide the text in distinct components

Zero-shot vs. few-shot

Prompting Strategie	Example Structure
Zero-shot	{"role": "system", "content": "Text of System Prompt"}, {"role": "user", "content": "(Text to classify) + classification question"}
One-shot	{"role": "system", "content": "Text of System Prompt"}, {"role": "user", "content": "(Example text) + classification question"}, {"role": "assistant", "content": "Example classification"}, {"role": "user", "content": "(Text to classify) + classification question"}
Few-shot	{"role": "system", "content": "Text of System Prompt"}, {"role": "user", "content": "(Example text) + classification question"}, {"role": "assistant", "content": "Example classification"}, {"role": "user", "content": "(Example text) + classification question"}, {"role": "assistant", "content": "Example classification"}, ... more examples {"role": "user", "content": "(Text to classify) + classification question"}
Chain-of-Thought	{"role": "system", "content": "Text of System Prompt"}, {"role": "user", "content": "(Text to classify) + reasoning question"}, {"role": "assistant", "content": "Reasoning"}, {"role": "user", "content": "Classification question"}

Table 1: Example structures of different prompting strategies for annotation purposes

Problems with closed-source models

So far, the best-performing LLMs are proprietary and closed. Why could this be a problem for researchers?

- ▶ **Dependence** -> No guarantee of continued support of older version of the same model
- ▶ **Training corpus 1)**-> We do not know what inputs were used to train the model (Copyright)
- ▶ **Training corpus 2)** -> *Garbage in, garbage out* (interesting model: Phi-3)
- ▶ **Training corpus 3)** -> General, not necessarily specialized
- ▶ **Cost**
- ▶ **Reproducibility**
- ▶ **Privacy & data storage**

But why are proprietary LLMs so good?

- ▶ Massive datasets (the Internet!)
- ▶ Cutting-edge transformer models
- ▶ Hardware and GPU
- ▶ Cloud computing
- ▶ Cost of training a state-of-the-art LLM can be several millions USD.

What constitutes an open-source LLM?

- ▶ Researchers advocating the use of open-source LLMs (Spirling 2023; Ollion et al. 2024)
- ▶ It is not so simple

What constitutes an open-source LLM?

- ▶ Researchers advocating the use of open-source LLMs (Spirling 2023; Ollion et al. 2024)
- ▶ It is not so simple
- ▶ It is a spectrum as opposed to a binary
- ▶ Just release the code?
- ▶ Entire pipeline (including training data)
- ▶ And what about the use license?
- ▶ Control, customization and transparency: Greater ability to fine-tune for specific task

But beware...

- ▶ 'With open- source large language models, researchers can look at the guts of the model to see how it works, customize its code and flag error' (Spirling, 2023). But is this something we really want to do?
- ▶ Beware that more coding knowledge is very likely to be required compared to off-the-shelf, closed-source LLMs (think about operating systems analogy)
- ▶ University/institute running own server

Taking a step back

- ▶ GPT3.5 surpasses performance of crowd-workers in relevance, stance, topic identification and frame detection (Gilardi, Alizadeh, and Kubli 2023)
- ▶ ChatGPT 4.0 outperforms expert coders in detecting party affiliation based on Tweets (Törnberg 2023)

Some encouraging news: Comparing open vs. closed-source models in applied social science research

Results

- ▶ Alizadeh et al. (2023) fine-tuned open-source LLMs surpass zero-shot GPT-3.5 and GPT 4
- ▶ Iterative process, depending on task and fine-tuning

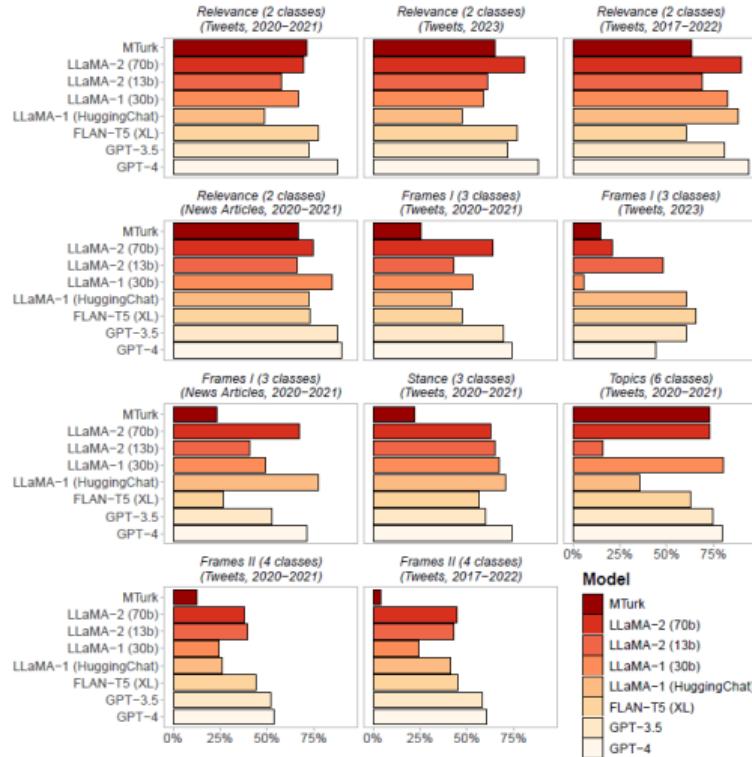
Test

- ▶ **Relevance:** Is the text about politics or not
- ▶ **Topic detection:** Is the text about a set of pre-defined topics
- ▶ **Stance detection:** Is the text positive/neutral/negative
- ▶ **Frame detection:** Is the text framed as a problem or solution

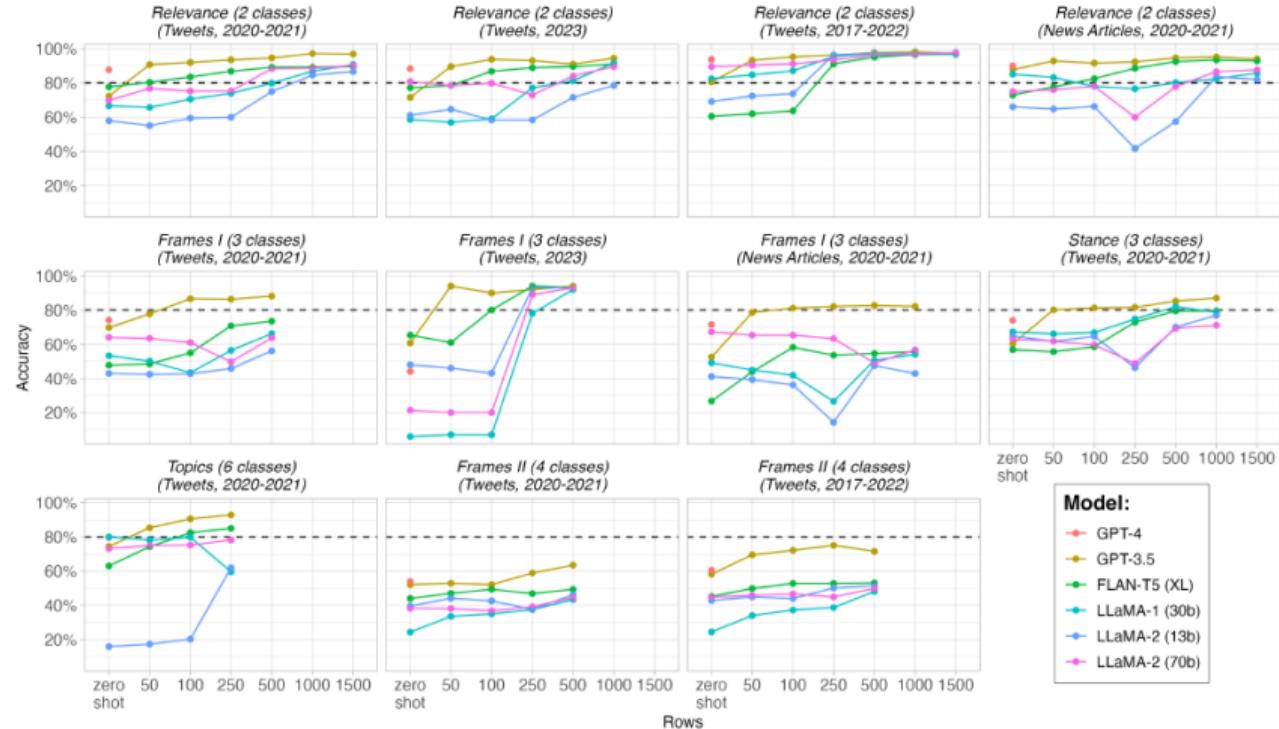
Data

Tweets and newspaper articles on content moderation

Results



Results



Some things to consider

- ▶ CPU vs. GPU
- ▶ Quantisation -> model compression
- ▶ Choose number of parameters, depends on your machine, but probably <7 Billion
- ▶ Parameter counts: Bigger models require greater resources, balance between power and efficiency
- ▶ If you download the LLM, store information locally, no need to communicate with cloud server. Therefore more secure data transmission (could even switch off wi-fi)
- ▶ Other local alternatives: LM Studio and Ollama
- ▶ Google colab or runpod renting out GPU

Okay, but how can I know which open-source LLMs are even available? The Hugging face open source LLM leaderboard

Select Columns to Display:

Average  IFEval IFEval Raw BBH BBH Raw MATH Lvl 5
 MATH Lvl 5 Raw GPQA GPQA Raw MUSR MUSR Raw MMLU-PRO
 MMLU-PRO Raw Type Architecture Precision Not_Merged
 Hub License #Params (B) Hub  Model sha Chat Template

Precision
 bfloat16 float16

Select the number of parameters (B)
6 10

Hide models
 Deleted/incomplete Merge/MoErge MoE Flagged
 Show only maintainer's highlight

T	Model	Average 	IFEval	BBH	MATH Lvl 5	GPQA	MUSR	MMLU-PRO
🕒	Owen/Owen2-72B-Instruct 	42.49	79.89	57.48	35.12	16.33	17.17	48.92
🕒	meta-llama/Meta-Llama-3-70B-Instruct 	36.18	80.99	58.19	23.34	4.92	10.92	46.74
◆	Owen/Owen2-72B 	35.13	38.24	51.86	29.15	19.24	19.73	52.56
🕒	mistralai/Mixtral-8x22B-Instruct-v0.1 	33.89	71.84	44.11	18.73	16.44	13.49	38.7
🕒	HuggingFaceH4/zephyr-orpo-141b-A35b-v0.1 	33.77	65.11	47.5	18.35	17.11	14.72	39.85
🕒	microsoft/Phi-3-medium-4k-instruct 	32.67	64.23	49.38	16.99	11.52	13.05	40.84
🕒	01-ai/Yi-1.5-34B-Chat 	32.63	60.67	44.26	23.34	15.32	13.06	39.12
🕒	CohereForAI/c4ai-command-x-plus 	30.86	76.64	39.92	7.55	7.38	20.42	33.24
🕒	internlm/internlm2_5-7b-chat 	30.46	61.4	57.67	8.31	10.63	14.35	30.42
🕒	Owen/Owen1.5-110B 	29.56	34.22	44.28	23.84	13.65	13.71	48.45

III Hands-on example

What we will discuss

1. Paper rationale
2. Data collection & data wrangling
3. Performing an analysis with LLMs
4. Evaluating results

Paper rationale

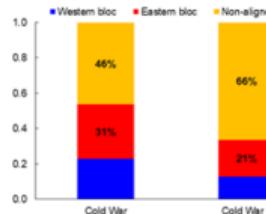
The Economist
The Republican meltdown
Does AI doom screens?
Africa loses faith in democracy
Eulogy to a sycamore
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ARE FREE MARKETS HISTORY?
The rise of homeland economics

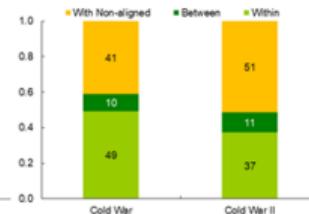
But this time could be different (2)

Greater economic heft and integration with rival blocs of non-aligned countries

Relative bloc size during the Cold War and currently
(share of total population)



Trade between, within blocs and with non-aligned
(share of total trade)



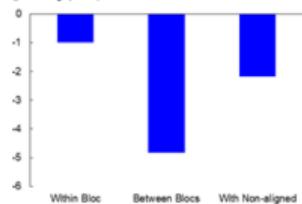
Sources: Frouard and Mihalj (2018), CEPR, Golosman (2017), IMF, World Economic Outlook, Trade Data Monitor, and the staff calculations.

Note: Western bloc: US, Europe, Canada, Australia and non-aligned economies are defined based on Golosman (2017) for the Cold War period. For the current period, a hypothetical Western Bloc includes US, Europe, Canada, Australia and New Zealand. The hypothetical Eastern Bloc comprises Belarus, China, Mali, Nicaragua, Russia, and Syria, with the rest of the countries considered 'Non-aligned'.

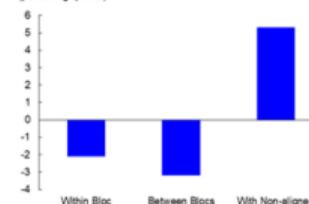
Emerging fault lines

Geopolitical considerations are already affecting trade and investment

Change in trade growth post war
(percentage points)



Change in FDI shares post war
(percentage points)



Sources: Ex Markets, Trade Data Monitor, and IMF staff calculations.

Note: In both charts, the 'Within' category refers to the difference in log bilateral trade, which are then aggregated using bilateral nominal trade as weights. The chart on the left plots the change in the number of FDI (measured as a share of the total number of FDI) between 2020Q2-2022Q2 and 2019Q1-2020Q1 within and between blocs and with non-aligned countries. In both charts, the hypothetical Western Bloc includes US, Europe, Canada, Australia and New Zealand. The hypothetical Eastern Bloc comprises Belarus, China, Mali, Nicaragua, Russia, and Syria. The rest of the countries are considered 'Non-aligned'.

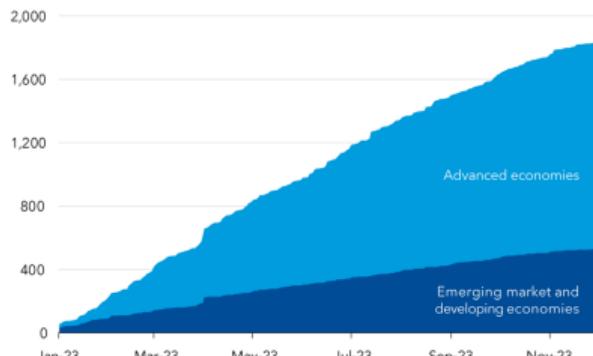
Efficiency, security, and resilience

Since the mid-2010s, we see a ‘growing confidence in governments’ ability to reshape their economies for the better’ (Wolf 2023) and a declining confidence that markets ‘always allocate capital productively and efficiently’ (Sullivan 2023). ‘These policies [...] are driven by straightforward national security considerations. We will not compromise on these concerns, even when they force trade-offs with our economic interests’ (Yellen 2023).

New measures

Advanced economies have been more active users of industrial policies in 2023.

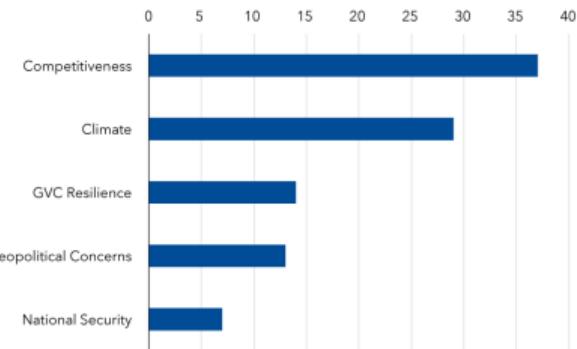
Number of industrial policy measures implemented in 2023



Distortive industrial policy drivers

New industrial policy measures are increasingly driven by climate mitigation, supply chain resilience and security.

Share of distortionary industrial policy measures by motive (percent)



The argument: efficiency reloaded

What is considered to be ‘good’ economic policy and good business strategy is remolded through economic security considerations.

	The efficiency calculus	The resilience calculus
Main justification	Factor endowment and efficient resource allocation	Providing economic security
State strategy	Carving out competitive niches Moving up the value chain	Pursuing technological sovereignty Integrating the value chain
‘Feasibility space’ for democratic decision-making	Circumscribed by technocracy	Circumscribed by national security
Business strategy	Last-mile efficiency (Just in Time) & spatially ‘blind’	Geopolitical risk minimization (Just in Case) & spatially conscious

The paper

1. Literature review: combining IR and IPE
2. Theory: efficiency reloaded
3. Case studies on U.S. and EU turn towards economic security in trade and industrial policies
4. Quantitative analysis of all corporate earnings calls that mention 'geopolitics' ($n=13.875$) as a way to study firms' revealed preferences (cf. Weber and Wasner 2023) using GPT-4.0 Turbo.
5. The Janus-faces of economic security (democratic choice, lock-out for emerging economies)

Data collection

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Slowing US inflation boosts chances of 3 Fed rate cuts in 2024

The market's preferred inflation measure grew by the smallest amount since March 2021.

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Results for geopolitical

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COMPANY INFORMATION	WEBSITE	INDUSTRY	GEOGRAPHY	COMPANY STATUS	SUPPORTING DOCUMENTS
Geopolitical Solutions Ltd. From company description: ...Geopolitical Solutions Ltd is a specialized consumer services company....		Specialized Consumer Services	Hampshire, United Kingdom	Operating	
Geopolitical Futures From company description: ...Geopolitical Futures operates as an application software company.... +1 more	www.geopoliticalfuture...	Application Software	USA	Operating	Key Developments
Geopolitical Advisory Services Ltd. From company description: ...Geopolitical Advisory Services Ltd is a diversified support services company....		Diversified Support Services	Middlesex, United Kingdom	Operating	
European Geopolitical Forum Sprl From company description: ...European Geopolitical Forum Sprl operates as a research and consulting services company....		Research and Consulting Services	Tervuren, Belgium	Operating	
Geopolitical Intelligence Services AG		Unclassified	Germany	Operating	

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Data collection III

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All Result Types (14,161)

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Key Developments

Transcripts & Presentations (14,161) Y (2) X

Select Industries (MI)

Select Geographies

Custom

01/01/2016 ↔ To OK

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Earnings Call

Dow Jones News

Nikkei News

Funds

Transactions And Offerings

Results for geopolitical

1 - 50 of about 14161 records

Transcripts & Presentations

	TRANSCRIPT INFORMATION	PUBLICATION DATE	TRANSCRIPT/PRESENTATION TYPE	RELATED COMPANIES
<input type="checkbox"/> ⋮	Careium AB (Publ), Q2 2024 Earnings Call, Jul 12, 2024 It's an extremely good question. We are, of course, like everyone, looking at options since no one really knows where the geopolitical winds are blowing. What I would say, though, it's not as easy (Answer)	7/12/2024 10:00:00 AM	Transcript - Earnings Call	(OM:CARE) Careium AB (Publ)
<input type="checkbox"/> ⋮	Nederman Holding AB (publ), Q2 2024 Earnings Call, Jul 12, 2024 -- the general economic environment and the investment appetite, it can impact on the investment decisions and geopolitical uncertainty is never usually a good thing for business and for investments (Presentation)	7/12/2024 8:00:00 AM	Transcript - Earnings Call	(OM:NMAN) Nederman Holding AB (publ)
<input type="checkbox"/> ⋮	Aker Solutions ASA, Q2 2024 Earnings Call, Jul 12, 2024 operational performance on our project portfolio. In these times of geopolitical tension impacting our markets and supply chain, I'm very proud to see that we continue to meet our execution milestones, for (Presentation)	7/12/2024 7:30:00 AM	Transcript - Earnings Call	(OB:AKSO) Aker Solutions ASA
<input type="checkbox"/> ⋮	Aritzia Inc., Q1 2025 Earnings Call, Jul 11, 2024 on estimates and assumptions made by management regarding, among other things, general economic and geopolitical conditions as well as the competitive environment. Actual results may differ materially (Presentation)	7/11/2024 8:30:00 PM	Transcript - Earnings Call	(TSX:ATZ) Aritzia Inc.
<input type="checkbox"/> ⋮	Firan Technology Group Corporation, Q2 2024 Earnings Call, Jul 11, 2024 . We shipped our first production orders last year, and we now have over \$17 million in orders due through 2026. With the more complex geopolitical situation in China, there might be concerns about (Presentation)	7/11/2024 12:30:00 PM	Transcript - Earnings Call	(TSX:FTG) Firan Technology Group Corporation
<input type="checkbox"/> ⋮	PepsiCo, Inc., Q2 2024 Earnings Call, Jul 11, 2024 reason why not. Of course, it could be big geopolitical reasons why we change our mind later in the year. But with the information we have today about geopolitics and stability of countries, that's our best guess today. (Answer)	7/11/2024 12:15:00 PM	Transcript - Earnings Call	(NASDAQ:PEP) PepsiCo, Inc.
<input type="checkbox"/> ⋮	Bonheur ASA, Q2 2024 Earnings Call, Jul 11, 2024 risen, albeit of a low demand and higher production costs. I think it's also fair to mention that we do expect gas prices to remain sensitive of any geopolitical developments, and if there is a rebound (Presentation)	7/11/2024 7:00:00 AM	Transcript - Earnings Call	(OB:BONHR) Bonheur ASA

What do earnings calls look like?

S&P Global
Market Intelligence

Qatar Aluminium Manufacturing Company Q.P.S.C. DSM:QAMC

FQ1 2024 Earnings Call Transcripts

Thursday, May 2, 2024 10:30 AM GMT

S&P Global Market Intelligence Estimates

	-FQ4 2023-			-FY 2023-			-FY 2024-
	CONSENSUS	ACTUAL	SURPRISE	CONSENSUS	ACTUAL	SURPRISE	CONSENSUS
EPS Normalized	NA	NA	NA	0.08	NA	NA	0.09
Revenue [mm]	776.00	NA	NA	1604.00	NA	NA	1506.90

Currency: QAR

Consensus as of: Mar-12-2024 5:22 AM GMT



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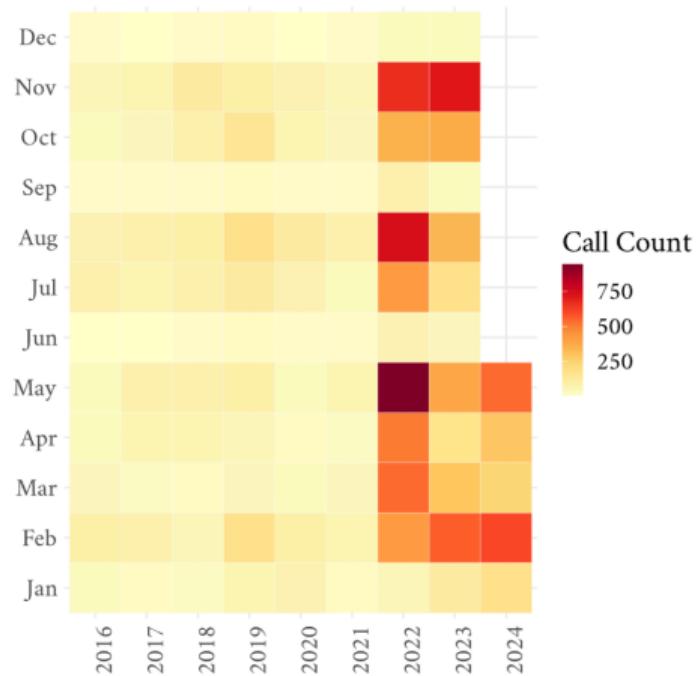
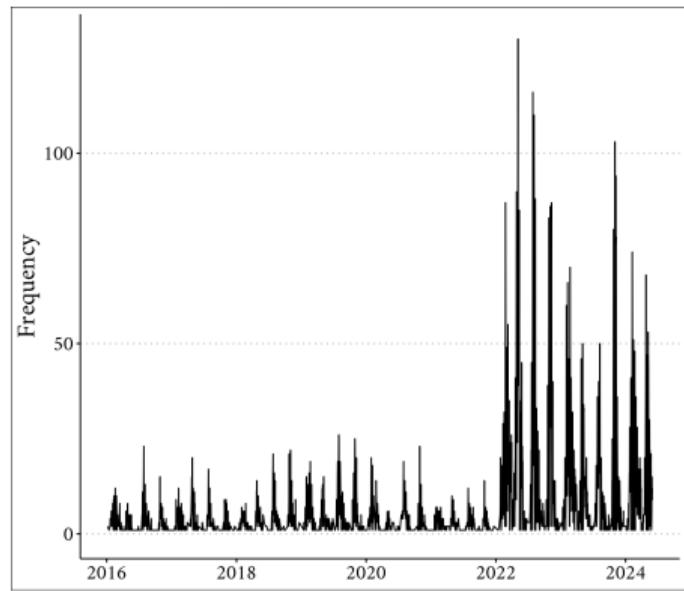
Call Participants	3
Presentation	4
Question and Answer	7

Data wrangling

	A	B	C	D	E
	all_extracted_triplets_final_cleaned				
1	#id	Company	Stock Exchange	Date	Sentences
2	20281	CIMB GROUP HOLDINGS BERHAD	KLSE:CIMB	2024-05-31	However, a bit of a cautious outlook. We continue to be -- I like to be cautious, particularly with the global economic [indiscernible], the uncertain geopolitical tension. But more importantly, I think most of you are aware, the likelihood of prolonged elevated interest rate and competitive operating environment, particularly in Indonesia, whereby I think the bank and not just us but all banks is facing challenges to pass on the higher cost of deposit to the customer.
3	20282	PREMIER EXPLOSIVES LIMITED	BSE:526247	2024-05-31	Sir, so you mentioned about the macroeconomic scenario hampering some of your supplies. So what is the scenario right now from the geopolitical front. And is that now in a way, has it recovered and the execution or the supplies have started or there is still a slowdown in that?
4	20283	TARSONS PRODUCTS LIMITED	NSEI:TARSONS	2024-05-31	I want to understand more on the revenue side. The revenue growth, let's assume these geopolitical things get over, then what can be the reason for not growing, right? Would it be on supply constraint or on the demand constraints?
5	20284	TARSONS PRODUCTS LIMITED	NSEI:TARSONS	2024-05-31	So if we win some contracts, I think the ratio would look very, very different, and it would go more heavily in favor of ODM. And I think if the global geopolitical scenario improves and the supply chains improve and people are more open to develop business to look at new opportunities, to look at new partnerships, I think, there would be an opportunity for us to grow our branded business. Operator We'll take our next question from the line of Jatin Chawla from RTL Investments.
6	20285	BLUMETRIC ENVIRONMENTAL INC.	TSXV:BLM	2024-05-31	We continue to be optimistic about our military market and Cleantech Systems given the robust pipeline we're seeing through active proposals. Global geopolitical tensions are driving increased military spend, which BluMetric continues to be a beneficiary of. These trends support the company's goal to expand geographically by integrating its mission-ready water technologies into a full-service solution throughout North America and globally with other allied nations.
7	20286	MARKSANS PHARMA LIMITED	NSEI:MARKSANS	2024-05-31	Perfect, sir. And just a final question, sir, with some geopolitical risk as well as some wars going on. So will our -- how will that impact on U.S. business as well as elections coming up out there also?
8	20287	MARKSANS PHARMA LIMITED	NSEI:MARKSANS	2024-05-31	spglobal.com/marketintelligence 14 Jhaveri, if I had that answer, I would have been a global leader right now. I honestly can't predict geopolitical issues and force measures which may be beyond our control. I don't have a crystal ball, unfortunately.
9	20288	STEELCAST LIMITED	BSE:513517	2024-05-31	Good afternoon, and welcome to everyone for joining this Steelcast Limited Investors call. As we step into FY '25, the global geopolitical landscape remains very challenging, marked by ongoing conflicts and significant elections worldwide. These events are poised to influence the direction of the global economy.
10	20289	STEELCAST LIMITED	BSE:513517	2024-05-31	While major central banks have hinted at potential rate cuts throughout the year, the persistent lack of progress on inflation remains a concern. As we previously communicated upon entering FY '24, we anticipate flat growth due to unfavorable geopolitical conditions. However, we maintain cautious optimism regarding a turnaround in the global situation, particularly from Q3 FY '25 onwards.
11	20290	STEELCAST LIMITED	BSE:513517	2024-05-31	The revenue for Q4 improved to INR 98.4 crores from INR 90.3 crores from the previous quarter, an improvement of 9%. However, revenue for Q4 FY '24 declined 18.2% compared to corresponding quarter of previous year from INR 120.3 crores to INR 98.4 crores due to adverse geopolitical and business situation. We've been able to maintain EBITDA margin of 29.3% during Q4 FY '24 against 30.3% during the previous quarter and 25.7% in the corresponding quarter of previous year.
12	20291	NBCC	BSE:534309	2024-05-31	Nikhil Abhyankar ICICI Securities Limited, Research Division Okay. And we did not face any pressure in the Maldives project once we had some kind of geopolitical tensions between us? Kellambally Puttaswamy Mahadevavaswamy Chairman, MD & Director of Commercial Not exactly.
13	20292	STEELCAST LIMITED	BSE:513517	2024-05-31	Chetankumar Manmohanbhai Tamboli Chairman, MD & CEO See, the supplies in the domestic -- in the defense industry is very significant if you really ask for in FY '24. And overall situation is a

Descriptives I

All earnings calls with statements about 'geopolitics' (or related terms) since 01-01-2016. Source: S&P's Capital IQ.

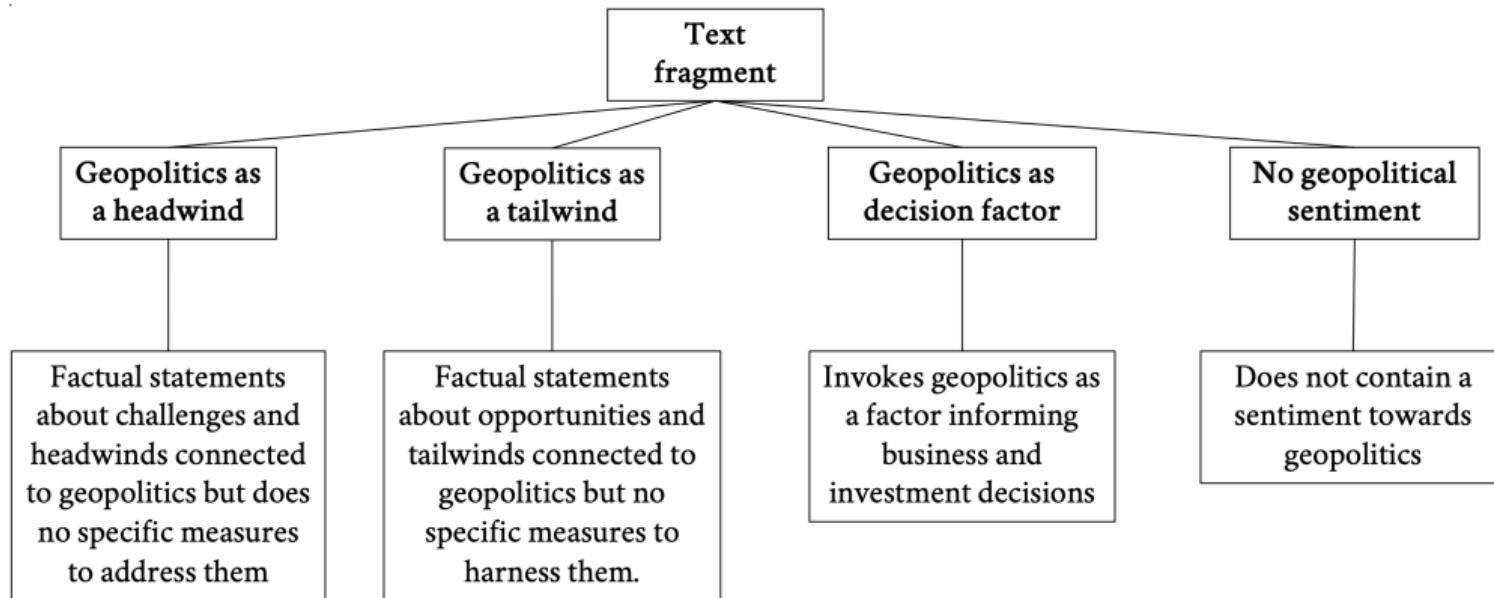


Descriptives II

Table 2: Information on earnings call data set

	#ID	Company	Date	Language
Unique observations	14564	4839	01-01-2016 - 01-06-2024	EN: 13875 JP: 488 CN: 201
Missing	0	0	234	0

Coding sheet



Some examples

Geopolitical headwinds

The global headwinds also could be a challenge. **The global slowdown and geopolitical tensions could pose some risks to India's export growth and foreign investments.** And obviously, the competition is intensifying.

And so that's a recent trend. But as you look at the general position globally sustained higher interest rates and the risk of continued inflation, the **global geopolitical landscape and some uncertainty around that, the election cycle and potential uncertainty around that.** We thought it was prudent for us as we look at the potential for disruptions to demand pattern associated with that environment to take a prudent view on our outlook for the year.

Some examples

Geopolitical tailwinds

We continue to be optimistic about our military market and Cleantech Systems given the robust pipeline we're seeing through active proposals. **Global geopolitical tensions are driving increased military spend, which BluMetric continues to be a beneficiary of.** These trends support the company's goal to expand geographically by integrating its mission-ready water technologies into a full-service solution throughout North America and globally with other allied nations.

BlackRock's underlying business momentum remains incredibly strong. And we believe there are more money being put to work as investors [gain] clarity on the path, the path of rate movements, **related to geopolitical issues and more people are seeking opportunities with BlackRock.** I do see great opportunities ahead for our clients and look forward to delivering more opportunity for you, our shareholders, our investors.

Some examples

Geopolitical choices

In addition, given the geopolitical scenario, **all major customers want to have alternate suppliers** and do not want to depend on a solely Chinese origin materials.

We are not yet seeing deflation at a holistic build cost level, though, but there has been deflation some materials and goods. We continue to monitor the various global geopolitical tensions, which could put pressure on materials and supply. And **we are actively looking to put further resilience into our supply chain.**

Our clients are trying to understand the implications of the rapidly changing investment environment. **The Russian invasion of Ukraine marks a profound geopolitical shift that is accelerating a reassessment of global supply chains.** It also creates a supply shock in commodities that is further increasing inflation.

Some examples

No geopolitical sentiment

Perfect, sir. And just a final question, sir, with some geopolitical risk as well as some wars going on. So will our – how will that impact on U.S. business as well as elections coming up out there also?

Unknown Analyst I want to understand more on the revenue side. The revenue growth, let's assume these geopolitical things get over, then what can be the reason for not growing, right? Would it be on supply constraint or on the demand constraints?

Performing the analysis

```
system_msg = f"""
    You are a research assistant to a social scientist. You will be provided
    with a text snippet and you must determine if it contains any content that
    mention 'geopolitics'. \
    Classify the following text into one of the given categories: {categories}
    Only include the selected category in your response and no further text
"""

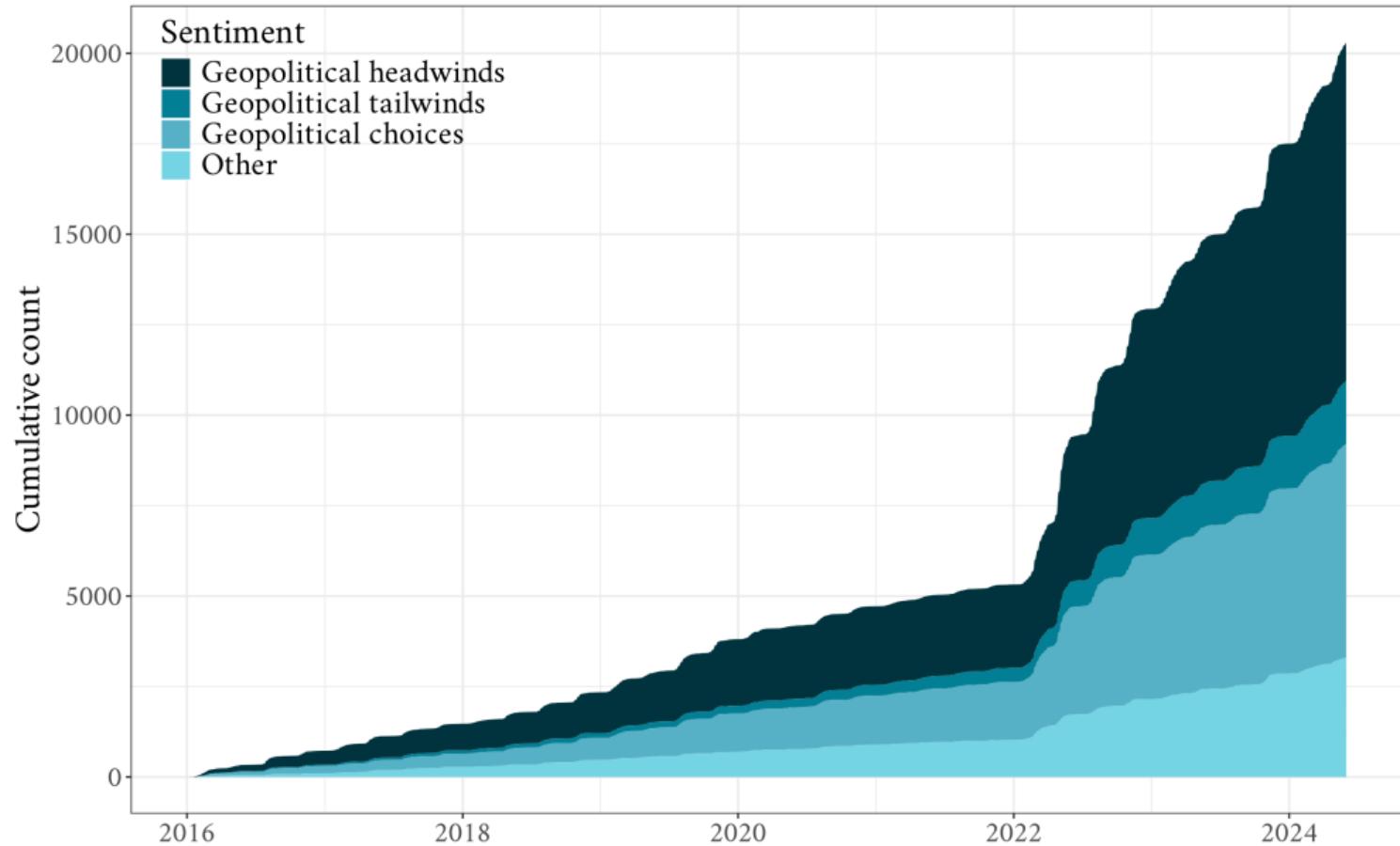
messages = [
    {"role": "system", "content": system_msg},
    {"role": "user", "content": review}
]

categories = ["1", "2", "3", "4"]

definitions = """
You will categorize the text as 1 when Geopolitics and geopolitical factors
are mentioned in the text.
You will categorize the text as 2 when Geopolitics and geopolitical factors
are not mentioned in the text.
You will categorize the text as 3 when Geopolitics and geopolitical factors
are mentioned in the text, but they are not the main focus.
As an absolute last resort, you will categorize the text as 4 when no clear
indication of geopolitics or geopolitical factors can be found.
"""

print(definitions)
```

GPT's analysis



GPT's analysis II

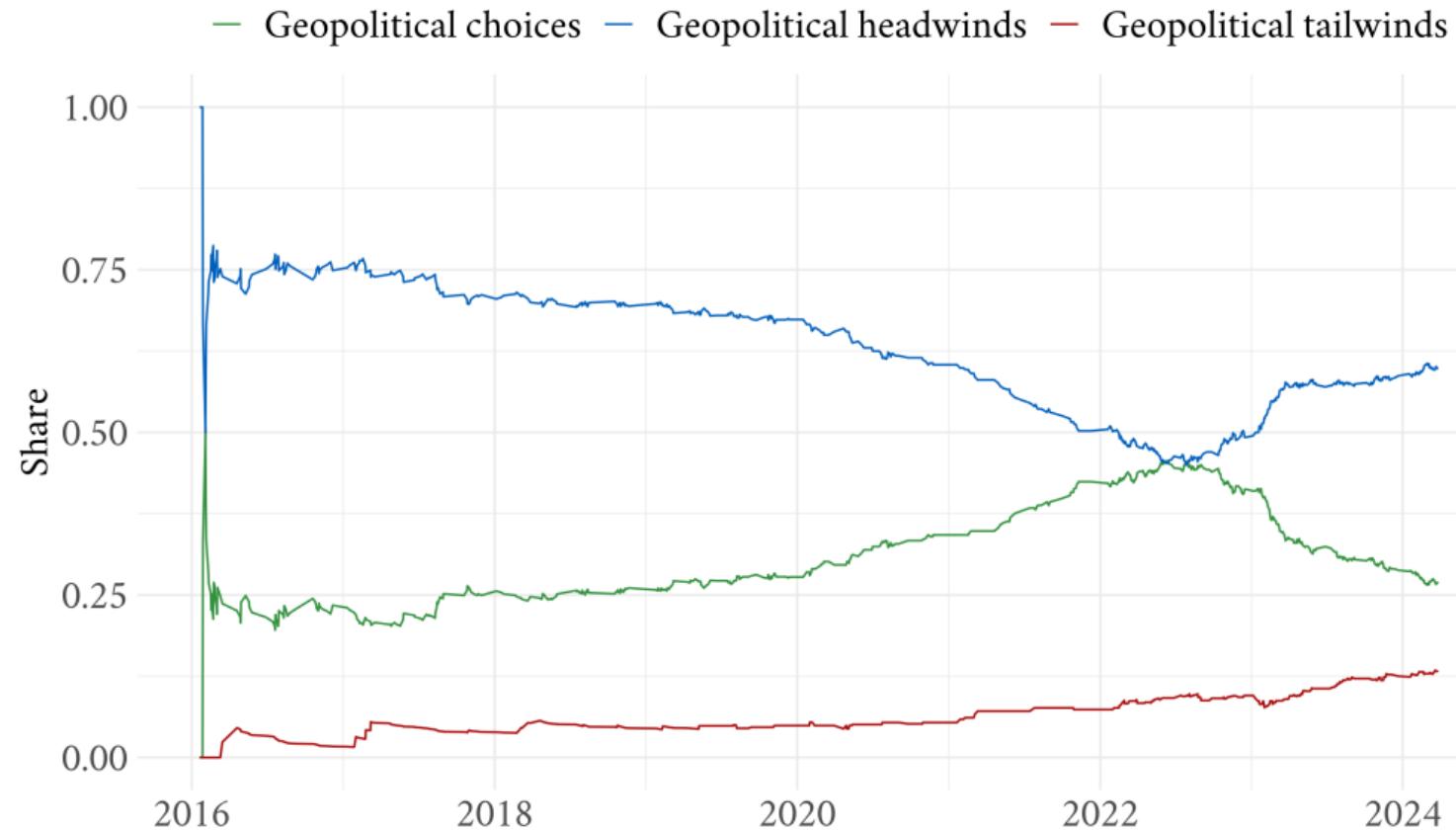


Figure 1: Relative share of sentiments, 200 day moving average

Evaluation

With all that has been said about the advantage of open-source models and classifier models, why did I opt for a closed-source generative model?

Let's take a look at performance and validation.

Evaluation

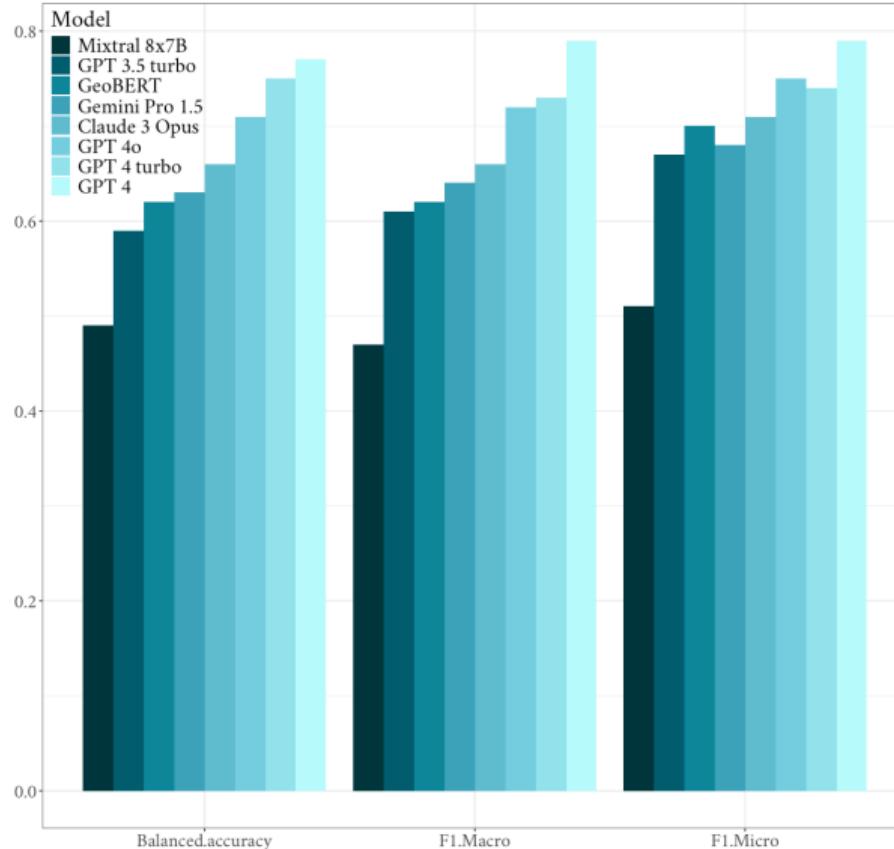


Figure 2: Accuracy and F1 scores per model

Next steps

Sectors

H0: Sentiments about geopolitics are evenly dispersed across sectors

H0a: Sentiments about geopolitics are not evenly dispersed across sectors

Geographies

H1: Sentiments about geopolitics are evenly dispersed across geographies

H1a: Sentiments about geopolitics are not evenly dispersed across geographies

Taxonomy

Develop a taxonomy of business choices concerning geopolitics to further disaggregate the 'choices' category

Conclusion

- ▶ Avoid the ‘rule of cool’
- ▶ Think critically about how much time you want to invest and how it can help:
costs, time & rewards
- ▶ Fast-moving field of research in which models quickly become obsolete
- ▶ Next steps for this workshop series...

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