Unravelling causal CBD impact on technological startup growth

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Diamentowy Grant

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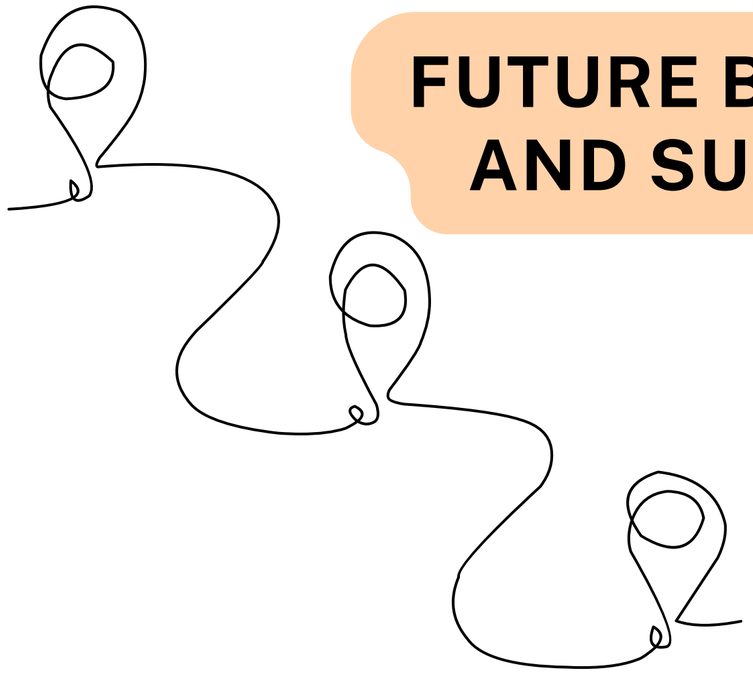
Business location *impacts*

FUTURE BUSINESS GROWTH AND SURVIVAL CHANCES



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Many channels of location impact

Vast literature on business location theories, agglomeration externalities, effect of clusters, etc.

(e.g. Capello, 2013; Capello & Nijkamp, 2019; Malecki, 2021; Müller, 2016)

agglomeration efffects

(Andersson, 2017; Raman, 2010; Muller, 2016; Andersson et al, 2019; Jang et al. 2017)

local competition

(Andersson, 2017; Kearns & Parkinson, 2001; Lapatinas et al., 2022; Raman, 2010)

market access

(Zhou & Vertinsky, 2001; Muller, 2016)

local benefits (specialisation/ employees)

(Audretsch et al., 2012; Rogers, 2012; Beer & Clower, 2009; Graf & Mudambi, 2005; Karakaya & Canel, 1998)

...

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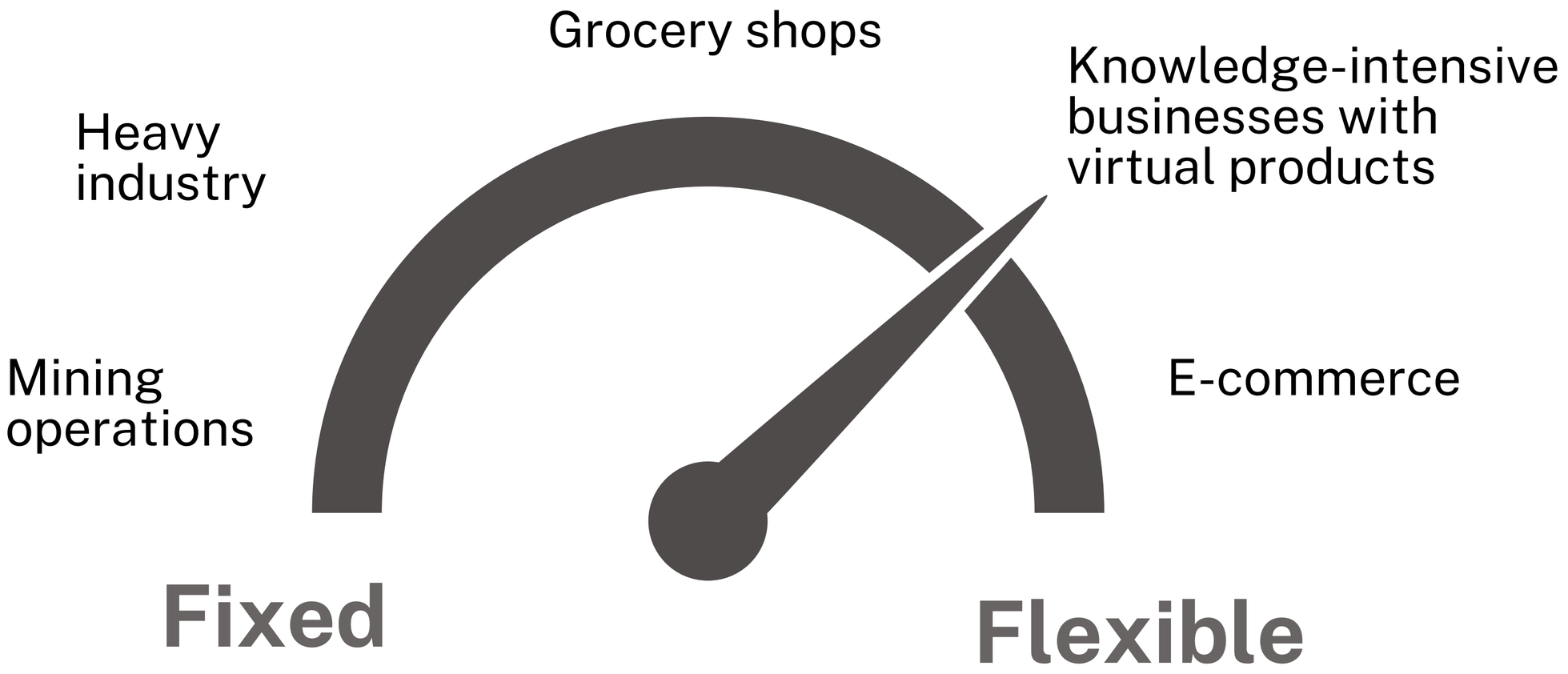
Varying flexibility for business location choice



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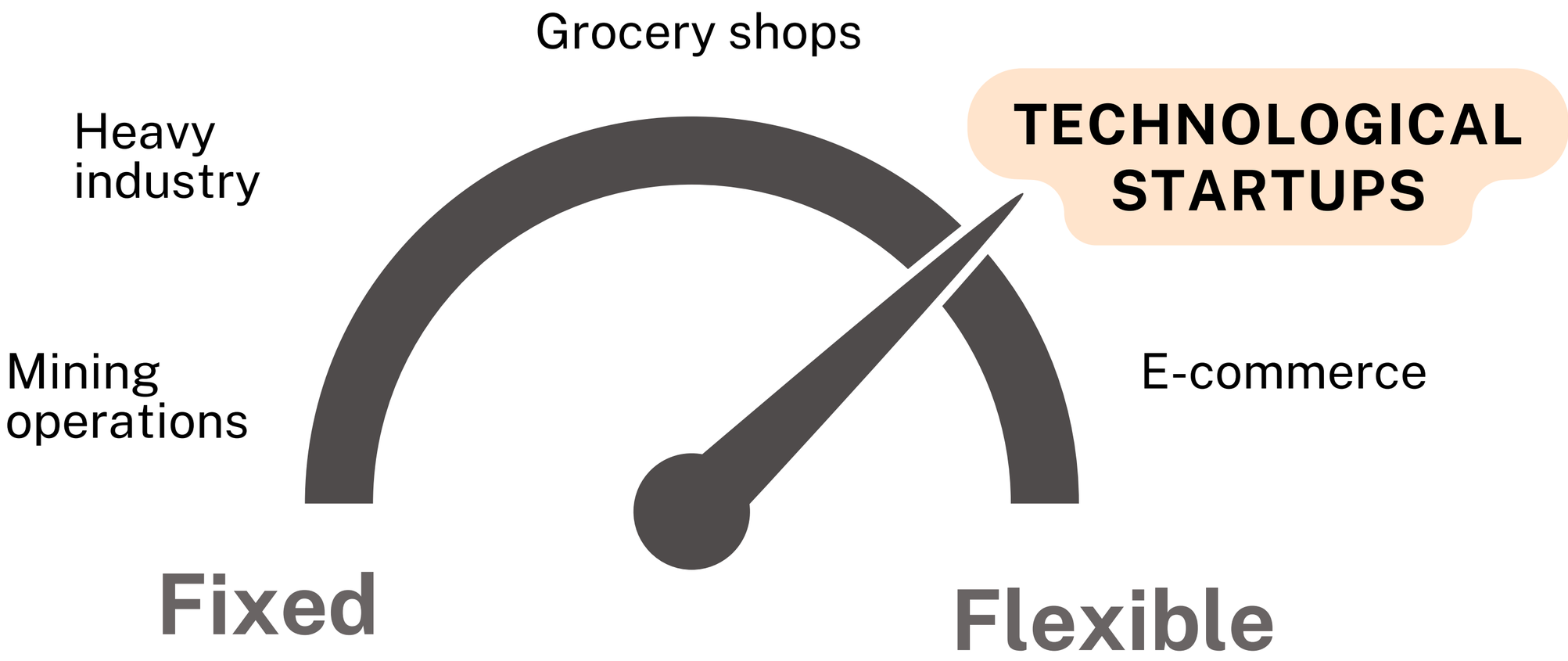
Varying flexibility for business location choice



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growth
innovation
high risk

TECHNOLOGICAL STARTUPS

Success factors?

INITIAL CAPITAL

ACCESS TO INVESTORS

MANAGEMENT STYLE

MARKETING STRATEGIES

...

ACCELERATORS

e.g. see reviews by Song et al., (2008), and Nicoló (2017)

LOCATION?

"NEGLECTED DETERMINANT OF FIRM GROWTH"
(AUDRETSCH & DOHSE, 2013)

HOW DOES INTRA-URBAN LOCATION IMPACT GROWTH OF TECHNOLOGICAL STARTUPS?

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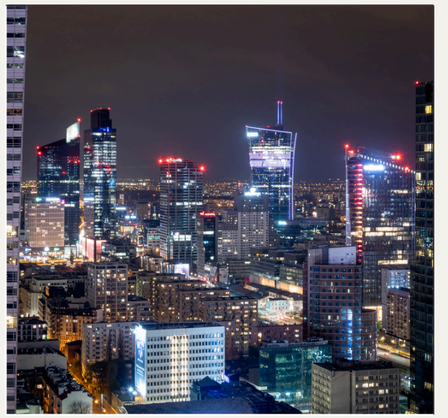
Warsaw, Poland

DENSE LIVING DISTRICTS FROM 80S



CBD AREA

Diversified intra-urban space

offers diverse business growth conditions

BUSINESS CENTRE

SUBURBIAN DISTRICTS

52.2

52.20°N

20.9°E

21.0°E

21.1°E

21.2°E

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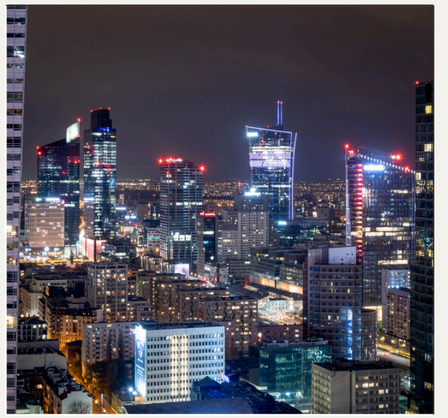
DENSE LIVING DISTRICTS FROM 80S



CBD AREA

Diversified intra-urban space

offers diverse business growth conditions

BUSINESS CENTRE

SUBURBIAN DISTRICTS

CBD STANDS OUT AS THE MOST UNIQUE AREA

52.20°N

20.9°E 21.0°E 21.1°E 21.2°E

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ACCESS TO INVESTORS

(Madaleno et al, 2022; Pauwels et al., 2016)

PRESTIGE / SIGNALLING

(Connelly et al. 2011)

ACCESS TO QUALIFIED EMPLOYEES

(Drozdz & Appert, 2011)

HIGHER COMPETITION

(McColl, 2014; de Groot et al., 2016)

HIGHER OFFICE PRICES

(Aspelund et al., 2005)

CONGESTION

(McColl, 2014; Drozdz & Appert, 2011)

Hypothesis: CBD will affect growth of technological startups in a heterogenous way, depending on the individual characterics of a company

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How to measure heterogenous causal CBD impact on technological startups growth?

Instrumental Variables

Difference-in-differences

Linear Models

Propensity Score Matching

Average Treatment Effect is not interesting --> does not find the individual effects

Causal Forest

- interpretable results
- estimates individual Heterogenous Treatment Effects (HTE)
- works with complex non-linear relations

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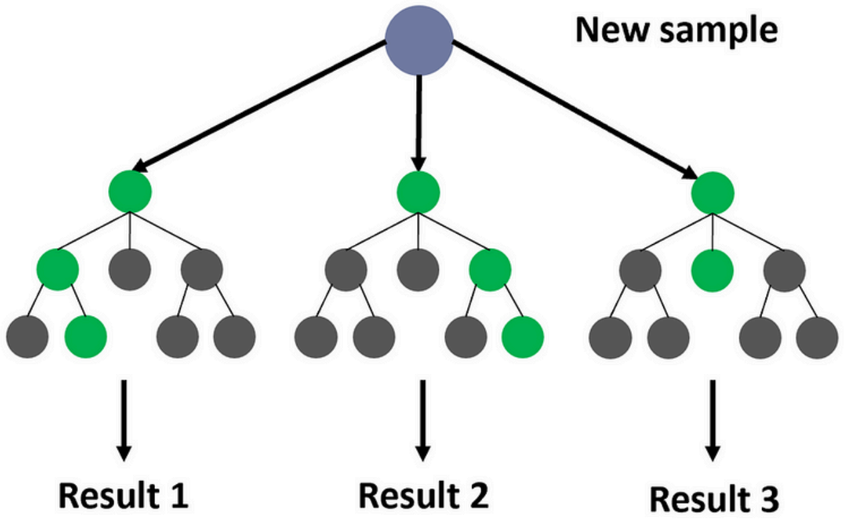
Random Forest efficiency for causal effect estimation

Causal Forest



In RF in each leaf there are observations which have similar y values,

while in CF there are observations which react similarly to treatment

- similar structure to random forest: trees used for prediction, trees ensembled for the forest result
- trees in RF minimise the variance of *y* (put similar observations in each leaf)
- trees in CF are build to **minimise** the difference between **treatment effects** across observations in each leaf
  --> this enables HTE prediction
- CF has all the benefits of RF (like variable importance scores, XAI), but it is optimised on a different goal (minimse TE)
- for CF bootstrapped confidence intervals for the treatment effects are reported

Wager, S., & Athey, S. (2018). Estimation and Inference of Heterogeneous Treatment Effects using Random Forests. Journal of the American Statistical Association, 113(523), 1228–1242. https://doi.org/10.1080/01621459.2017.1319839

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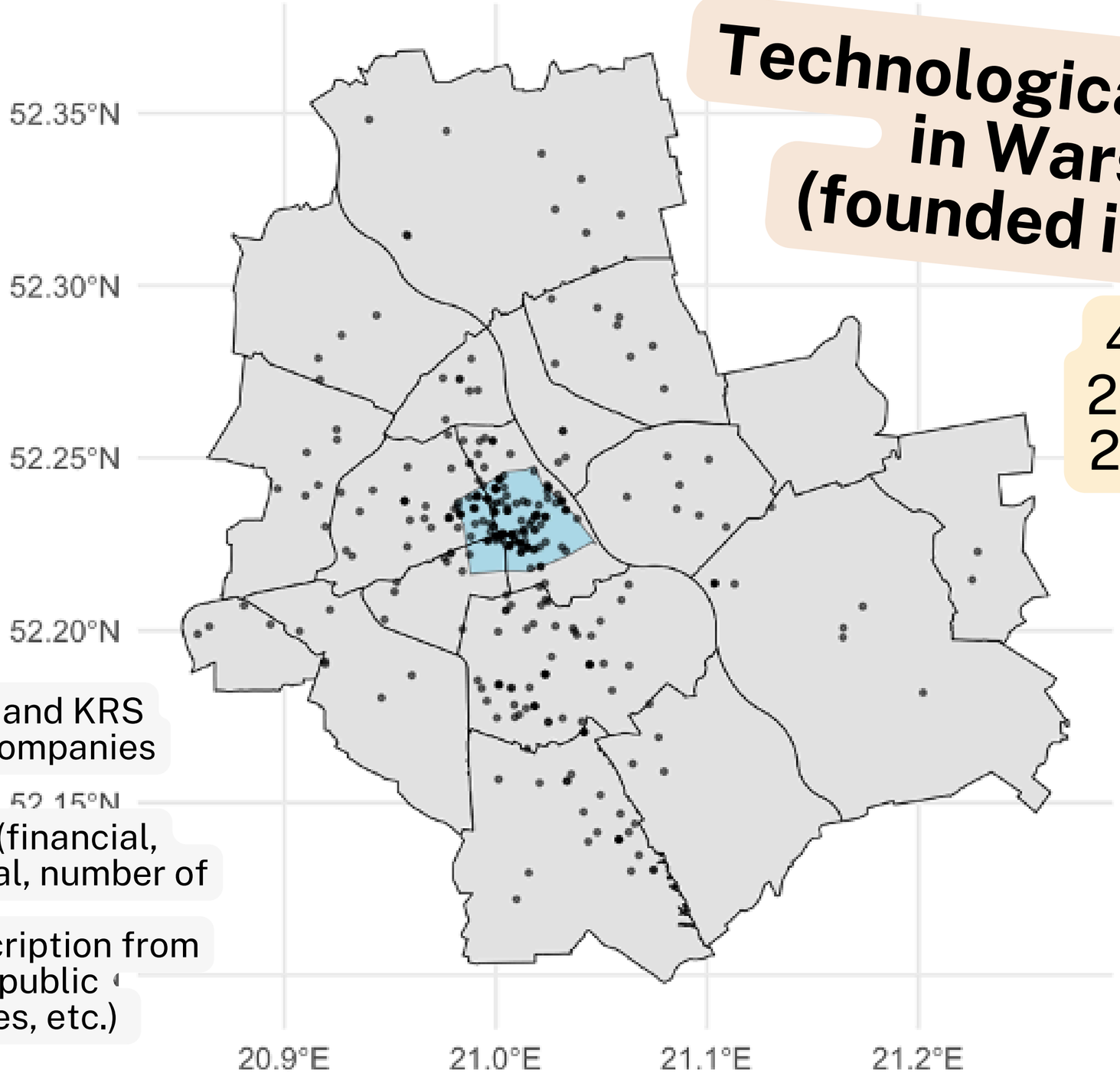
Technological startups in Warsaw (founded in 2016)

457 firms
246 in CBD
211 outside



Data from ORBIS and KRS
Limited liability companies

Initial conditions (financial, dominating capital, number of investors)
Surrounding description from OpenStreetMap (public transport, facilities, etc.)

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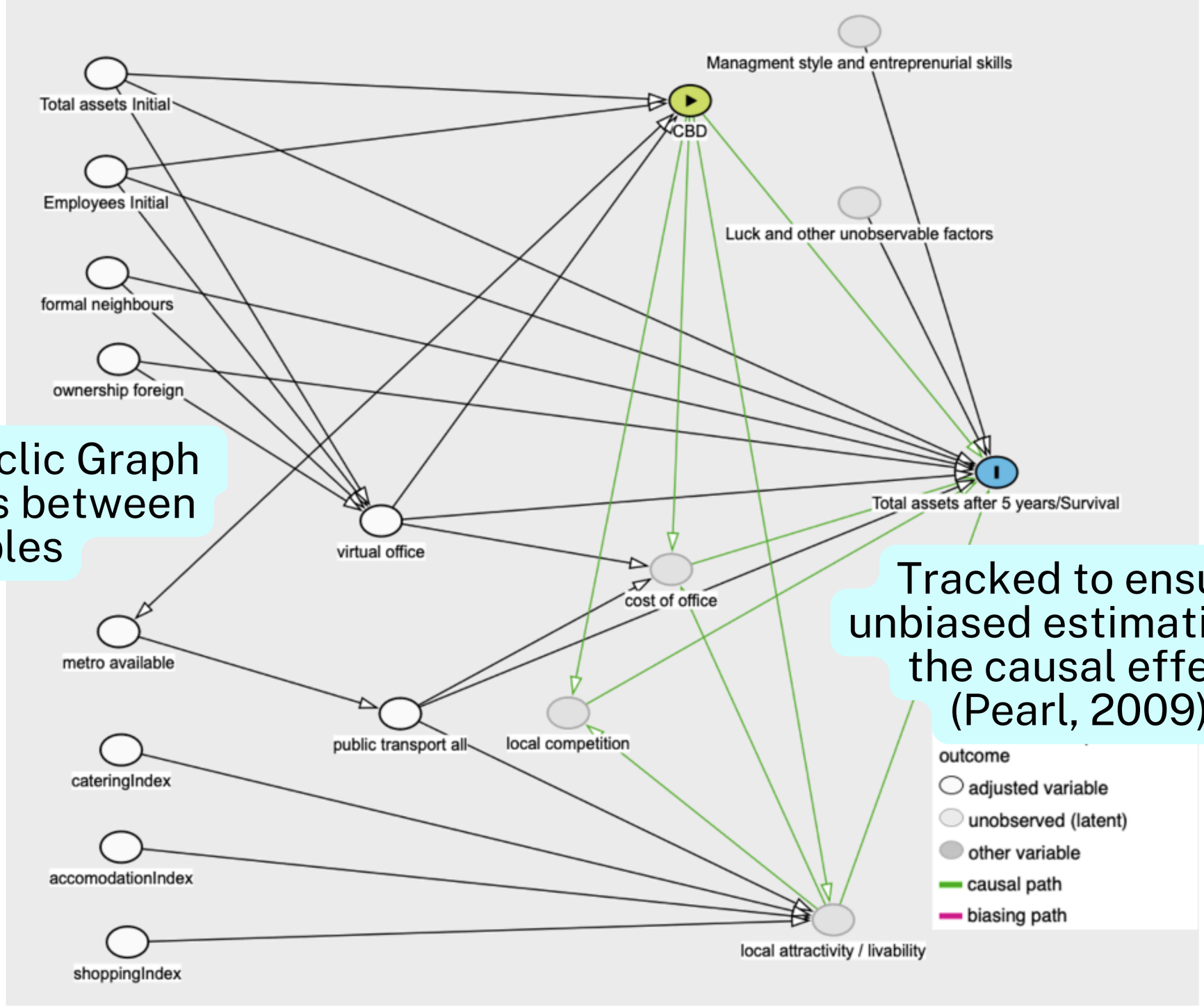
Directed Acyclic Graph of influences between variables



Tracked to ensure unbiased estimation of the causal effect (Pearl, 2009)

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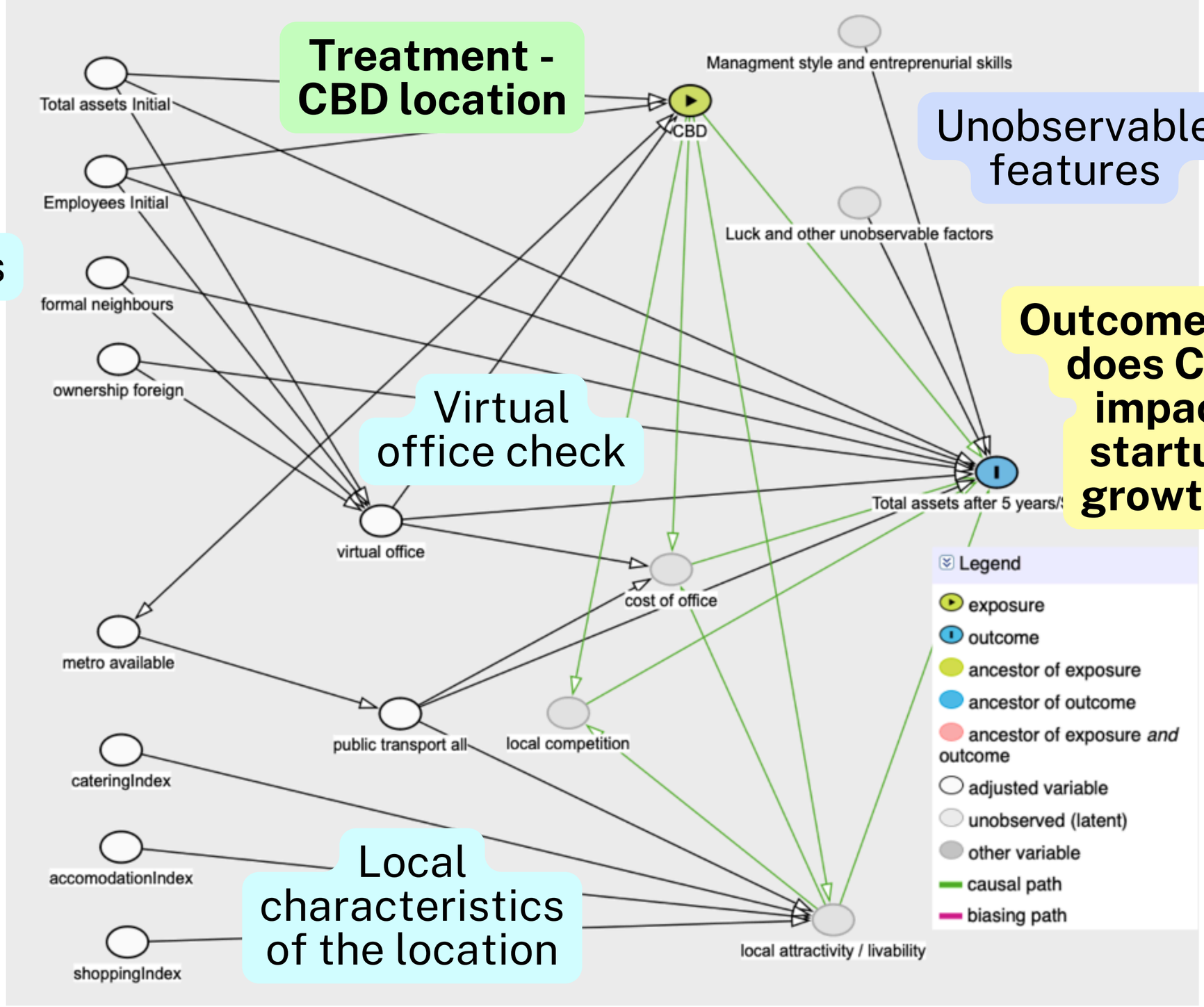
Initial conditions



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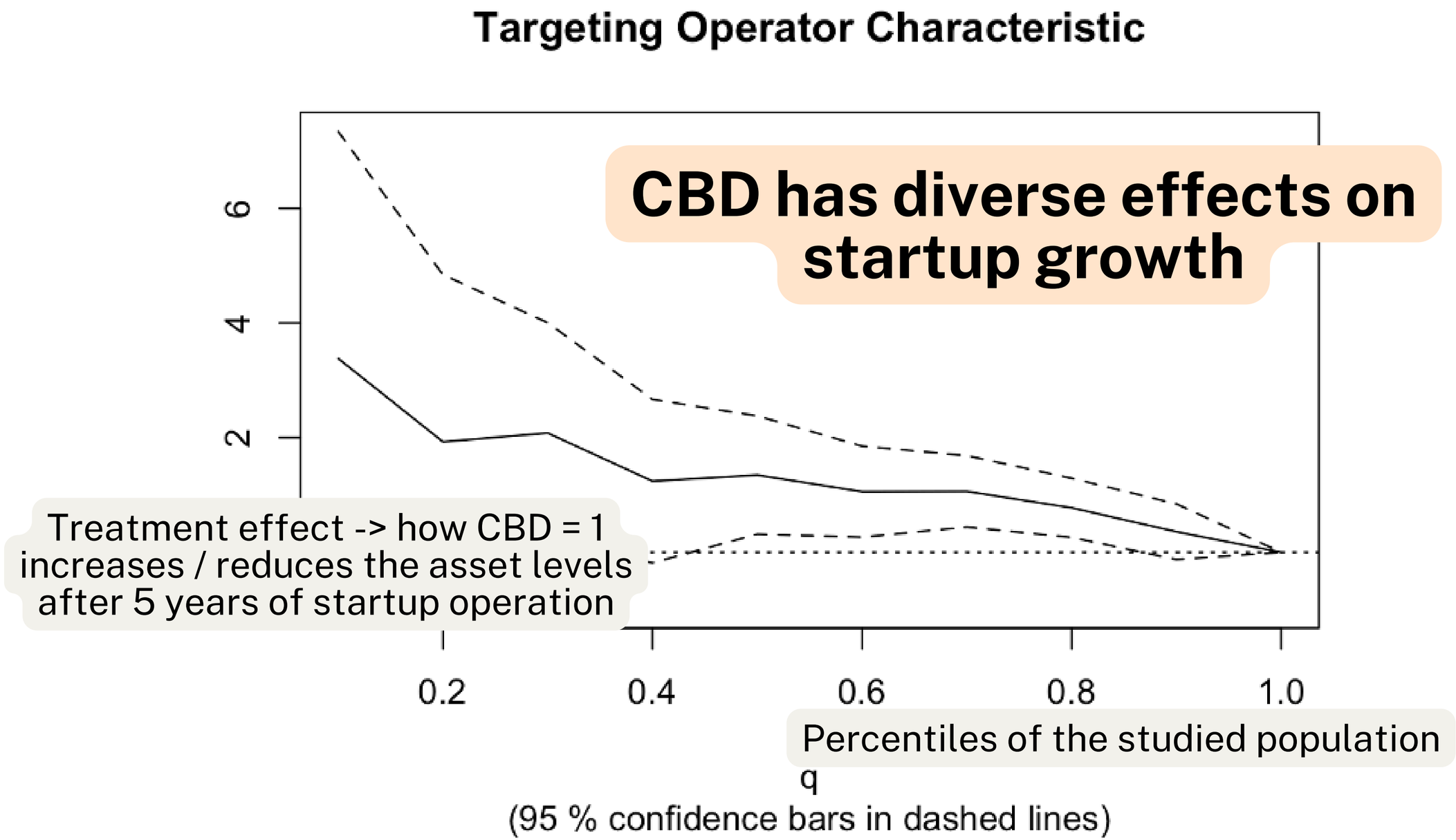

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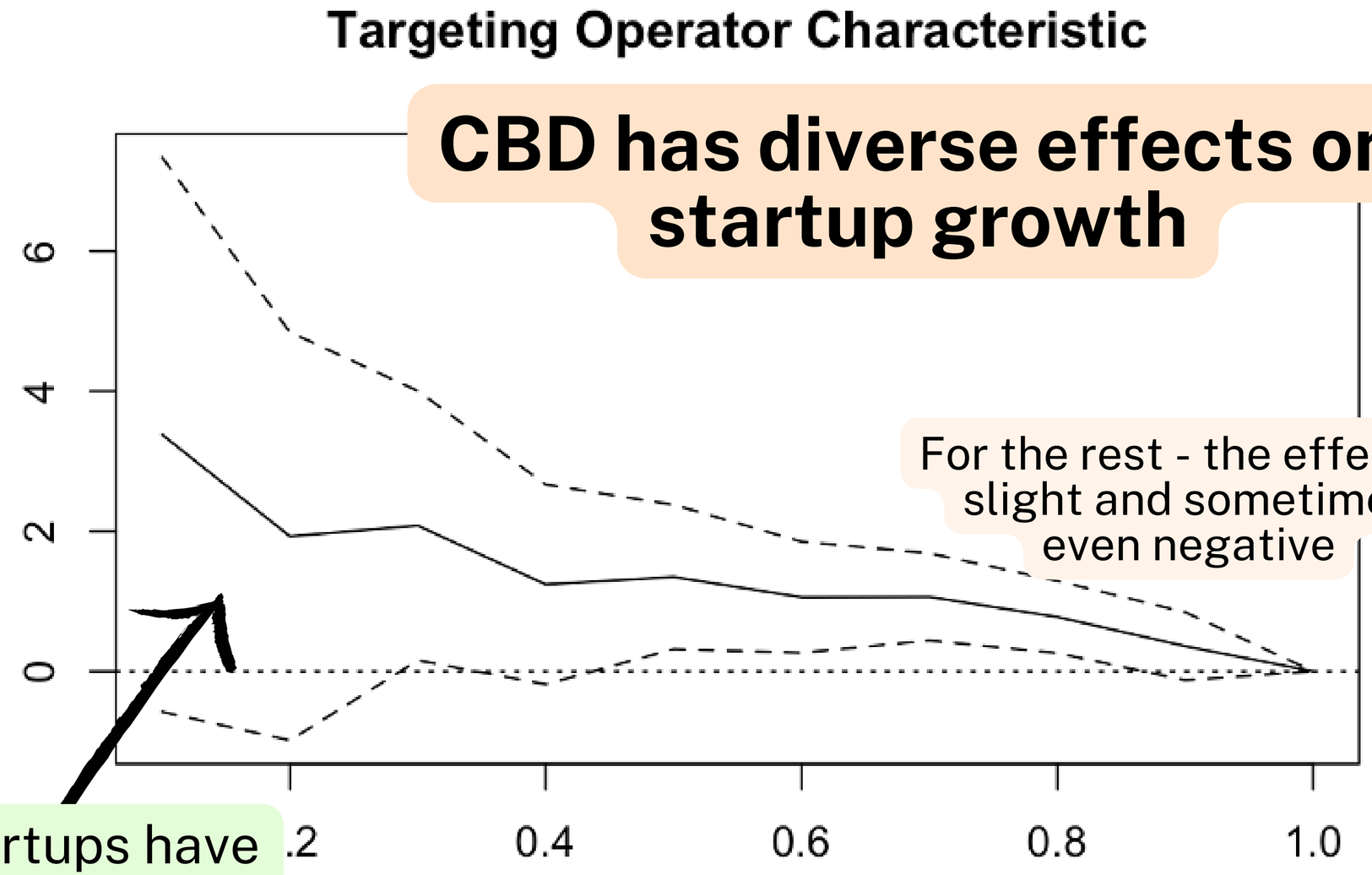
CBD has diverse effects on startup growth

Treatment effect -> how CBD = 1 increases / reduces the asset levels after 5 years of startup operation



For the rest - the effect is slight and sometimes even negative

20% of startups have large benefits of CBD location, but the variation is very high!

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Variable name	Variable importance (in %)
Total Assets Initial	42.744
Number Of Investors	12.861
Public Transport Index	11.531
Accommodation Index	10.386
Number Of Employees Initial	7.542
Metro Availability (Binary)	5.473
Virtual Office (Binary)	4.061
Shopping Index	3.529
Ownership By Foreign Capital (Binary)	0.968
Catering Index	0.906

The most important characteristics that modify the CBD impact are connected to the initial state of the company (especially the initial asset level)

Having a virual office is not a very important predictor of CBD impact

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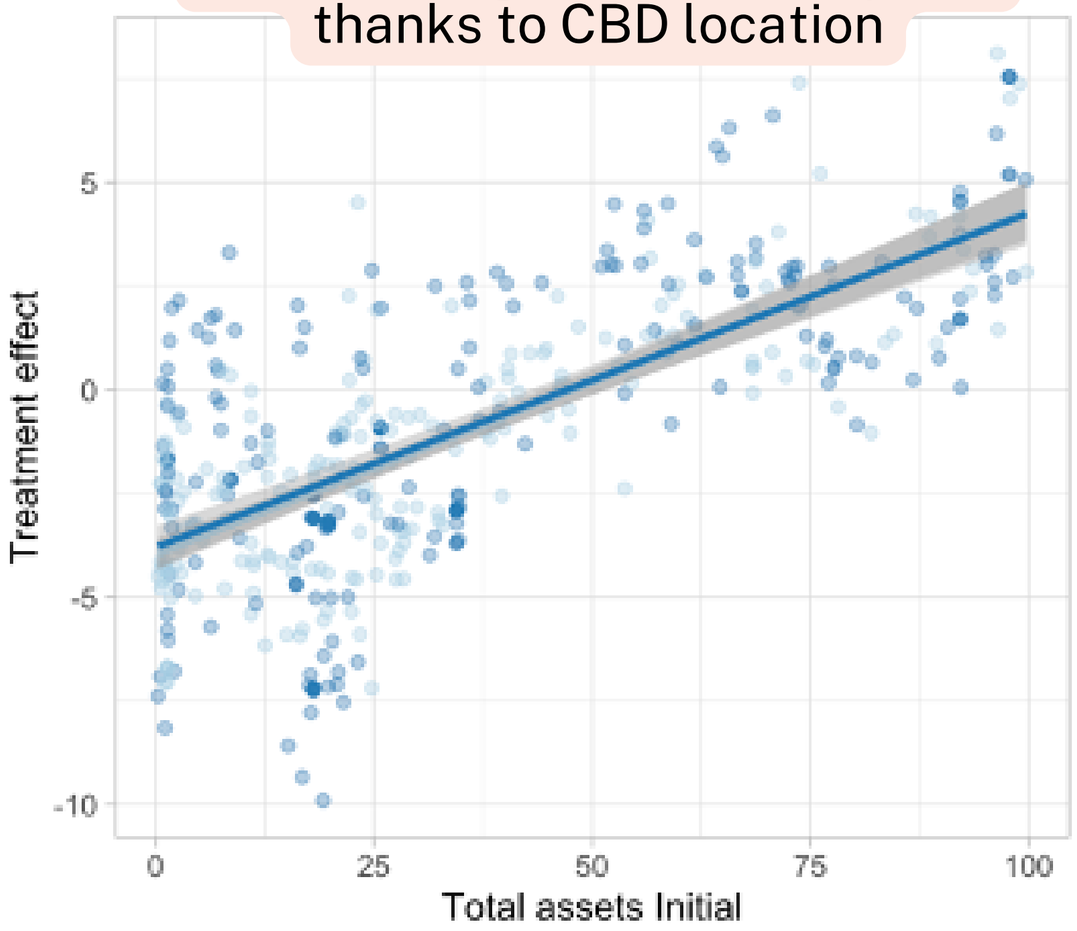
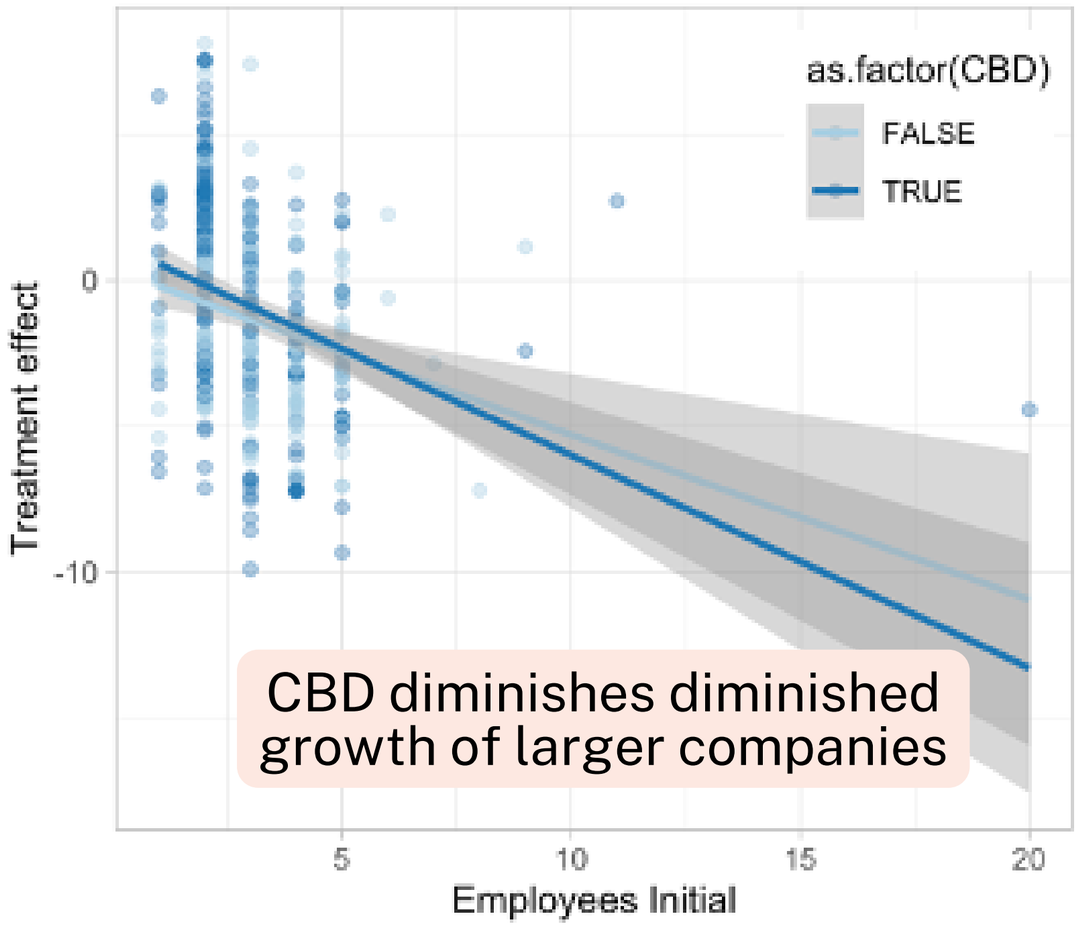
Total asset growth after 5 years thanks to CBD location



Companies with larger initial assets benefit from CBD location



CBD diminishes diminished growth of larger companies

... but this effect diminishes as startup employs more people

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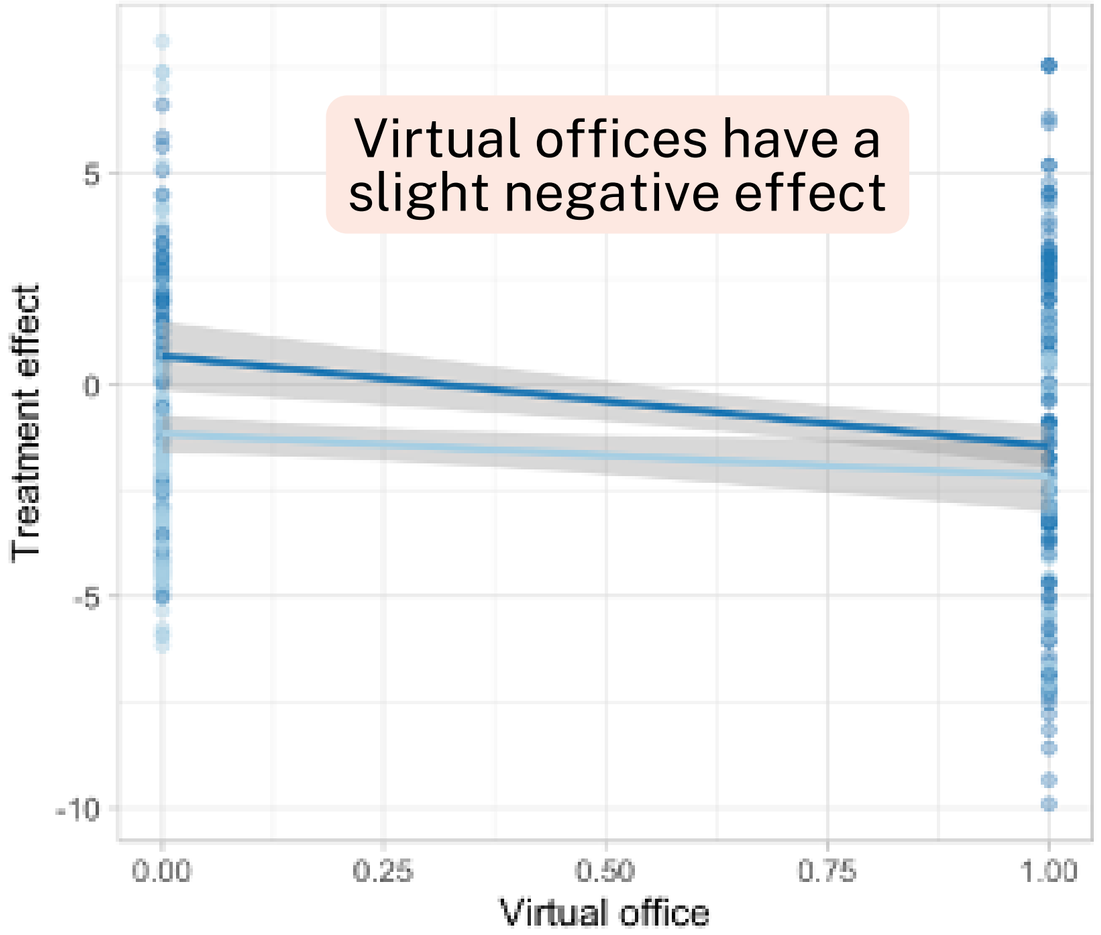

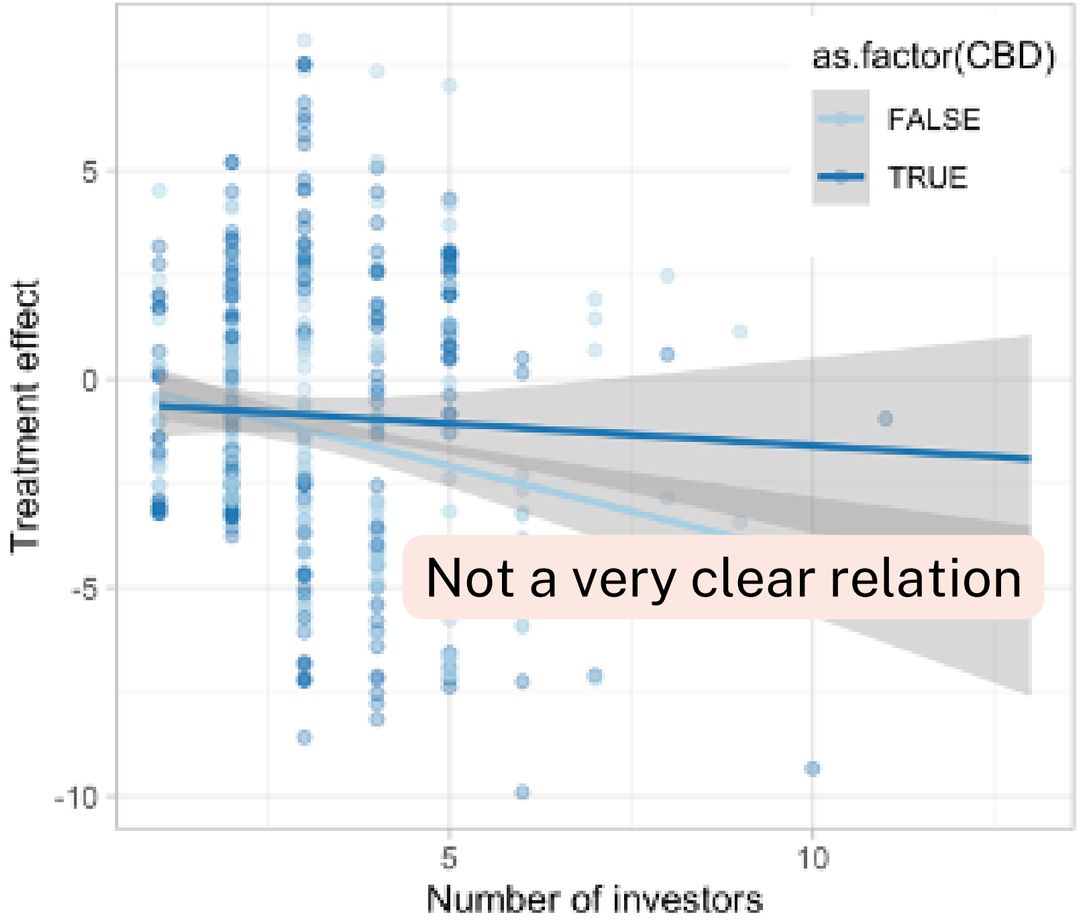

Virtual and traditional offices have similar effects

...and the number of investors is not a very important factor either

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Why can’t it be done with a linear model?

Variable name	Estimate	Std. Error	T-value	Pr(>|t|)
(Intercept)	-3.142491	3.468420	-0.9060	0.3654
Total Assets Initial	-0.059906	0.050661	-1.1825	0.2377
Number Of Employees Initial	-0.444792	0.454861	-0.9779	0.3287
Ownership By Foreign Capital	1.435518	2.582982	0.5558	0.5787
Virtual Office	1.432749	2.421803	0.5916	0.5544
Availability Of Metro	1.358773	3.367853	0.4035	0.6868
Catering Index	-4.608606	17.623508	-0.2615	0.7938
Accommodation Index	7.186446	13.314002	0.5398	0.5896
Public Transport Index	3.202487	9.398272	0.3408	0.7335
Shopping Index	-4.283145	10.838616	-0.3952	0.6929
Number Of Investors	-0.085352	0.554008	-0.1541	0.8776

Best Linear Prediction tries to fit a linear model to estimate the same treatment effects. Results are highly biased and non-significant. The relations between variables are not linear

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Summary

- CBD has a **causal impact** on the technological startups growth
- Across startups CBD impact **differs in magnitude and direction**, depending on the individual characteristics of a company
- Startups with **larger initial assets** are more likely to benefit from CBD location
- Positive CBD impact becomes less intensive, as a startup grows in size
- Location in a **virtual office does not change** much the way of CBD influence
- **CBD impact is separate** from the overall characteristics of a location
- **Causal forest** can provide detailed insights into the individual **heterogenous treatment effects** and can work with complex non-linear relations between observed factors
- Insights from this study can be utilized for **derive tailored recommendations** for young entrepreneurs

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Thank you!

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