Minerals, Critical Materials & Alaska's Economy

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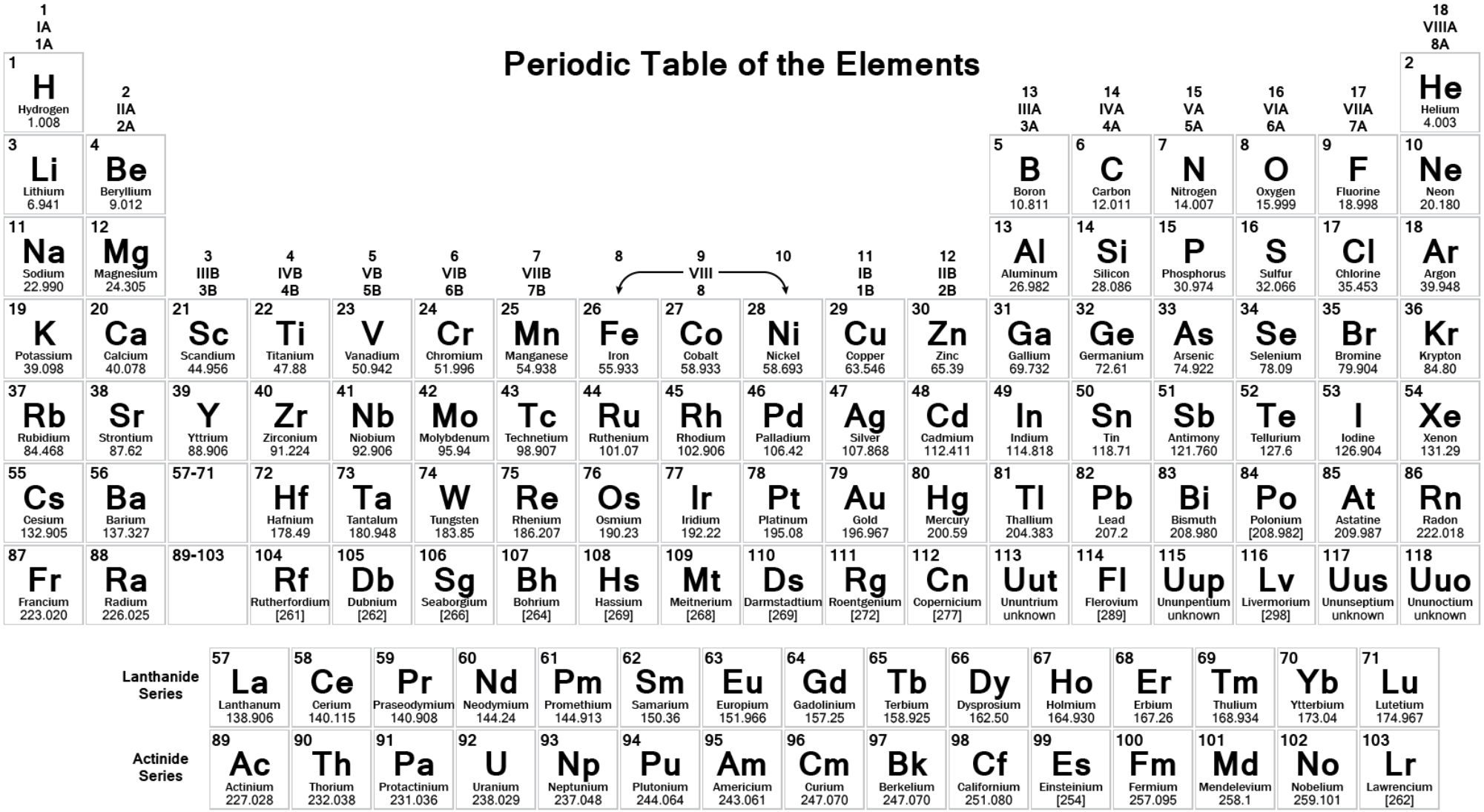
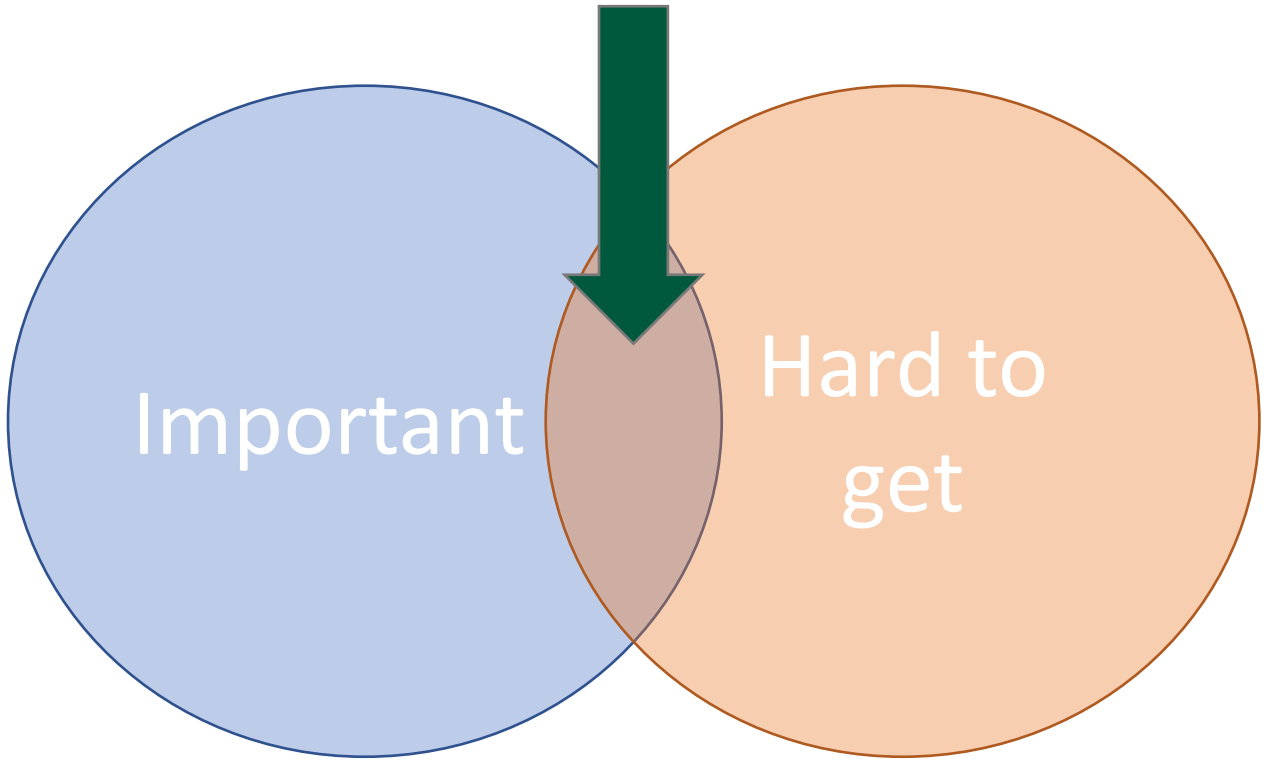
Defining “Critical Minerals”



Defining “Critical Minerals”

- Critical minerals are *IMPORTANT* and also *HARD TO GET*

Consequence of Disruption
- Manufacturing Supply chains = Lost GDP



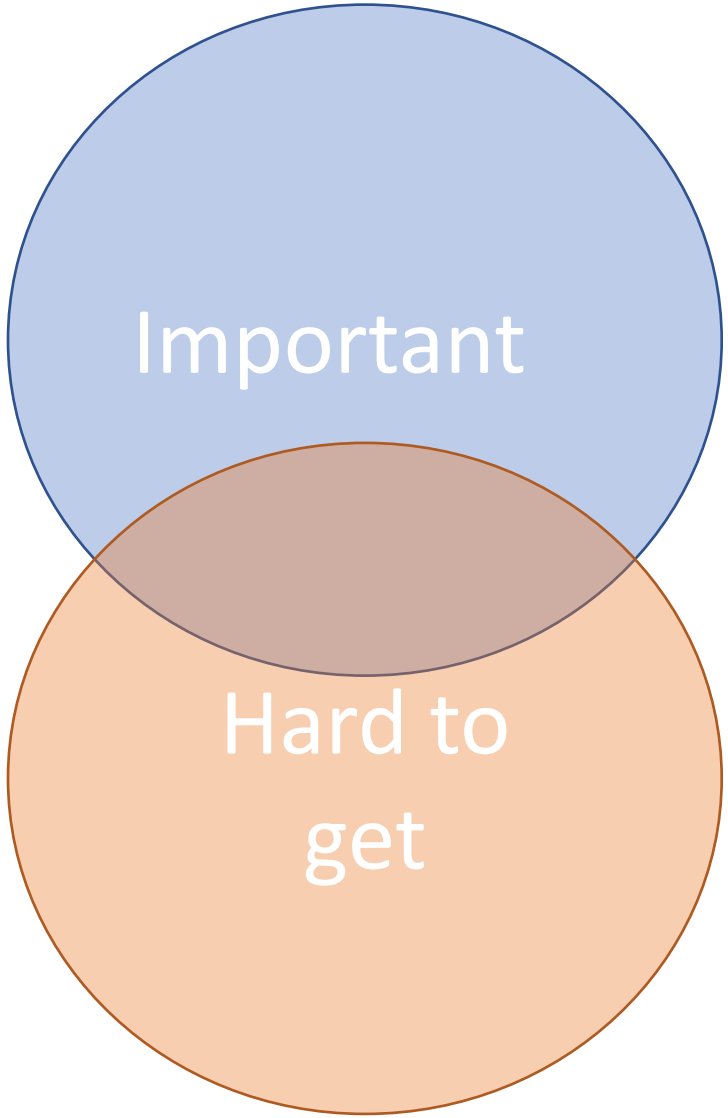
Probability of Disruption
- Concentrated production
- Market volatility
- Competition from other users
- Bottlenecks

What's "Critical" Depends on Your Perspective

- At a country level: The *US*'s manufacturing industry has a different perspective than *Germany's*
  - We make different things
  - We have different supply chains
- At a company level: *Tesla* different than *Toyota*
  - Tesla only makes EVs
  - Toyota makes ICE, hybrid, and EVs
- *China's* supply risk is different than the *UK's*
  - China dominates secondary processing
  - BUT still faces risks

A look at one perspective: USGS

- USGS in 2018 released list of “critical” minerals in response to Executive Order No. 13817
- The Energy Act of 2020 now requires USGS to update method and list every 3 years.
  - Critical minerals defined as minerals which:
  - (i) are essential to the economic or national security of the United States;
  - (ii) the supply chain of which is vulnerable to disruptions (including restrictions associated with foreign political risk, abrupt demand growth, military conflict, violent unrest, anti-competitive or protectionist behaviors, and other risks throughout the supply chain); **and**
  - (iii) serve an essential function in the manufacturing of a product (including energy technology-, defense-, currency-, agriculture-, consumer electronics-, and healthcare-related applications), the absence of which would have significant consequences for the economic or national security of the United States”



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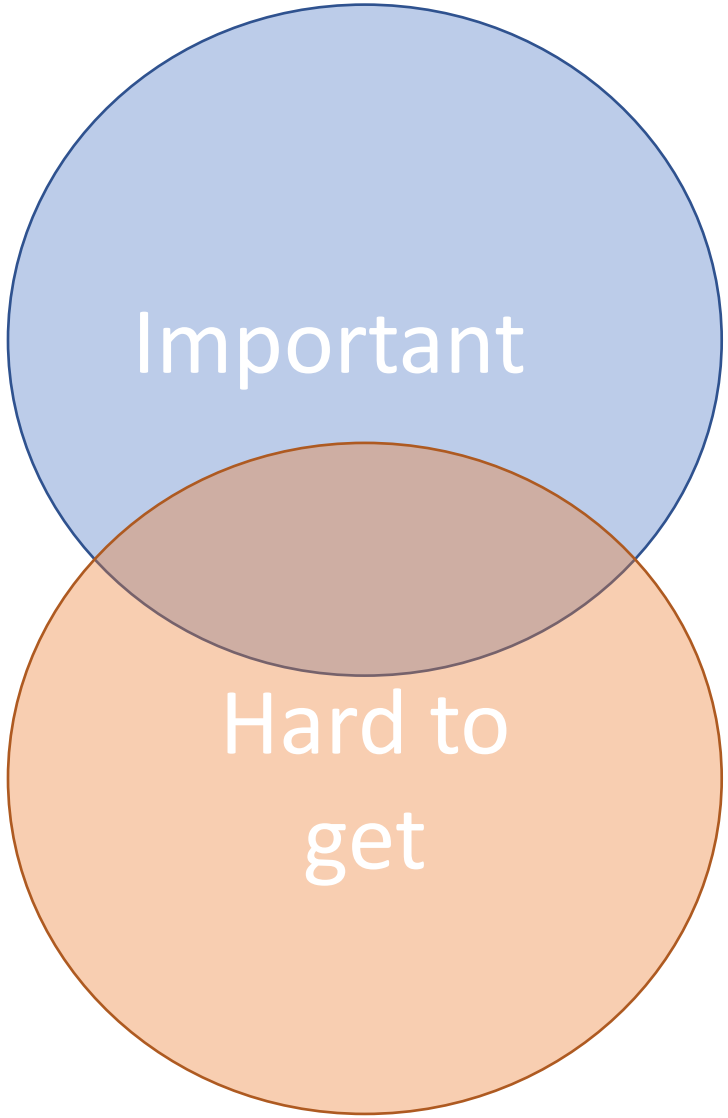
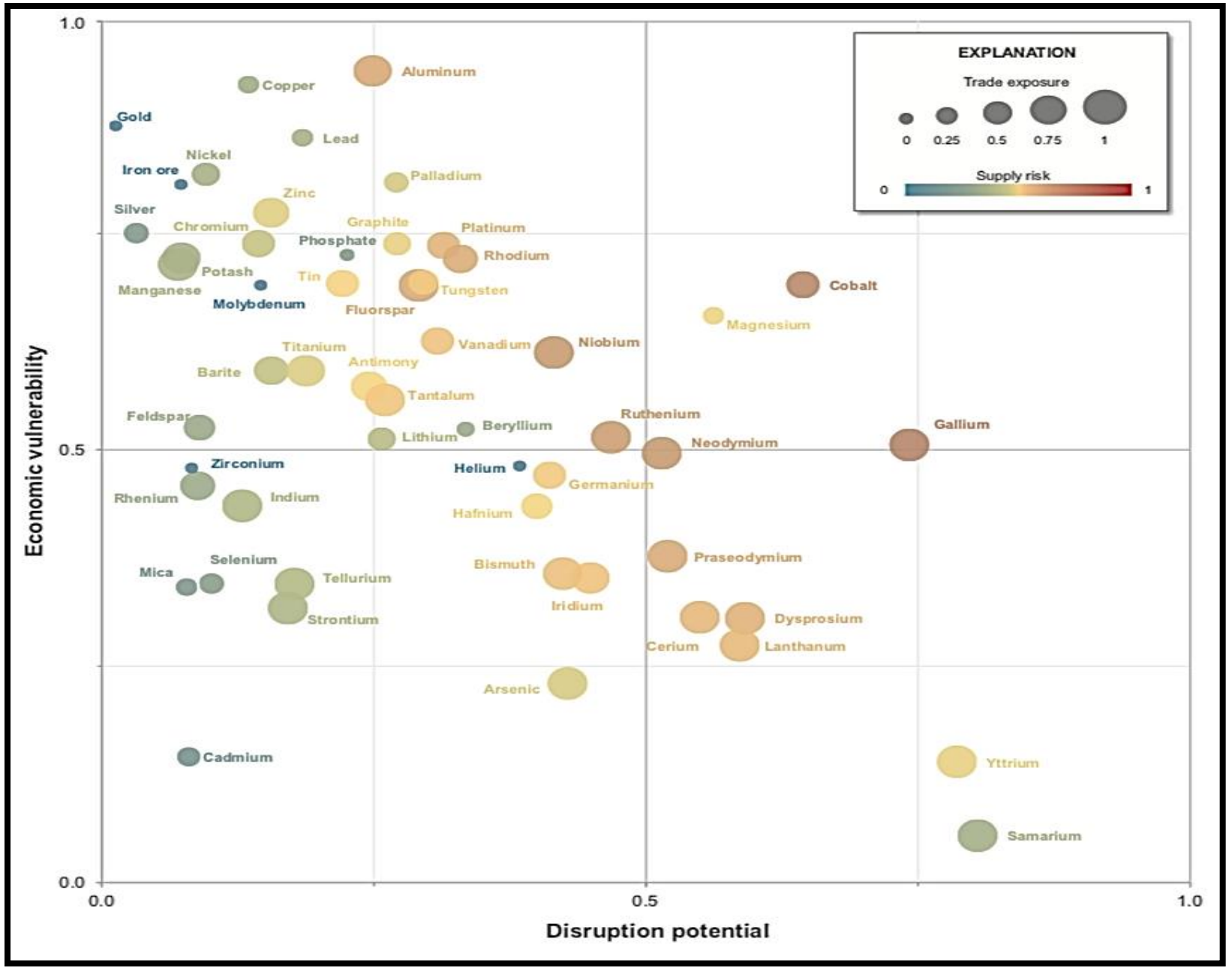


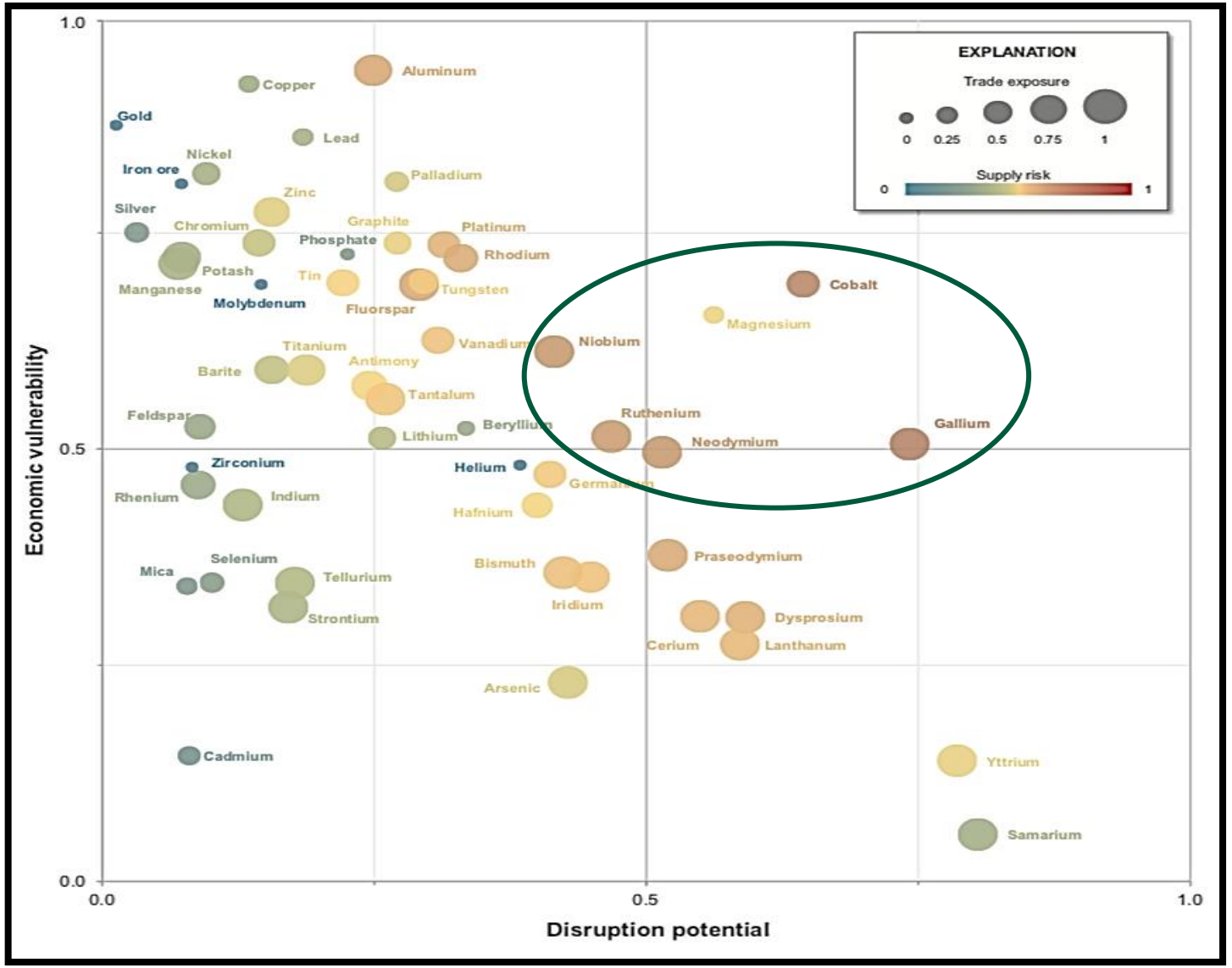
Important



Hard to get

Commodity	2018	Recency-weighted mean	Leading producing countries: Names and process stages
Gallium		0.67	China
Niobium		0.66	Brazil
Cobalt		0.65	DRC (mining), China (refining)
Neodymium		0.65	China (mining and refining)
Ruthenium		0.63	South Africa
Rhodium		0.62	South Africa
Dysprosium		0.61	China (mining and refining)
Aluminum		0.60	China (alumina and aluminum); Australia (bauxite)
Fluorspar		0.60	China
Platinum		0.60	South Africa
Iridium		0.59	South Africa
Praseodymium		0.58	China (mining and refining)
Cerium		0.56	China (mining and refining)
Lanthanum		0.56	China (mining and refining)
Bismuth		0.55	China
Yttrium		0.54	China (mining and refining)
Antimony		0.53	China
Tantalum		0.53	DRC
Hafnium		0.51	France
Tungsten		0.51	China
Vanadium		0.51	China
Tin		0.50	China (mining and smelting)
Magnesium		0.49	China
Germanium		0.49	China
Palladium		0.48	Russia
Titanium		0.48	Australia (mineral concentrate), China (sponge)
Zinc		0.48	China (mining and smelting)
Graphite		0.47	China
Chromium		0.47	South Africa
Arsenic		0.45	China
Barite		0.44	China
Indium		0.41	China
Samarium		0.40	China (mining and refining)
Manganese		0.40	South Africa
Lithium		0.40	Australia (mining), China (refining)
Tellurium		0.40	China
Lead		0.39	China (mining and refining)
Potash		0.38	Canada
Strontium		0.36	China
Rhenium		0.36	Chile
Nickel		0.36	Indonesia (mining), China (refining)
Copper		0.34	Chile (mining), China (smelting and refining)
Beryllium		0.33	United States
Feldspar		0.32	Turkey
Phosphate		0.25	China
Silver		0.25	Mexico
Mica		0.22	China
Selenium		0.23	Japan
Cadmium		0.11	China
Zirconium		0.09	Australia
Molybdenum		0.07	China
Gold		0.00	China
Helium		0.00	United States
Iron ore		0.00	Australia

A look at one perspective: USGS



Different Perspectives + Different Timing = Different Lists

Mineral	US 2018	US 2022	EU 2023	Japan 2023	Strategic Defense
Current Production in Alaska					
Zinc		✓		✓	
Gold					
Silver					
Lead					

Mineral	US 2018 (35)	US 2022 (50)	EU 2023 (34)	Japan 2023 (35)	Strategic Defense (12)
Historical Production in Alaska					
Antimony	✓	✓	✓	✓	✓
Tin	✓	✓		✓	
Tungsten	✓	✓	✓	✓	✓
Chromium	✓	✓		✓	
Platinum		✓			
Palladium		✓			
Platinum Group Metals	✓		✓	✓	
Uranium	✓				
Mercury (not on current lists)					

Different Perspectives – Different Lists

Mineral	US 2018 (35)	US 2022 (50)	EU 2023 (34)	Japan 2023 (35)	Strategic Defense (12)
Confirmed Resources in Alaska					
Rare Earth Elements (REE)	✓		✓	✓	✓
Cerium		✓		✓	
Neodymium		✓		✓	
Praseodymium		✓		✓	
Dysprosium		✓		✓	
Erbium		✓		✓	
Europium		✓		✓	
Gadolinium		✓		✓	
Holmium		✓		✓	
Lanthanum		✓		✓	
Lutetium		✓		✓	
Samarium		✓		✓	
Terbium		✓		✓	
Thulium		✓		✓	
Ytterbium		✓		✓	
Yttrium		✓		✓	✓
Copper			✓*		
Molybdenum	✓	✓		✓	
Cobalt	✓	✓	✓	✓	
Nickel		✓	✓*	✓	
Graphite (Natural)	✓	✓	✓	✓	✓
Lithium	✓	✓	✓	✓	

Mineral	US 2018 (35)	US 2022 (50)	EU 2023 (34)	Japan 2023 (35)	Strategic Defense (12)
Speculative Potential in Alaska					
Aluminum/Bauxite	✓	✓	✓	✓	
Arsenic	✓	✓	✓	✓	✓
Barite	✓	✓	✓	✓	
Beryllium	✓	✓	✓	✓	
Bismuth	✓	✓	✓	✓	✓
Boron/Borate			✓	✓	
Cesium	✓	✓		✓	
Coking Coal			✓		
Feldspar			✓		
Fluorspar	✓	✓	✓	✓	
Gallium	✓	✓	✓	✓	✓
Germanium****	✓	✓	✓	✓	✓
Hafnium	✓	✓	✓	✓	
Helium	✓		✓	✓	
Indium	✓	✓		✓	✓
Iridium		✓			
Magnesium	✓	✓	✓	✓	
Manganese	✓	✓	✓	✓	
Niobium	✓	✓	✓	✓	
Phosphate Rock			✓		
Phosphorus			✓	✓	
Potash	✓				
Rhenium	✓			✓	
Rhodium		✓			
Rubidium	✓	✓		✓	
Ruthenium		✓			
Scandium	✓	✓	✓	✓	✓
Silicon Metal			✓		
Strontium	✓		✓	✓	
Tantalum	✓	✓	✓	✓	✓
Tellurium	✓	✓		✓	
Titanium	✓	✓	✓	✓	
Vanadium	✓	✓	✓	✓	
Zirconium	✓	✓		✓	

Why create lists?

- Method for prioritization of R&D research spend:
- Diversify production: *Increase primary supply*
  - Reduce mining & milling private and external cost
  - Increase mill/refinery recovery efficiency
- Develop substitutes: *Reduce demand*
  - Improve manufacturing processes
  - Use less to achieve same properties
  - Substitute metals
  - Substitute technology
- Promote circular economies: *Enhance End of Life Recycling*

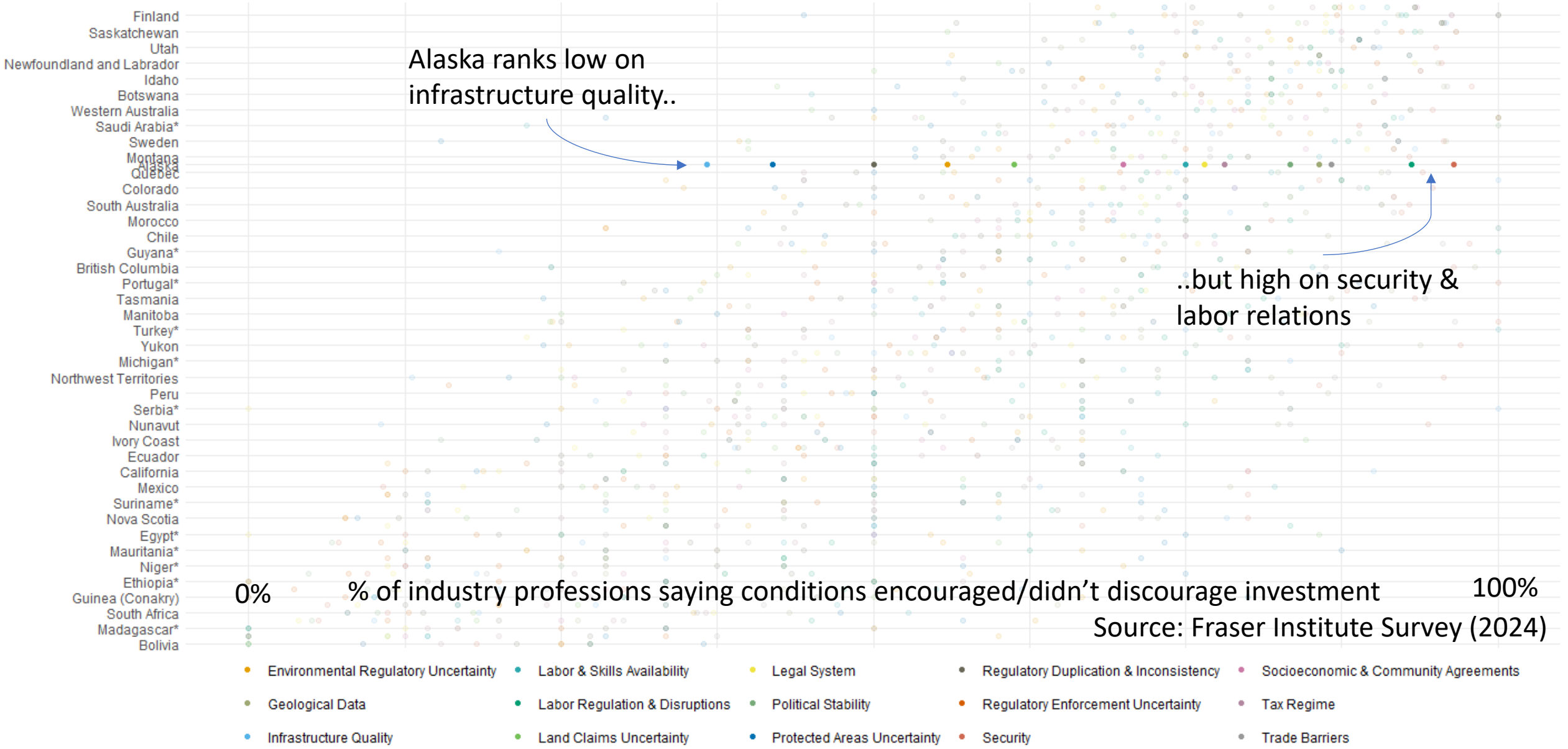
Why create lists?

- Primary CM policy: R&D funding allocation (see previous slide)
- However, other policy includes:
- Permitting & Facilitating IBA/FPI Consent
- Stockpiles, Take/Pay contracts, Grants, Subsidies, etc
- Identify workforce needs
- Trade policy
- Information

What are jurisdictions trying to achieve?

- Supply chain disruptions can impact manufacturing activity
  - For strategic minerals – national defense implications
  - For critical minerals – impacts to economy via manufacturing disruption
- Other goals (eg decarbonization) require deployment of significant manufactured capital
  - High external cost of delayed deployment

Alaska's Investment Landscape



Thank you

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