THE LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE

EUROPEAN INVESTMENT FUND

The Role of Corporate Financial Constraints on the Development of the European Greentech Ecosystem

LSE MPA Capstone Project
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ROADMAP

1. Introduction: Motivation & data
2. Mapping: Where are Greentech hubs located?
3. Modelling: Can access to finance explain Greentech investing?
4. Policy implications & conclusions

1

INTRODUCTION

MOTIVATION

- EU: 55% emission target reduction (2030), climate neutrality (2050)
- Climate financing has increased significantly but still *falls short* of what is necessary to catalyse green transition and fulfil policy targets

DEFINING GREENTECH

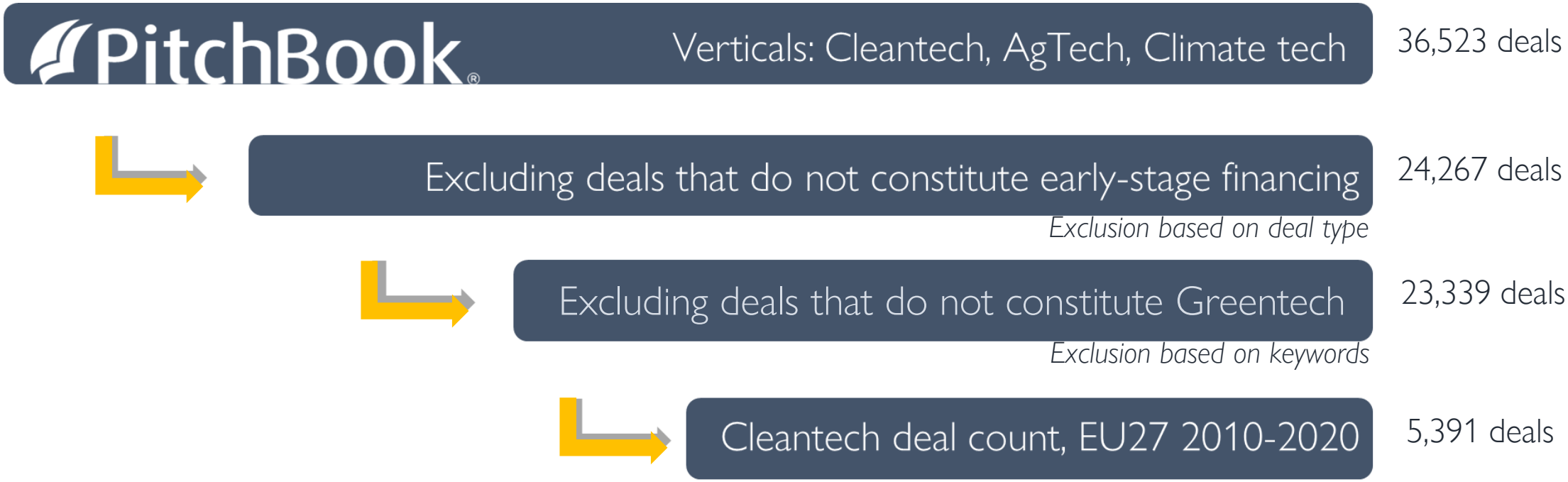
Based on Ghisetti et al. (2017)'s definition of *Cleantech:* "**innovations that contribute to economic and environmental sustainability**," including renewable energy, green mobility, clean production, sustainable agriculture, waste and water management

SECTION 2:
Mapping the EU Greentech ecosystem

SECTION 3:
Analysing the effect of access to finance on Greentech investment in the EU

DATA

Data source: Pitchbook deal, firm, and investor databases



Measure: Greentech deal counts *(missing data problem with deal size (USD))*

2

MAPPING THE EU GREENTECH ECOSYSTEM

MAPPING THE EU **GREENTECH ECOSYSTEM**

(I) Identifying the **LOCATION** of key Greentech hubs in the EU

(II) Analysing **INVESTMENT FLOWS** into EU Greentech companies

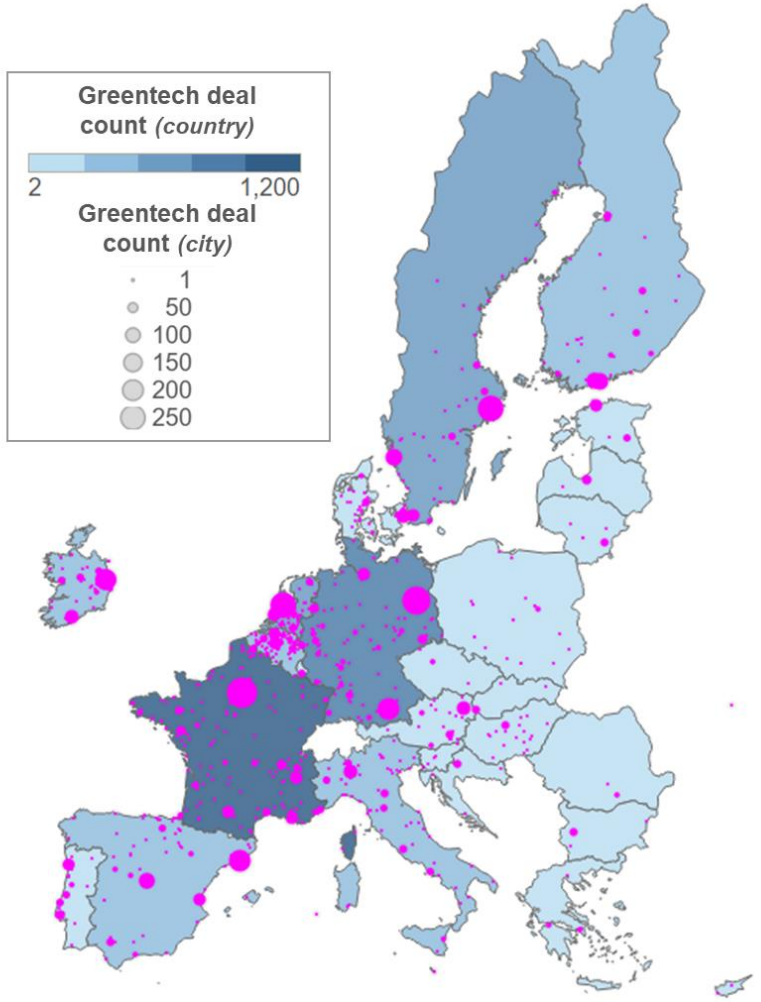
(III) Disaggregating patterns by **TECHNOLOGICAL SPECIALISATION**

(IV) Comparing the development of the EU ecosystem with the **USA** & **CHINA**

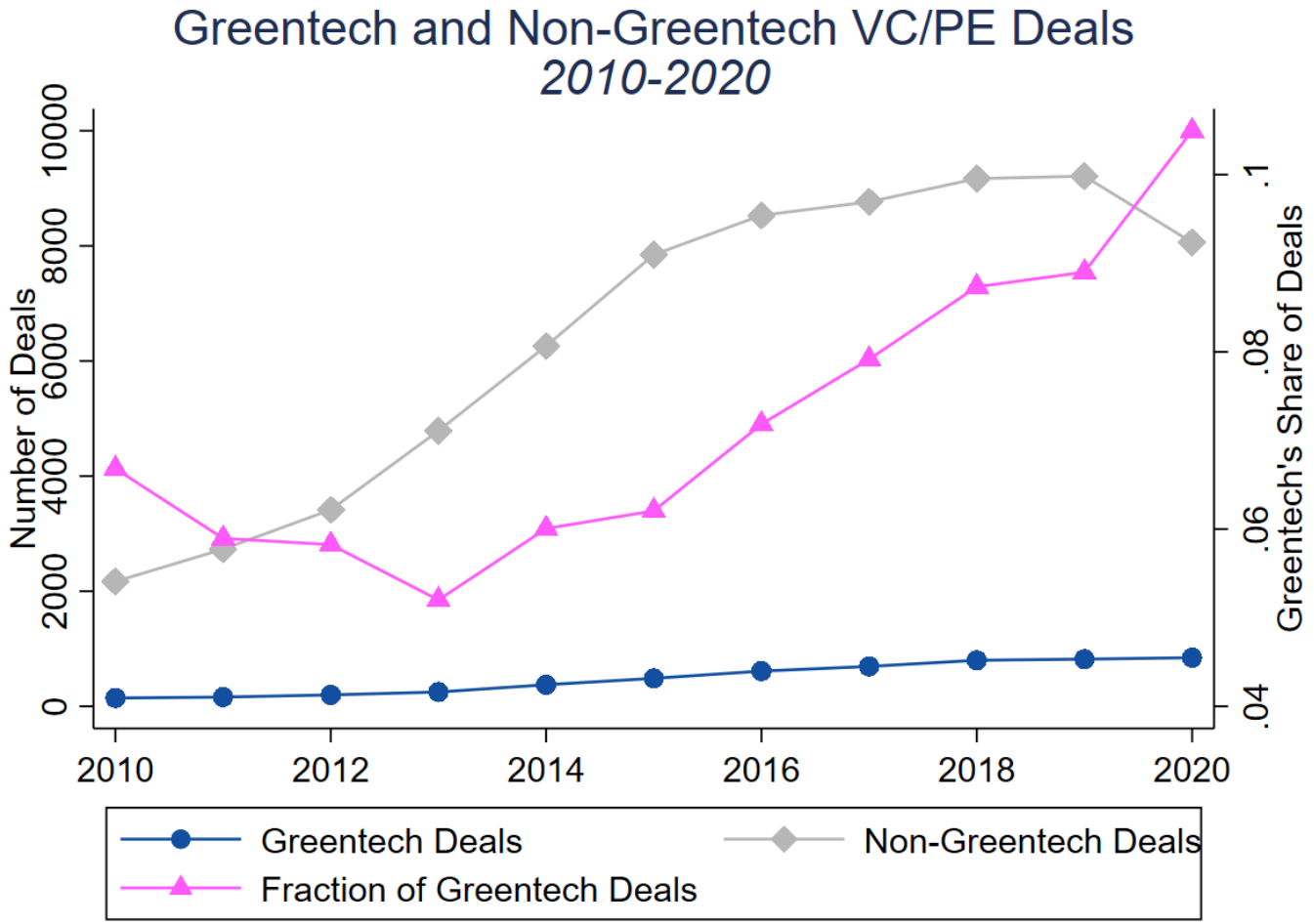
WHERE ARE THE EU'S MAJOR GREENTECH HUBS?

Greentech activity is **concentrated** in major urban centres

Leading Countries *Absolute deal counts* (2010-2020)		Leading Countries *Per million inhabitants* (2010-2020)		Leading Cities *Absolute deal counts* (2010-2020)	
France	1,191	Ireland	62.1	Paris	242
Germany	724	Finland	50.8	Berlin	207
Netherlands	547	Sweden	50.1	Stockholm	173
Sweden	502	Luxembourg	46.9	Amsterdam	171
Spain	433	Estonia	42.3	Barcelona	139



GREENTECH DEALS HAVE INCREASED



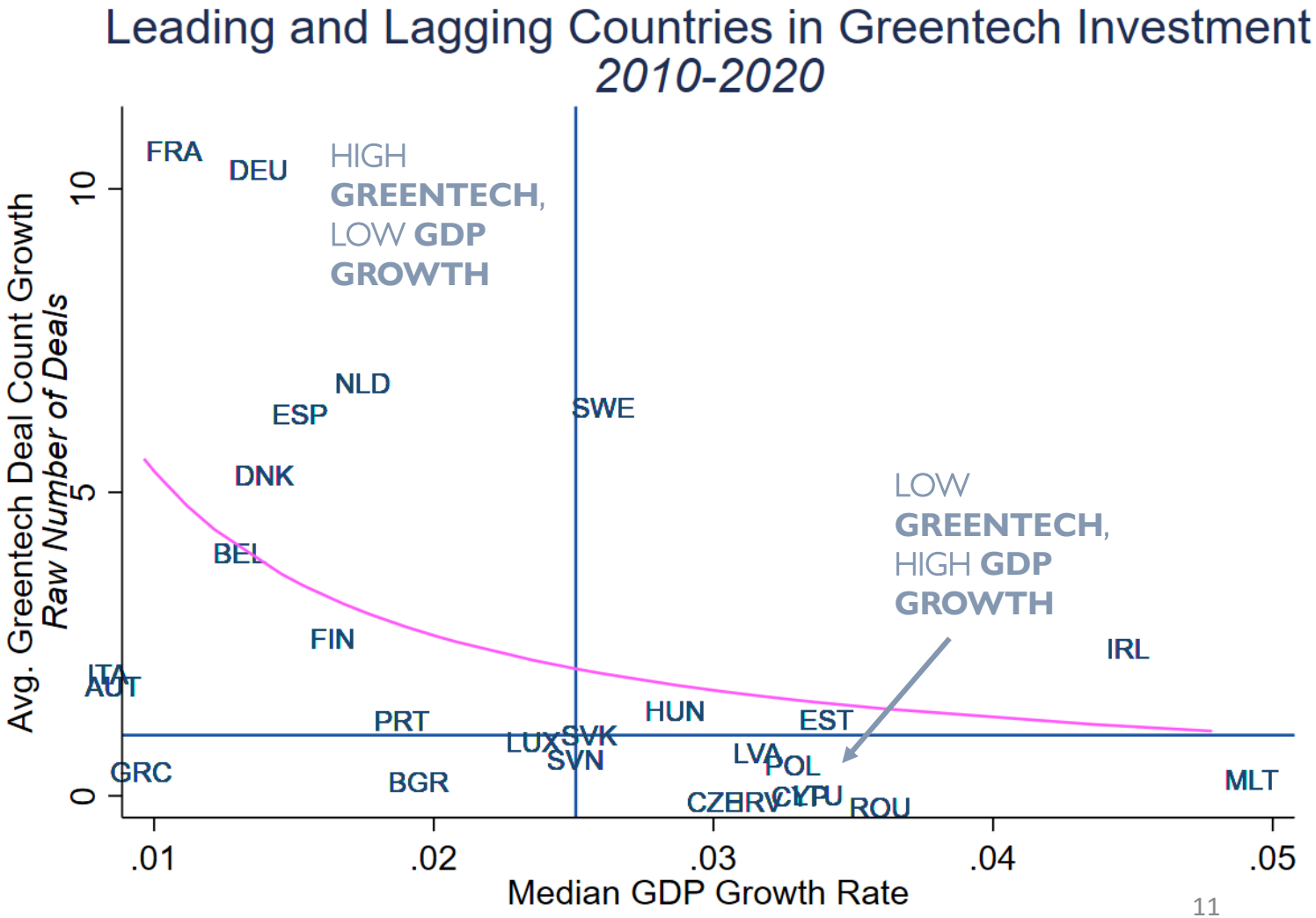
Greentech deal activity has **intensified** in the past 11 years, both in absolute counts and as a share of total VC/PE deals

→ Today: more than 10% of total VC/PE deals

ARE GREENTECH LEADERS ALSO LEADING IN GDP GROWTH?

More developed economies – with lower GDP growth – have higher Greentech growth, with some notable exceptions

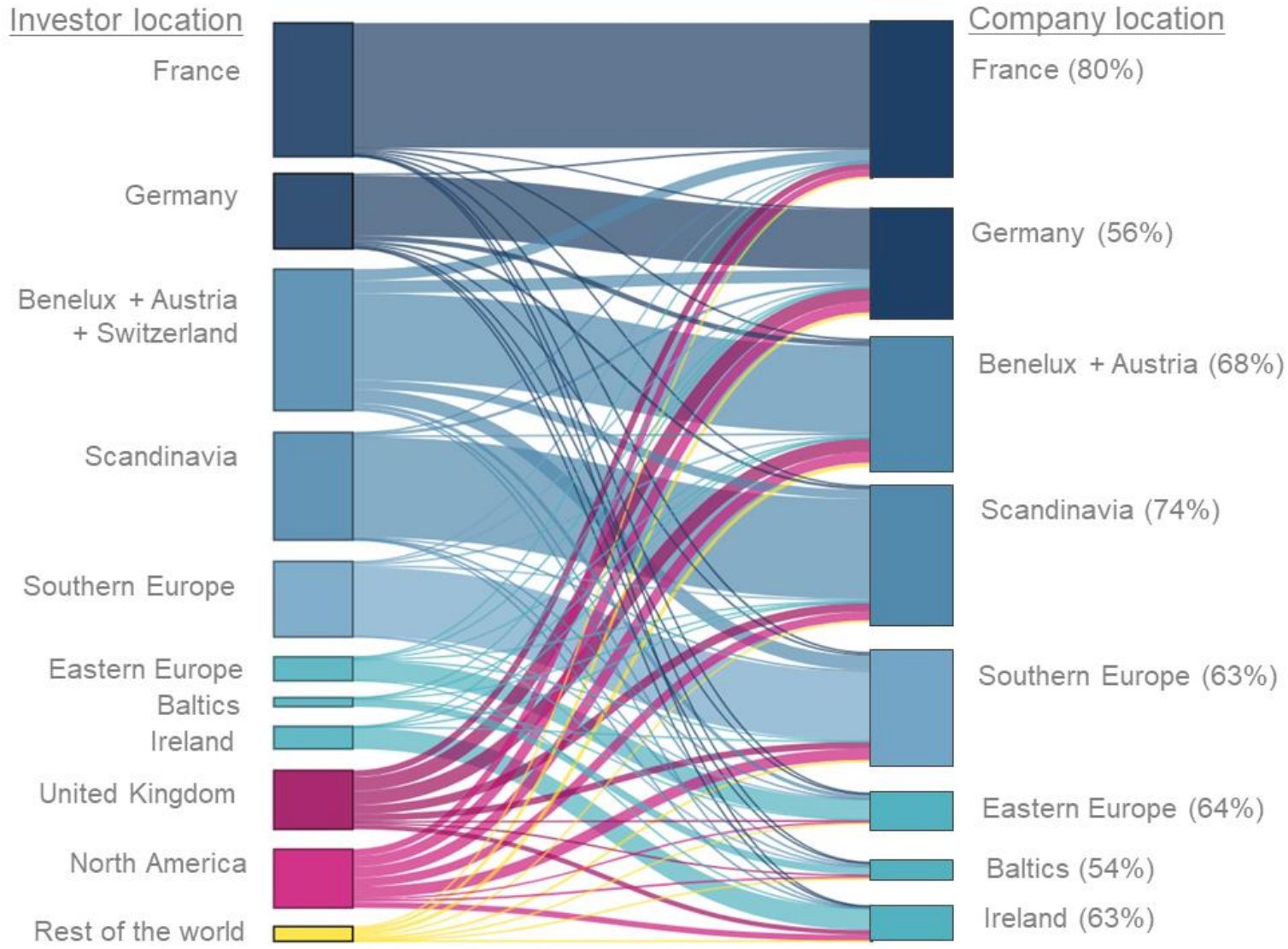
Stable over time – leading countries in 2020 were also leading in Greentech investment in 2010



WHERE DO INVESTMENTS COME FROM?

Approach: Matching first-listed investor of each deal-company observation

- Greentech leaders (countries and cities) generally also have a **large investor presence**
- Greentech companies receive funding predominantly from investors within the **same country** or **region**
  - Within country: 65%
  - Within city: 19%



INTERNATIONAL INVESTMENTS & DEAL SIZE

EUROPEAN SCALE-UP GAP:

- Deals < 0.5 million USD constitute 40% of deals with recorded deal volume
- Fraction of investments from outside the EU increases with deal size

Deals by investment size (million USD)	Deals by investment size (as % of total deals)	Deals with cross-border investment (%) (intra- and extra-EU)	Deals with investors from outside the EU (%) (extra-EU only)
Total	**100**	**34.6**	**19.8**
0 – 0.5	40.1	37.9	21.9
0.5 – 1	10.8	14.4	7.4
1 – 2	13.4	19.2	8.8
2 – 5	15.6	30.2	13.1
5 – 10	7.4	36.7	23.0
10 – 20	6.3	40.1	23.4
20 – 50	3.0	46.3	31.3
50 – 100	1.2	56.3	43.8
100 – 500	1.0	63.0	51.9
500 +	0.3	57.1	42.9

Note: 32% of observations are missing deal sizes, and 55% of observations are missing investor information. The information in the table above is based only on the sub-sample of deals for which data is available.

GREENTECH TAXONOMY

We developed a Greentech taxonomy based on **keywords** (inspired by existing taxonomies)

CLEAN ENERGY GENERATION

Renewable energy generation: solar, wind, geothermal, marine (hydro, wave, ocean), biomass, renewable fuels, waste-to-energy, fuel cells

ENERGY STORAGE, INFRASTRUCTURE, EFFICIENCY

- Energy storage
- Energy management/efficiency
- Grid technology & semiconductors
- Fuel efficiency
- Construction, building, heating & lighting

ELECTRIC VEHICLES

- Electric cars
- Electric vehicle infrastructure
- Electrification of freight transportation (road, rail, maritime)

MOBILITY

- Carsharing
- Urban mobility solutions
- Public transportation
- Fleet management
- Sustainable logistics

AGRICULTURE

- Agtech innovation
- Food systems
- Crop efficiency
- Agricultural chemicals
- Meat alternatives

ENVIRONMENT

- Water
- Waste and recycling
- Land use and forestry
- Air quality
- Carbon capture

CLEAN INDUSTRY

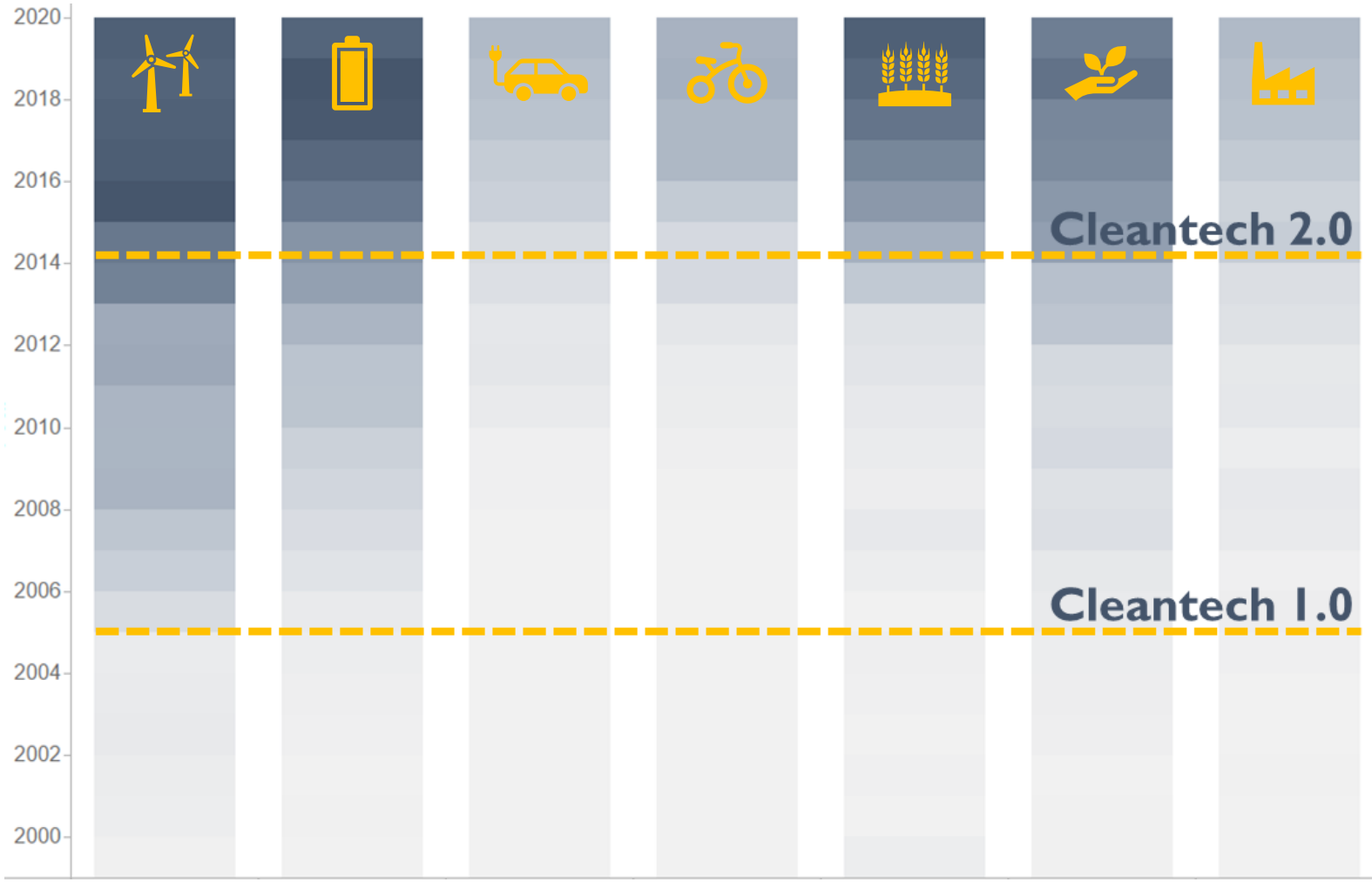
- Chemicals
- Mining
- Materials
- Clean production and manufacturing

OTHERS

- Energy and environmental consulting
- Other Cleantech services/products

EVOLUTION OF THE EU27 GREENTECH ECOSYSTEM

Report by *Cleantech for Europe* (2021) finds ***three generations*** of Greentech innovation



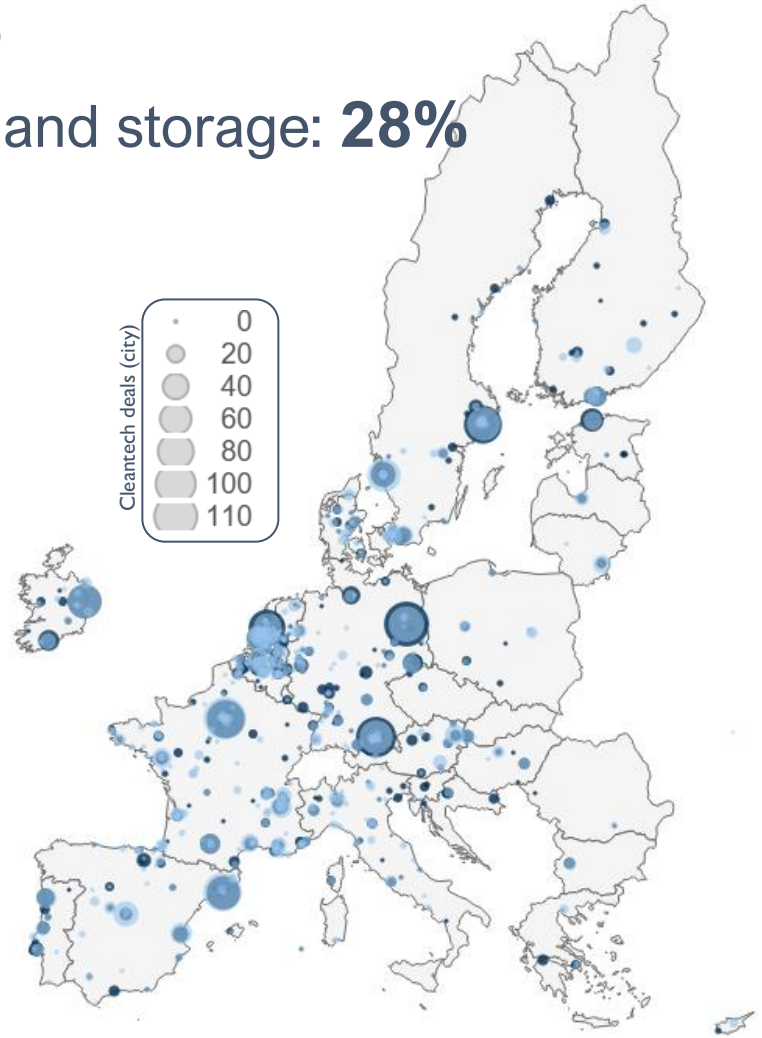
CLEANTECH 2.0 (2014)
Shift in technological focus to products that are more compatible with the VC model, *diversification* across Cleantech areas

CLEANTECH 1.0 (2005)
Focus mainly on *renewable energy generation*, especially solar & wind

CLEAN ENERGY IN THE EU27

- Energy generation: **32%**
- Efficiency, infrastructure and storage: **28%**

- Most prevalent in large cities and hubs
- Dispersion observable mainly in Central European countries



SOLAR 44% of CEG

WIND 21% of CEG

→ no clear patterns of regional specialisation

CLEAN ENERGY IN THE EU27

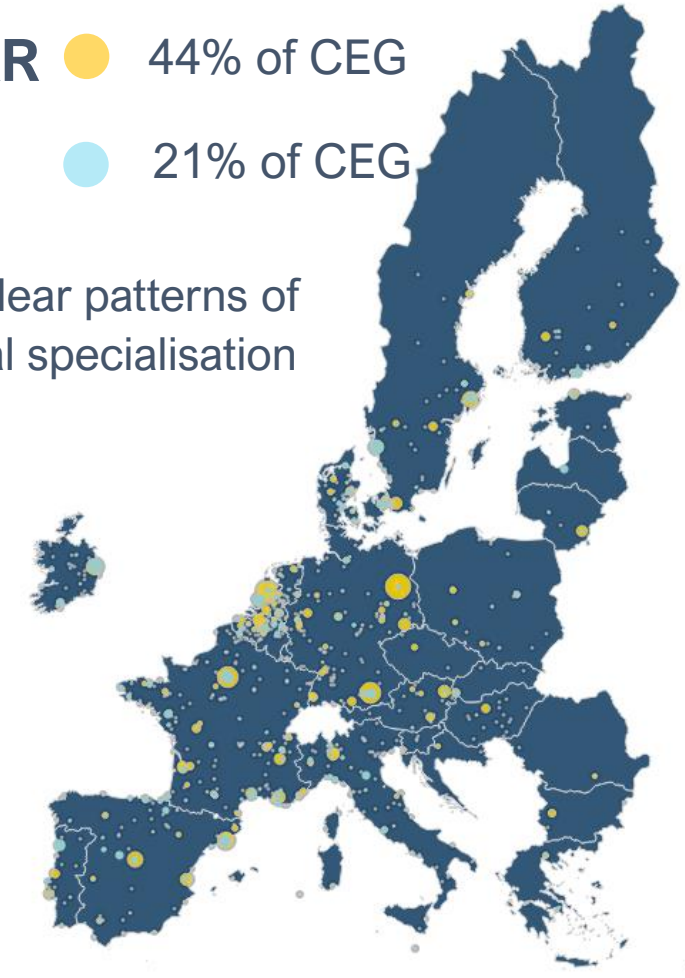
- Energy generation: **32%**
- Efficiency, infrastructure and storage: **28%**

- EU27: Energy-related deals are the most frequent
- Most prevalent in large cities and hubs
- Dispersion observable mainly in Central European countries

SOLAR 44% of CEG

WIND 21% of CEG

→ no clear patterns of regional specialisation



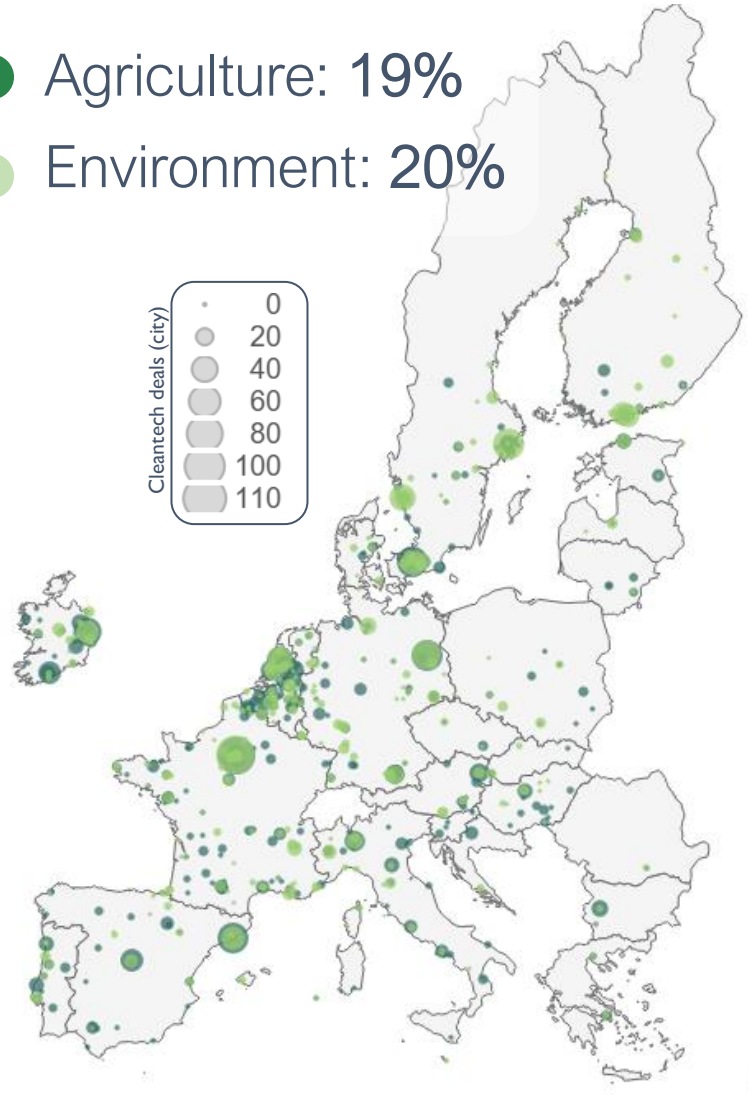
CLUSTERING BY GREENTECH TECHNOLOGY

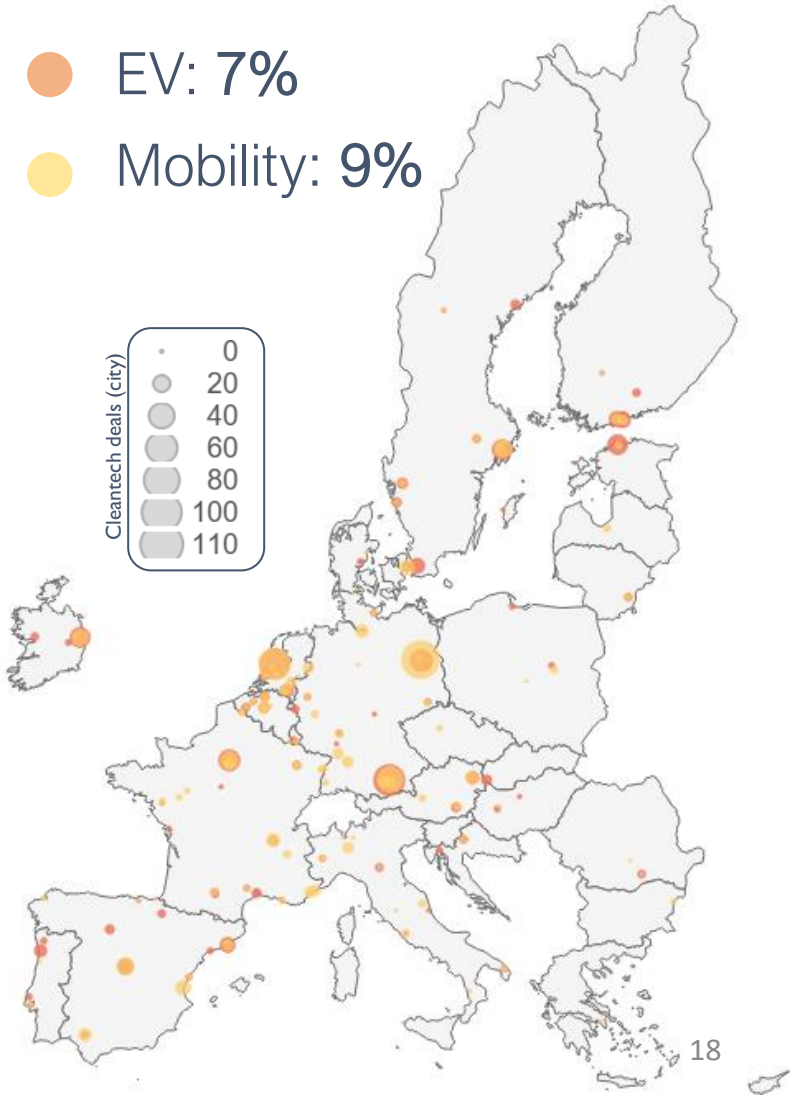
Agriculture & environment:

- Geographically dispersed

EV & mobility:

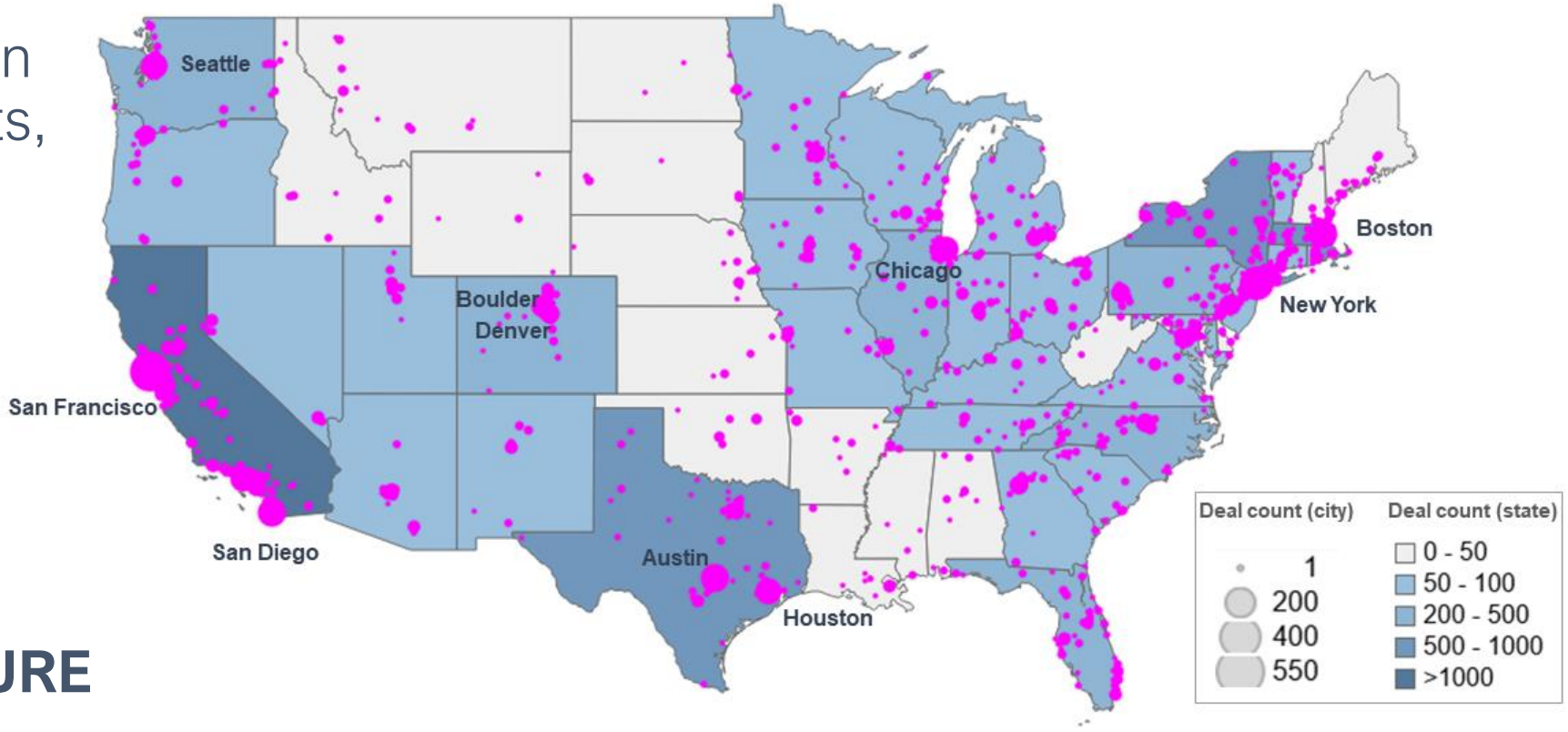
- Clustered around major hubs
- Very limited in Eastern European economies



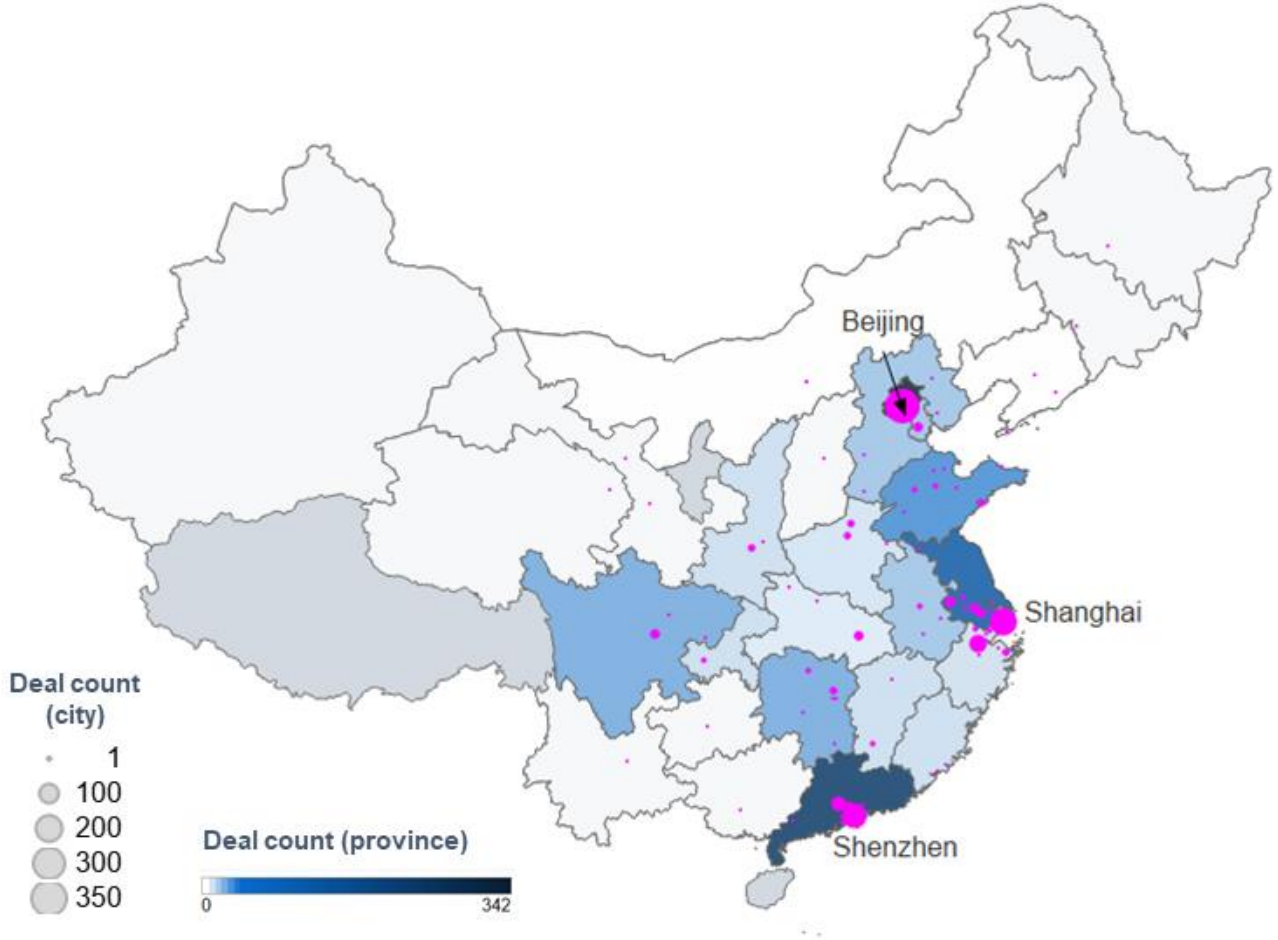


GREENTECH PATTERNS: USA

- 2010-2020: **10,979 deals**
- High Greentech activity in California, Massachusetts, New York, Texas, and Colorado
- **SAN FRANCISCO** outperforms most EU-27 countries
- Importance of well-developed US **VC/PE INFRASTRUCTURE**



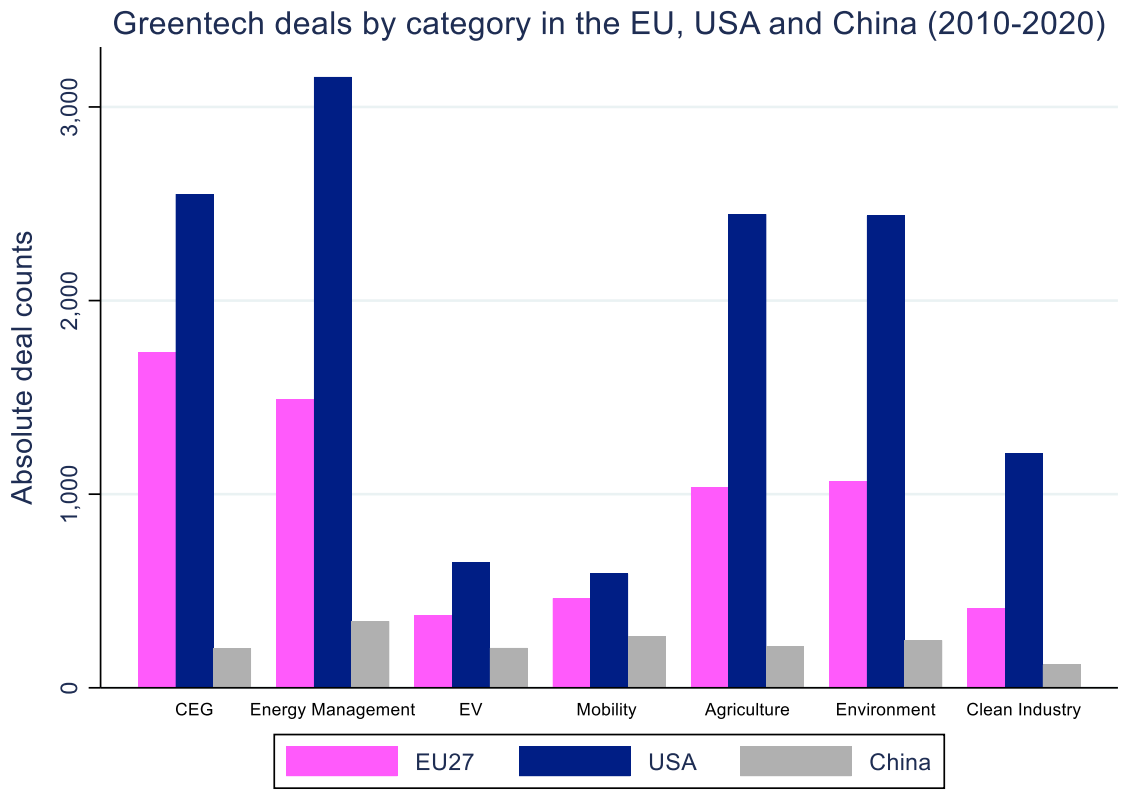
GREENTECH PATTERNS: CHINA

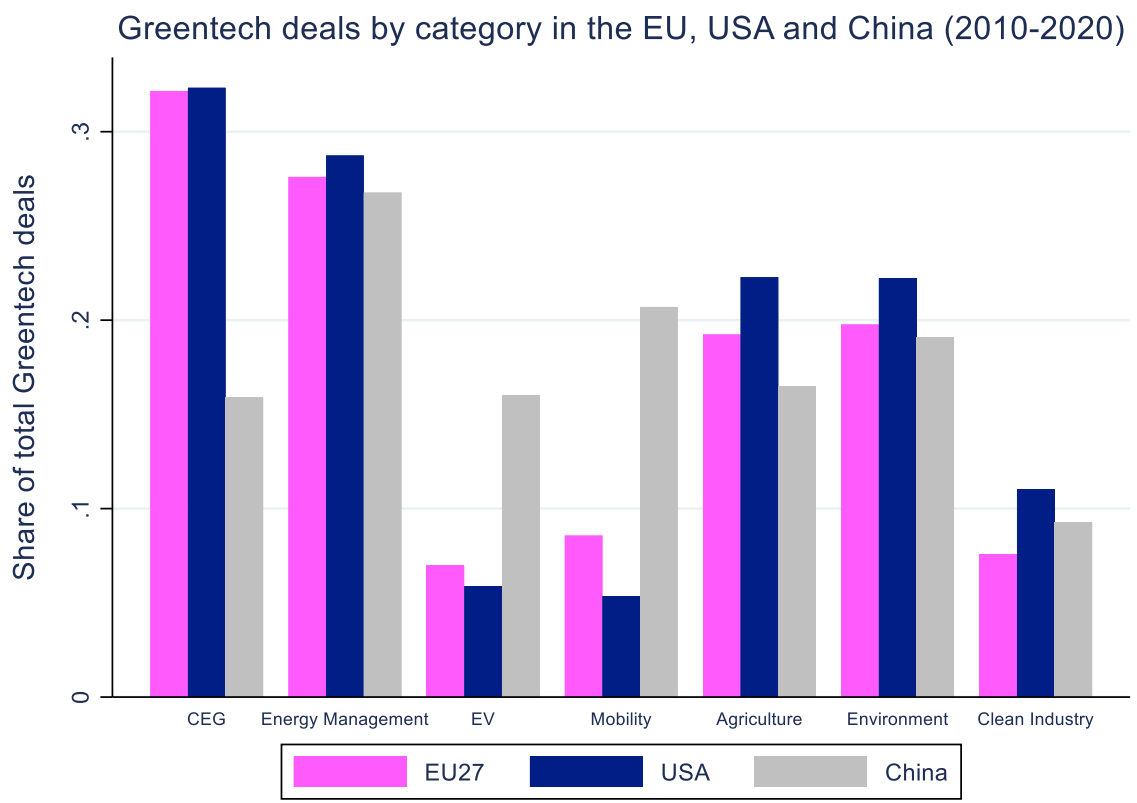


- **RAPID GROWTH**: 1,285 Greentech deals (2010-2020), compared to 70 recorded deals in the decade prior
- Greentech activity concentrated in **METROPOLITAN HUBS** e.g., Beijing (346), Shanghai (205), and Shenzhen (164)
- CONCERN: **UNDERESTIMATING** Greentech activity in China

GLOBAL PATTERNS IN GREENTECH INVESTING

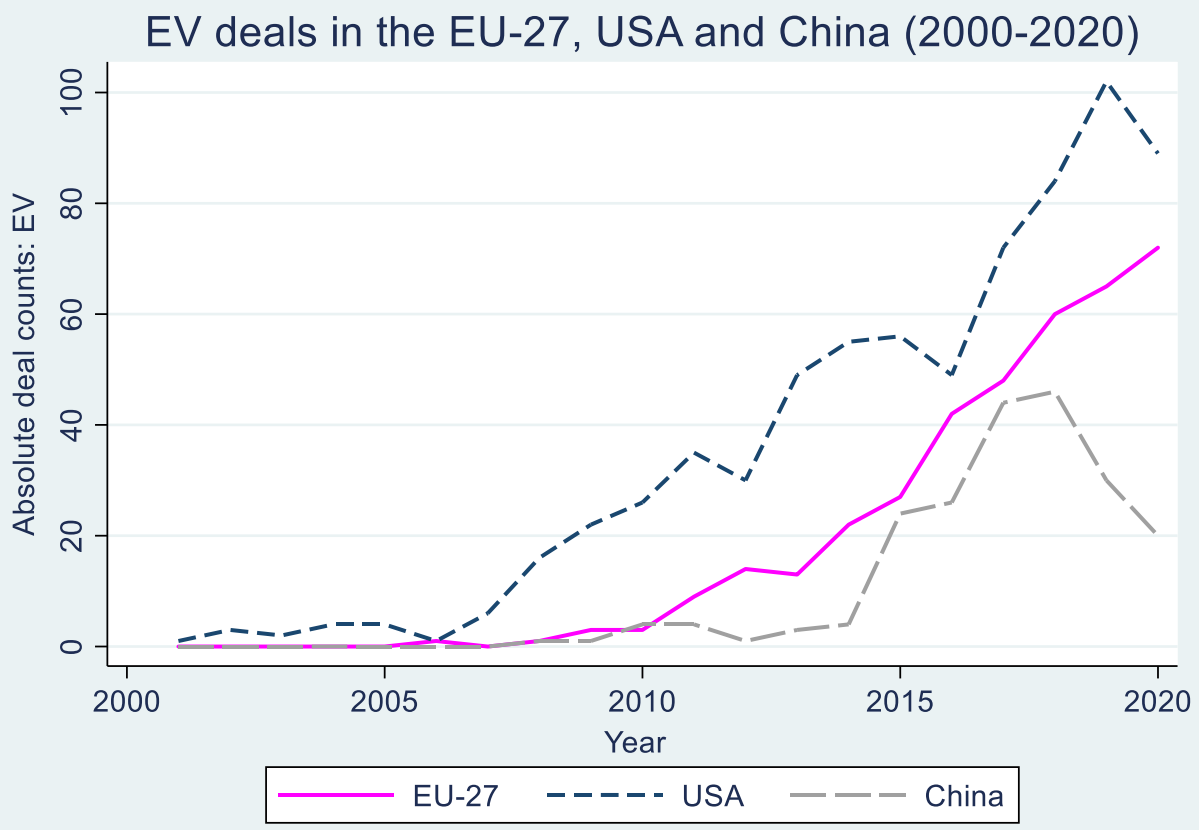
The USA leads across all fields in absolute counts, while we observe **more variation** for relative shares (*proportion of total Greentech activity in a country or region*)

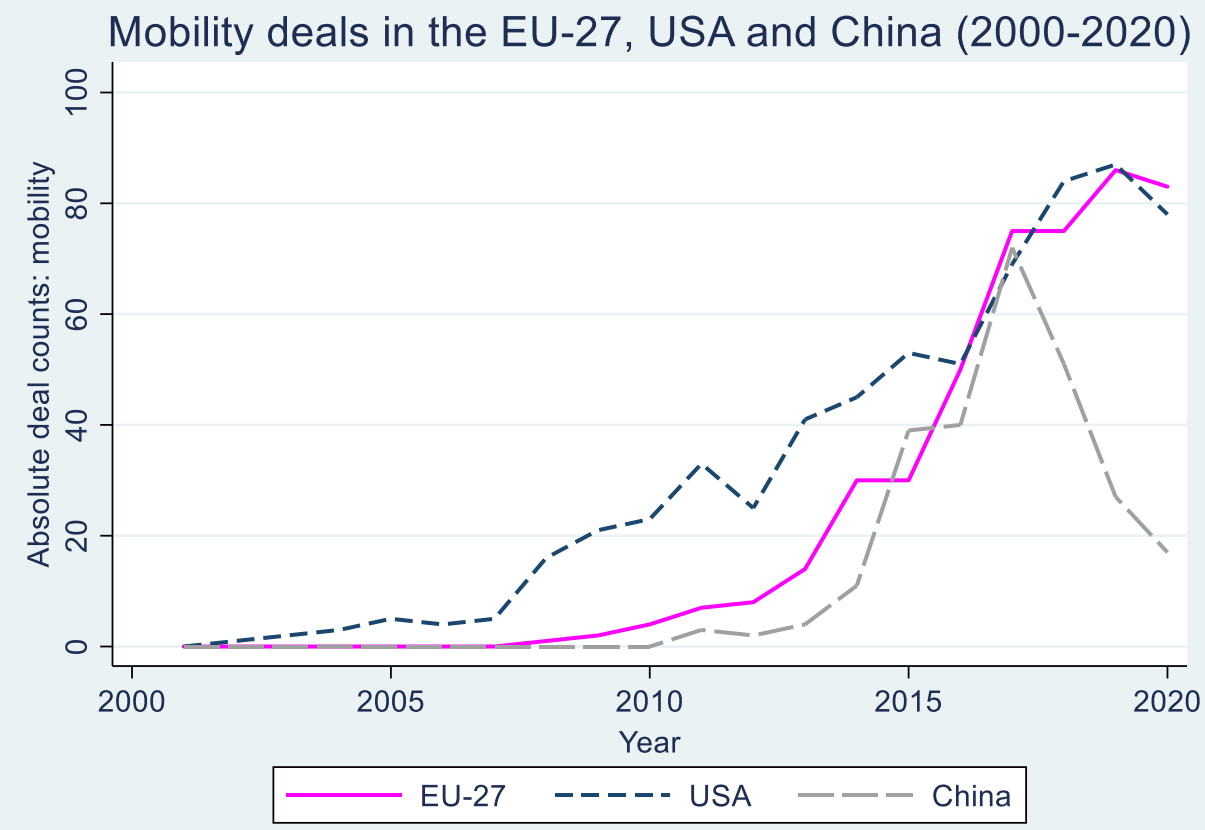




ZOOMING IN: EV PRODUCTION & MOBILITY

EV production and mobility are **dynamic fields**, with EU27 emerging as a mobility leader in 2020





3

THE EFFECT OF ACCESS TO FINANCE

LITERATURE: WHAT DETERMINES GREENTECH INVESTMENT?

We reviewed the literature on determinants of Greentech investing across multiple regions

MACRO-LEVEL FACTORS

GREENTECH POLICY ENVIRONMENT

Green regulations, e.g., carbon taxes

Government spending & subsidies, e.g., tax rebates, FITs, FF subsidies (Ang et al. 2017; Polzin, 2017)

INSTITUTIONAL ENVIRONMENT

Regulatory and government quality, level of corruption, rule of law, political stability (Grilli et al., 2019)

MACRO-ECONOMIC ENVIRONMENT

Price of non-renewable energy, e.g., oil (Cumming et al., 2016)

Inadequate banking system (Ang et al., 2017)

GDP, Population

ENTREPRENEURIAL ENVIRONMENT

Degree of innovation support predicts VC activity (Schertler, 2003)

Tertiary education (Eyraud et al., 2013)

CHALLENGES TO ACCESSING FINANCE

- Greentech SMEs face challenges in accessing **traditional financing** due to market failure (Owen et al., 2021)
- Colombo and Grilli (2007) argue that equity is the most suitable form of external capital for Greentech SMEs
- Greentech SMEs struggle to access VC and PE funding as well due to an unfavourable **risk-return balance** (Bocken, 2015) driven by a range of factors (e.g. absence of good networks, informational asymmetry, technological risks, liability of newness, etc.)

REGRESSION MODELS

RESEARCH QUESTION:

What is the impact of **access to finance** on Greentech **investments** in the EU27?

OUTCOME VARIABLES

Greentech deal ***counts***

=

EXPLANATORY VARIABLES

PROXIES *for access to finance*

+

CONTROLS

- Greentech policy environment
- Institutional environment
- Macro-economic environment
- Entrepreneurial environment

MODEL

POISSON QML

YEAR & COUNTRY FIXED EFFECTS

ROBUST, CLUSTERED SE

FOUR HYPOTHESES

We study access to finance through 4 dimensions and formulate the following hypotheses:

H_1 EARLY-STAGE INVESTMENT ENVIRONMENT

- **VC/PE** deal count excl. Greentech (lagged by one year)

H_2 EXIT ENVIRONMENT

- **M&A** deal count (lagged by one year)
- **IPO** deal count (lagged by one year)

H_3 PERCEPTIONS OF ACCESS TO FINANCE

- SMEs unwilling to apply for **bank loans** (%)
- SMEs unwilling to apply for **credit lines** (%)
- SMEs reporting no **financing obstacles** (%)

H_4 AVAILABILITY & COST OF ALTERNATIVE FINANCING

- SMEs using **bank loans** (%)
- SMEs using **credit lines** (%)
- Bank **non-performing loans** (% of total gross loans)
- Domestic **credit** to private sector (% of GDP)
- **Long-term interest rates**

BASELINE MODEL: CONTROLS

BASELINE MODEL

GREENTECH POLICY ENVIRONMENT

- Environment tax revenues

MACRO-ECONOMIC ENVIRONMENT

- GDP (ln)
- Population (ln)

ENTREPRENEURIAL ENVIRONMENT

- R&D expenditure
- Patent applications
- Tertiary education rates

INSTITUTIONAL ENVIRONMENT

- Regulation quality
- Rule of law
- Government effectiveness

FINDINGS

Patent applications are ***positively*** correlated with Greentech deal counts

+1k patents ⟷ +13.5% deals

Tertiary education rates are ***negatively*** correlated with Greentech deal counts

+1% attainment ⟷ -3.57% deals

Other variables are ***not statistically significant***

MODELS 1-3: NON-SIGNIFICANT RESULTS

		VARIABLES
MODEL 1	H_1 EARLY-STAGE INVESTMENT ENVIRONMENT	• VC/PE deal count excl. Greentech (lagged by one year)
MODEL 2	H_2 EXIT ENVIRONMENT	• M&A deal count (lagged by one year) • IPO deal count (lagged by one year)
MODEL 3	H_3 PERCEPTIONS OF ACCESS TO FINANCE	• SMEs willingness to request **bank loans** (%) • SMEs willingness to request **credit lines** (%) • SMEs reporting no **financing obstacles** (%)

FINDINGS

⊗ Results are ***not statistically significant***

MODEL 4:
AVAILABILITY AND COST OF ALTERNATIVE FINANCING

MODEL 4

H_4 AVAILABILITY & COST OF ALTERNATIVE FINANCING

VARIABLES

- SMEs using **bank loans** (%)
- SMEs using **credit lines** (%)
- Bank **non-performing loans** (% of total gross loans)
- Domestic **credit** to private sector (% of GDP)
- Long term interest rates

FINDINGS

Nonperforming loans are ***positively*** correlated with Greentech deal counts,

+1% non-performance ⟷ +3.4% deals

Use of credit lines is ***positively*** correlated with Greentech deal counts,

+1% credit line use ⟷ +0.79% deals

Other variables are ***not statistically significant***

4

POLICY IMPLICATIONS & CONCLUSION

POLICY IMPLICATIONS

> This investment will support the decarbonisation of Europe's economy, paving the way to climate neutrality in 2050, and reinforcing European technological leadership on a global scale.
>
> *– European Commission EVP Frans Timmermans*

SUPPORT GREENTECH CLUSTERS

DEVELOP INVESTING ENVIRONMENT

SUPPORTING GREENTECH CLUSTERS

STRENGTHEN EXISTING CLUSTERS

- Build on strong existing **network** and **agglomeration effects** to develop world-leading clusters
- Increase support of **EV** and **mobility sectors**
- Support momentum observed in the **Baltic region**

DEVELOPING NEW CLUSTERS

- Foster the development of Greentech clusters in **high-GDP growth countries** and those where Greentech VC/PE investment is high
- Target **agriculture** and **environment** technological fields as potential entry points

BUILDING A EUROPEAN SYSTEM OF INNOVATION

- Foster an **innovative environment** to attract investors with more promising investment targets (e.g., patents)
- Leverage regional specialisations through **knowledge sharing** and **productivity task forces**

FOSTER NETWORKS

ADEQUATE FINANCING

DEVELOPING INVESTING ENVIRONMENT

BUILD MORE CONDUCIVE INVESTING ENVIRONMENTS

VC/PE WITHIN THE BROADER FINANCING INFRASTRUCTURE

Cultivate conducive **financing environment**

- VC/PE is a **complement** to traditional finance
- Facilitate access to VC/PE as a **substitute** to debt

LACK OF INVESTOR PRESENCE

- Build up **investor presence** in countries that are currently **lagging** in Greentech investment

SCALE-UP FUNDING GAP

- Increase capacity for **scale-up funding**, without crowding out extra-EU financing
- Offer **larger** equity tickets

AREAS FOR FURTHER RESEARCH

Deeper understanding of:

- Deal size determinants
- Firm-level characteristics
- Direct comparisons between overall VC/PE investing and Greentech in particular

Different financing approaches other than traditional equity and debt:

- Blended finance
- Role of government-driven funding, especially when conducting international comparisons (e.g. China)

Impact of recent events on Greentech investments:

- European Green Deal
- Impact of COVID-19 on financing in EU27
- Push to decrease foreign energy dependency

THANK YOU
Q&A

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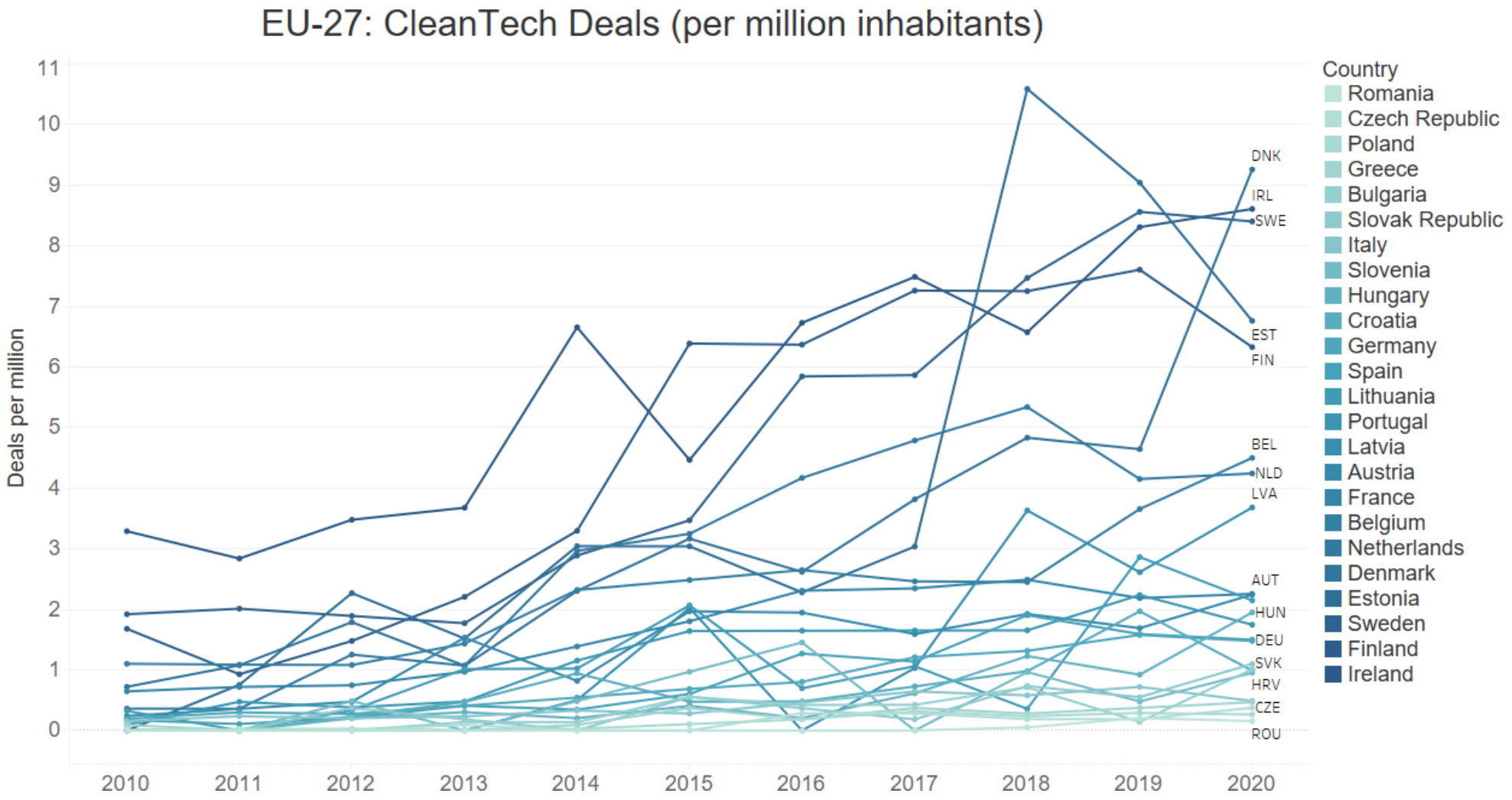
Henry Milander

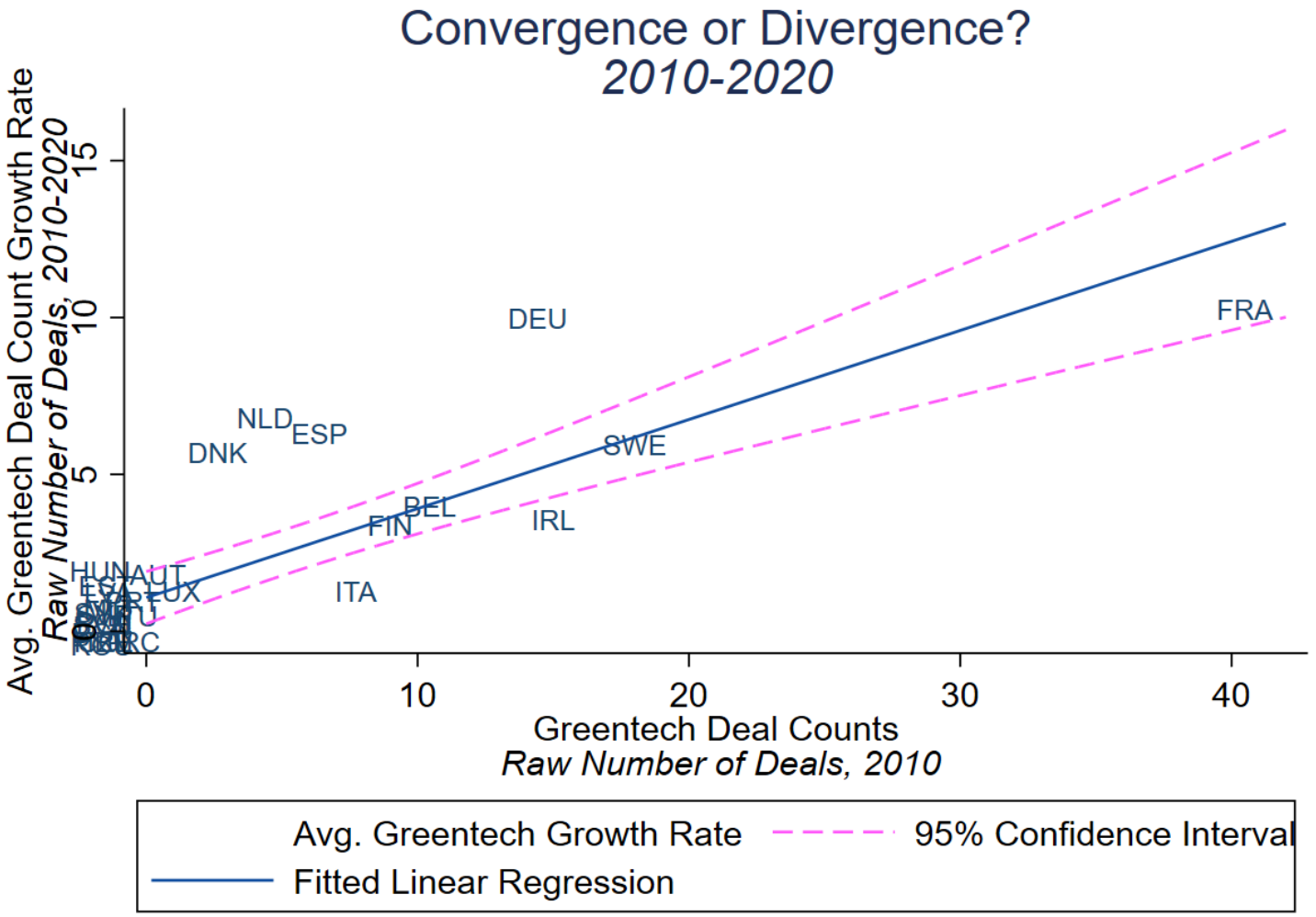
Xianxing Pan
Chloe Tian

APPENDIX

OVER-TIME TRENDS IN EU27



CONVERGENCE OR DIVERGENCE?



OVERVIEW OF VARIABLES

	Variable	Source
Outcome Variable	Greentech deal count	Pitchbook
Explanatory Variables (Access to Finance)	Long term interest rates (%)	European Central Bank
	Alternative financing - SMEs using bank loans (%)	European Commission - SAFE Survey
	Alternative financing - SMEs using credit lines (%)	European Commission - SAFE Survey
	Alternative financing - Bank non-performing loans (% of total gross loans)	World Bank – World Development Indicators
	Alternative financing - Domestic credit to private sector (% of GDP)	World Bank – World Development Indicators
	Perception - SMEs willingness to bank loans (%)	European Commission - SAFE Survey
	Perception - SMES willingness to credit lines (%)	European Commission - SAFE Survey
	Perception - SMEs without financing obstacles (%)	European Commission - SAFE Survey
	Exit environment - M&A deal count (in hundreds, lagged by one year)	Pitchbook
	Exit environment - IPO deal count (lagged by one year)	Pitchbook
	Overall VC/PE environment - VC/PE deal count excl. Greentech (in hundreds, lagged by one year)	Pitchbook
Control Variables	Macroeconomic environment - Natural logarithm of GDP	World Bank – World Development Indicators
	Institutional environment - Regulatory quality	Worldwide Governance Indicators
	Institutional environment - Rule of law	
	Institutional environment - Government effectiveness	
	Entrepreneurial environment - Patent applications submitted to the European Patent Office (in thousands)	Eurostat
	Entrepreneurial environment - R&D spending (% of GDP)	World Bank – World Development Indicators
	Entrepreneurial environment - Tertiary education rate (%)	World Bank – World Development Indicators
	Green policy environment - Environmentally related tax revenues (% of GDP)	Eurostat

MODEL SPECIFICATION

Outcome Variable	Specification	#	Note
Greentech deal count =	$F_{linear}\ (Controls)$	(0)	Baseline
	$F_{linear}\ (Overall\ VCPE\ Env\ Measure_{lagged}, Controls)$	(1)	Overall VC/PE environment
	$F_{linear}\ (Exit\ Environment_{lagged}, Controls)$	(2)	VC/PE exit environment
	$F_{linear}\ (SMEs\ Perception\ Measures, Controls)$	(3)	SMEs' perceptions on financing
	$F_{linear}\ (LTIR, Alternative\ Financing\ Measures, Controls)$	(4)	Financing situations SMEs face directly
	$F_{linear}\ (Access\ to\ finance\ proxies, Controls)$	(5)	All access to finance proxies

Regression Model Fitting

OLS

Poisson QLM

Outcome variable as counts

Preferred model due to robustness to misspecification errors, use of fixed effects

Other Considerations

Fixed Effects — Country and year

SE — Robust, country clustering

Functional Form — Log-linear

RESULTS TABLE

Control variables

- Patent applications is positively correlated with Greentech deal counts, significant with a 99% confidence
- Tertiary education rate is negatively correlated with Greentech deal counts, significant with a 99% confidence

Access to finance

- Nonperforming loans are positively correlated with Greentech deal counts, significant with a 99% confidence
- Use of credit lines is positively correlated with Greentech deal counts, significant with a 95% confidence

All other variables produce statistically insignificant results

Greentech deal count, poisson	(0)	(1)	(2)	(3)	(4)	(5)
ln GDP	-0.176	-0.207	-0.116	0.137	0.741	0.728
	(0.828)	(0.821)	(0.773)	(0.659)	(0.855)	(0.762)
ln Population	-3.306	-2.492	-3.385	-2.545	-4.806	-4.763
	(3.087)	(3.022)	(3.129)	(2.702)	(3.526)	(3.681)
Regulatory Quality	-0.118	-0.103	-0.107	0.0396	0.145	0.15
	(0.296)	(0.292)	(0.288)	(0.267)	(0.241)	(0.233)
Rule of Law	0.603	0.622	0.596	0.42	0.292	0.342
	(0.340)	(0.358)	(0.356)	(0.357)	(0.372)	(0.385)
Government Effectiveness	0.259	0.262	0.263	0.157	0.105	0.0752
	(0.303)	(0.312)	(0.306)	(0.281)	(0.292)	(0.283)
R&D expenditure	0.23	0.21	0.226	0.161	0.201	0.158
	(0.166)	(0.145)	(0.173)	(0.151)	(0.116)	(0.132)
Patent applications (K)	**0.135****	**0.146*****	**0.134****	**0.162*****	**0.180*****	**0.188*****
	(0.044)	**(0.040)**	**(0.045)**	**(0.031)**	**(0.039)**	**(0.041)**
Tertiary education rate	**-0.0357*****	**-0.0473****	**-0.0373****	**-0.0449****	**-0.0584*****	**-0.0651*****
	(0.011)	**(0.018)**	**(0.012)**	**(0.016)**	**(0.015)**	**(0.019)**
Environmental tax revenues	-0.285	-0.195	-0.261	-0.211	-0.138	-0.0603
	(0.222)	(0.187)	(0.219)	(0.166)	(0.154)	(0.192)
VC/PE Deal Count (H, lagged)		-0.0163				-0.00805
		(0.014)				(0.014)
M&A Deal Count (H, lagged)			-0.000193			0.00644
			(0.011)			(0.024)
IPO Deal Count (H, lagged)			0.000948			0.00213
			(0.002)			(0.002)
SMEs' Willingness for Bank Loans				0.0248		-0.00395
				(0.015)		(0.015)
SMEs' Willingness for Credit Lines				-0.00559		0.00474
				(0.013)		(0.015)
SMEs with No Financing Obstacles				-0.00576		-0.00603
				(0.004)		(0.003)
Long Term Interest Rate					0.0474	0.0486
					(0.043)	(0.043)
Nonperforming Bank Loans					**0.0344****	**0.0342****
					(0.011)	**(0.012)**
SMEs that used Bank Loans					0.00698	0.00699
					(0.005)	(0.006)
SMEs that used Credit Lines					**0.00791****	0.00595
					(0.003)	(0.004)
Domestic Credits to Private Sector					-0.00566	-0.00555
					(0.005)	(0.005)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	297	297	297	268	258	258

Standard errors clustered in country level in parentheses. * *p<0.05*, ** *p<0.01*, *** *p<0.001*