Lessons Learned from Causal Analysis from Army Project Data

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Document Markings

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Why Model Causal Structure

Depending on causal structure, factor loadings may or may not be identifiable by conventional adjustments

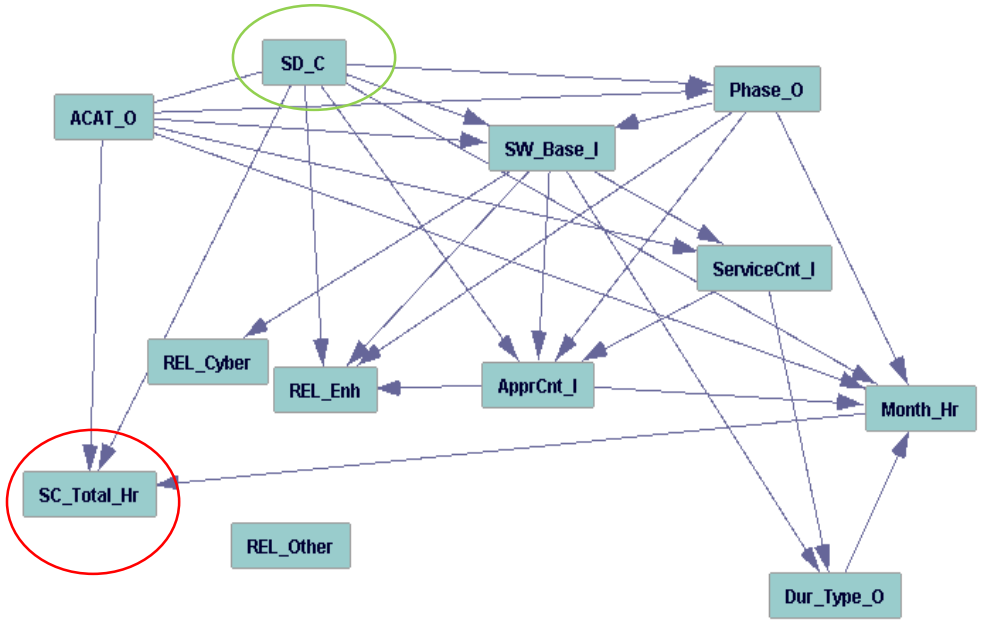
Bias can be introduced by

- Failure to adjust for Common Causes (Confounders)
- Adjusting on a Common Outcome (Colliders)
- Common sources of measurement error
- Treatment confounder feedback

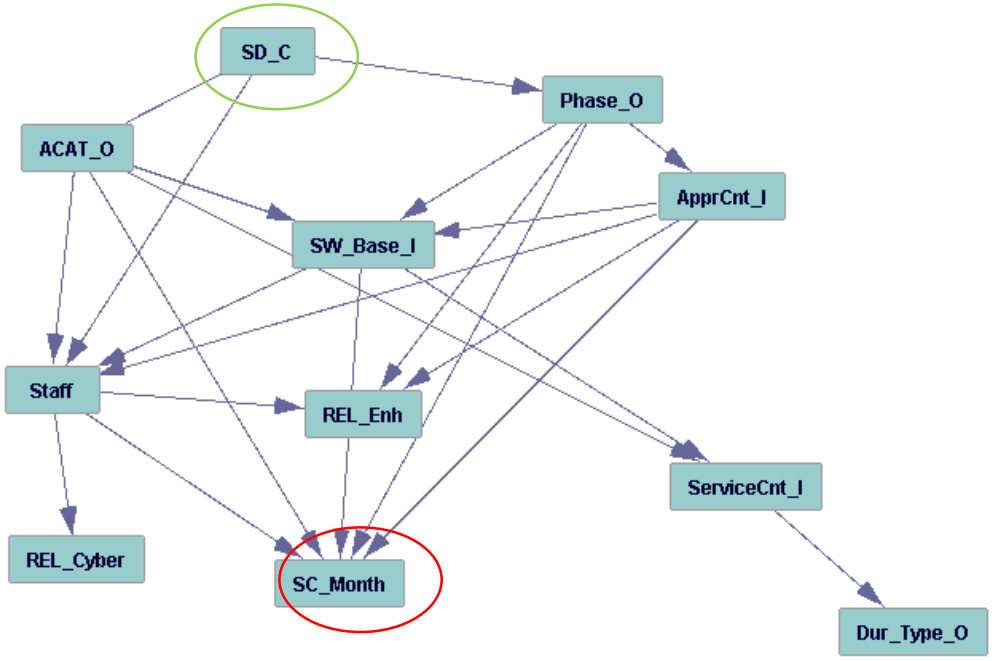
Therefore, causal structural assumptions are necessary to

- Correct (adjustment) for bias
- Interpreting covariate loadings in regression models (anova and ancova)
- Identify appropriate analysis methods (e.g. stratification, g-methods, and so forth)

Super Domain is Highly Connected Causal Node



Efficiency

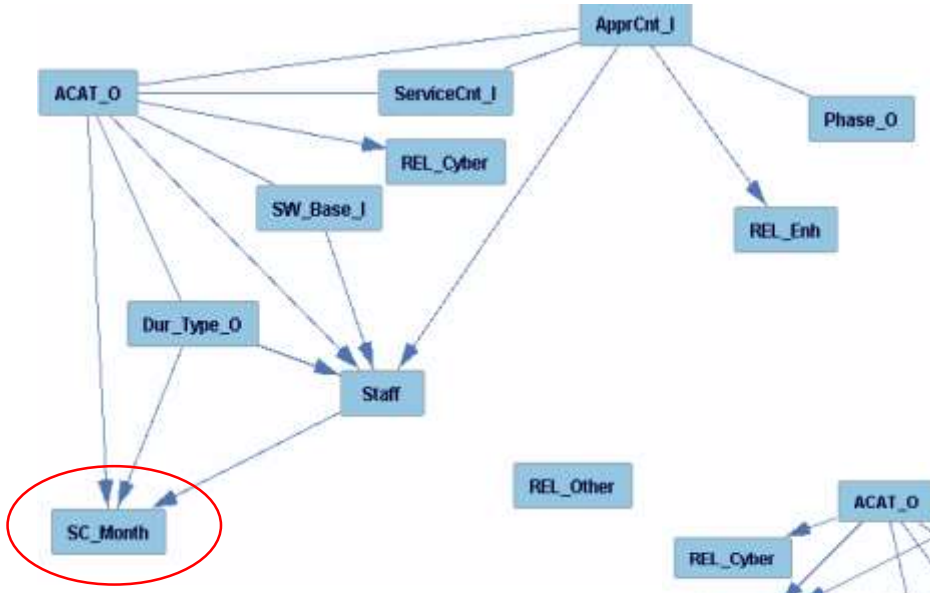


Throughput

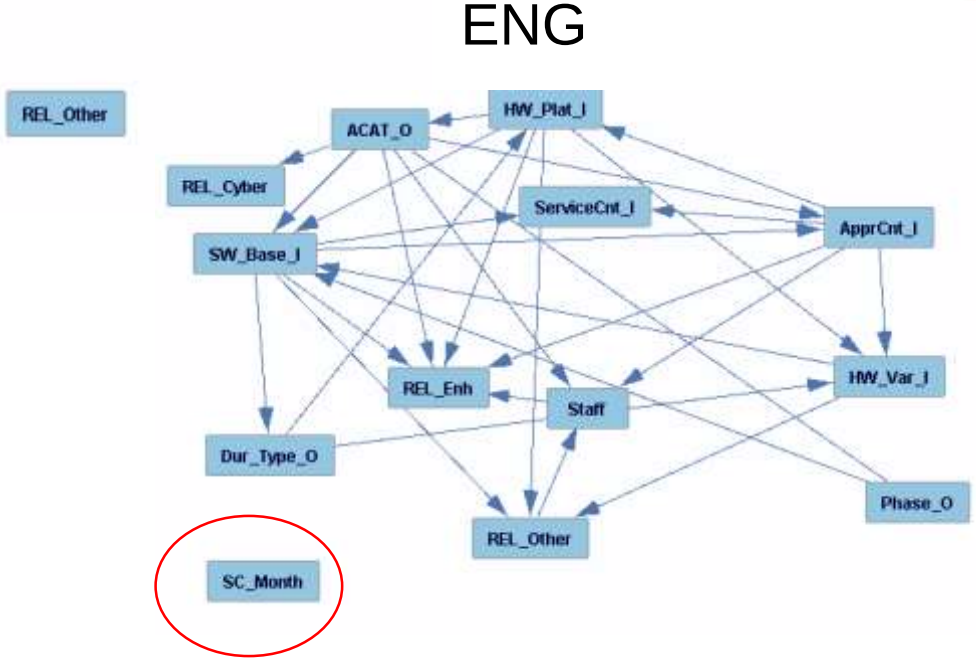
Super Domain may influence a number of factors, having both direct and indirect effects on the outcome.

AIS, Eng, and RT Causal Discovery by SuperDomain

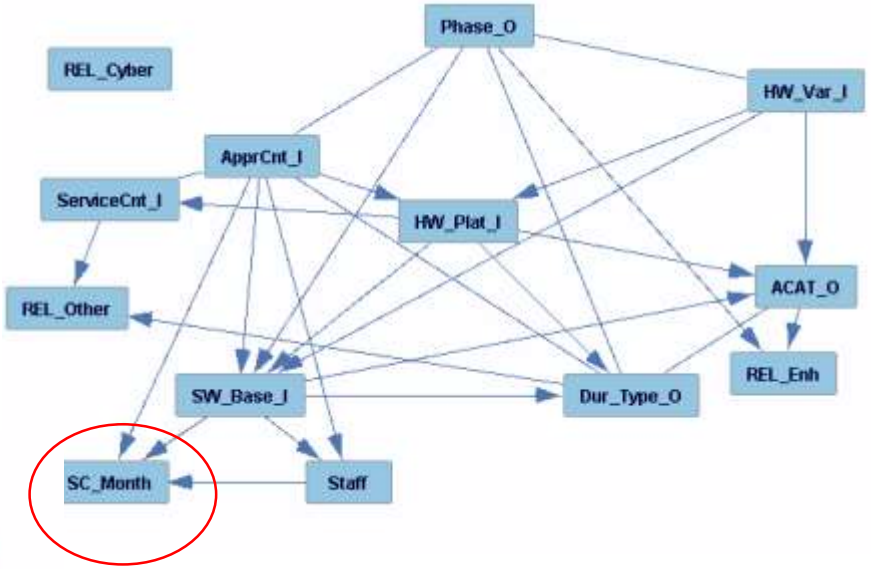
AIS



ENG

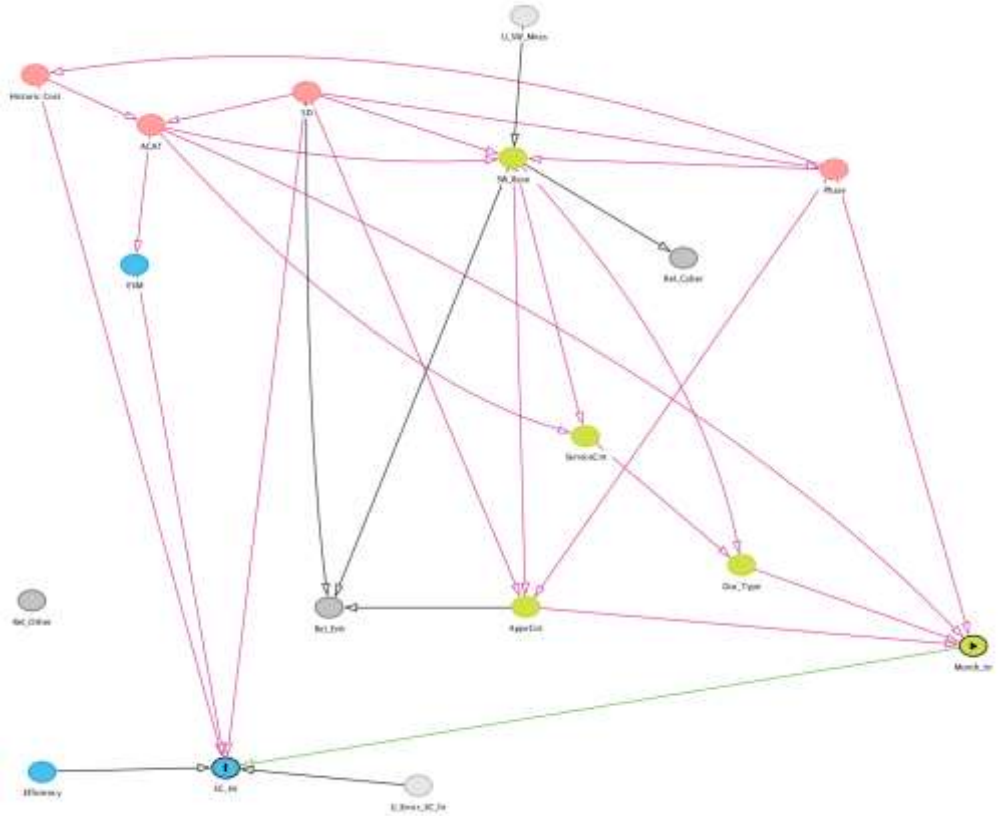


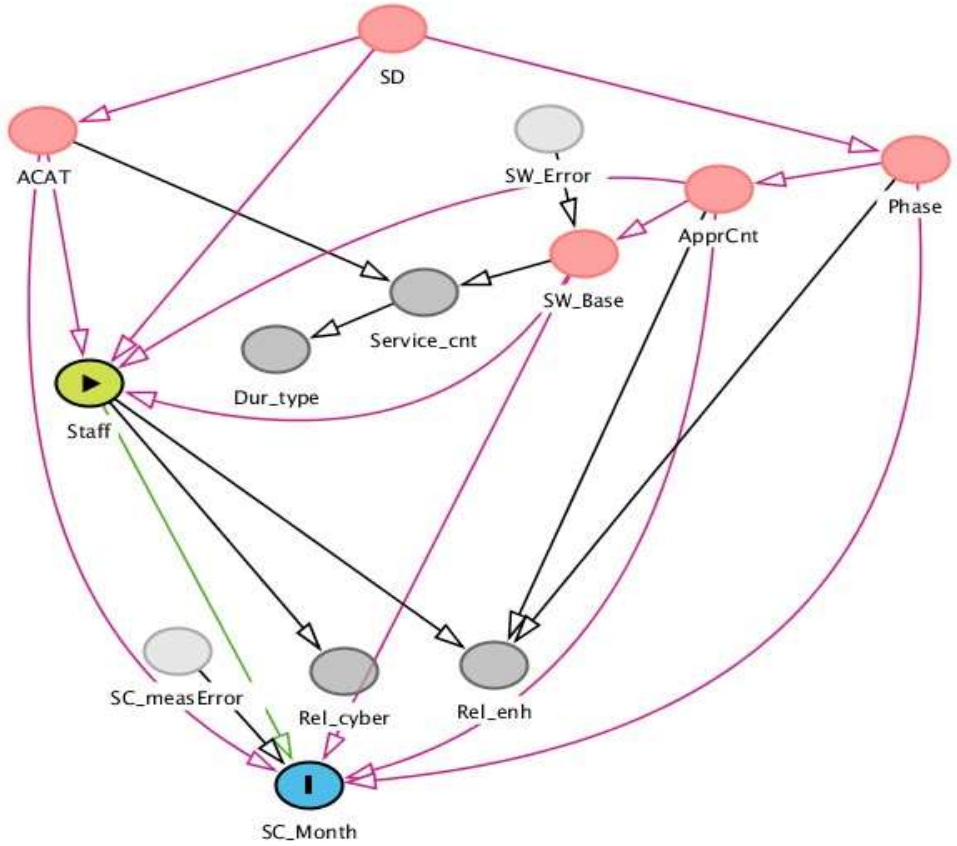
RT



How do the project goals affect the causal structure ? Differences between “Efficiency” and “Throughput”

Picture (optional)

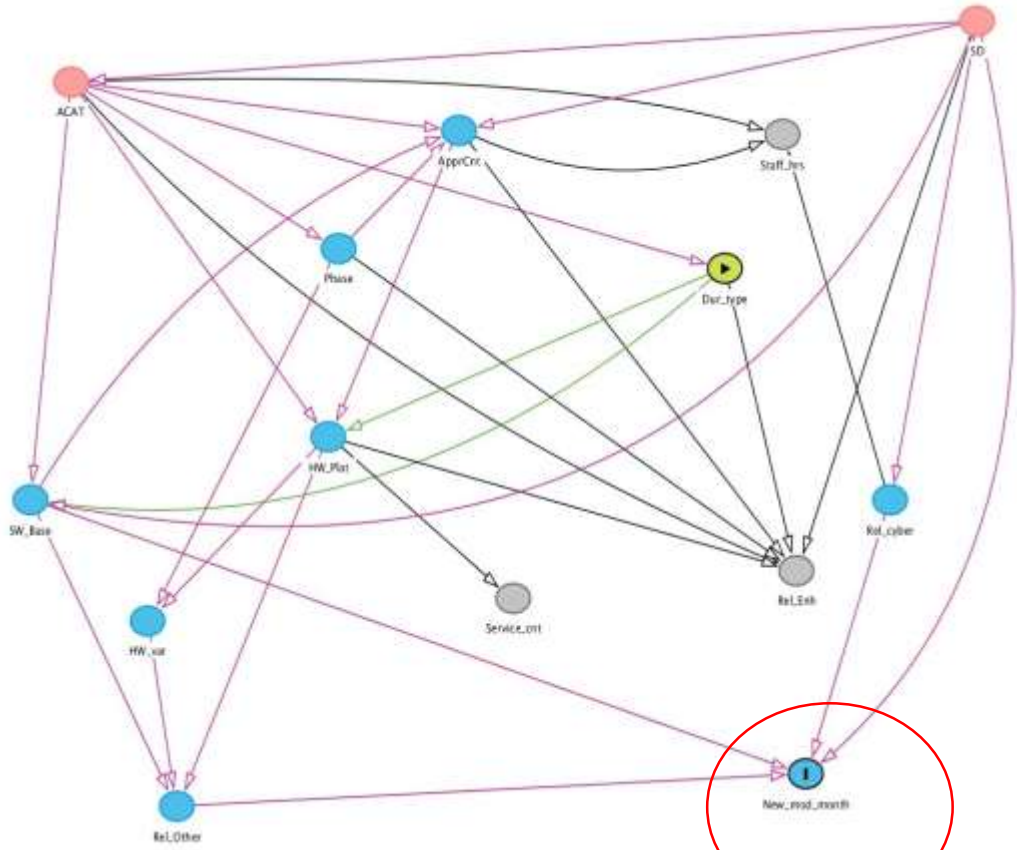


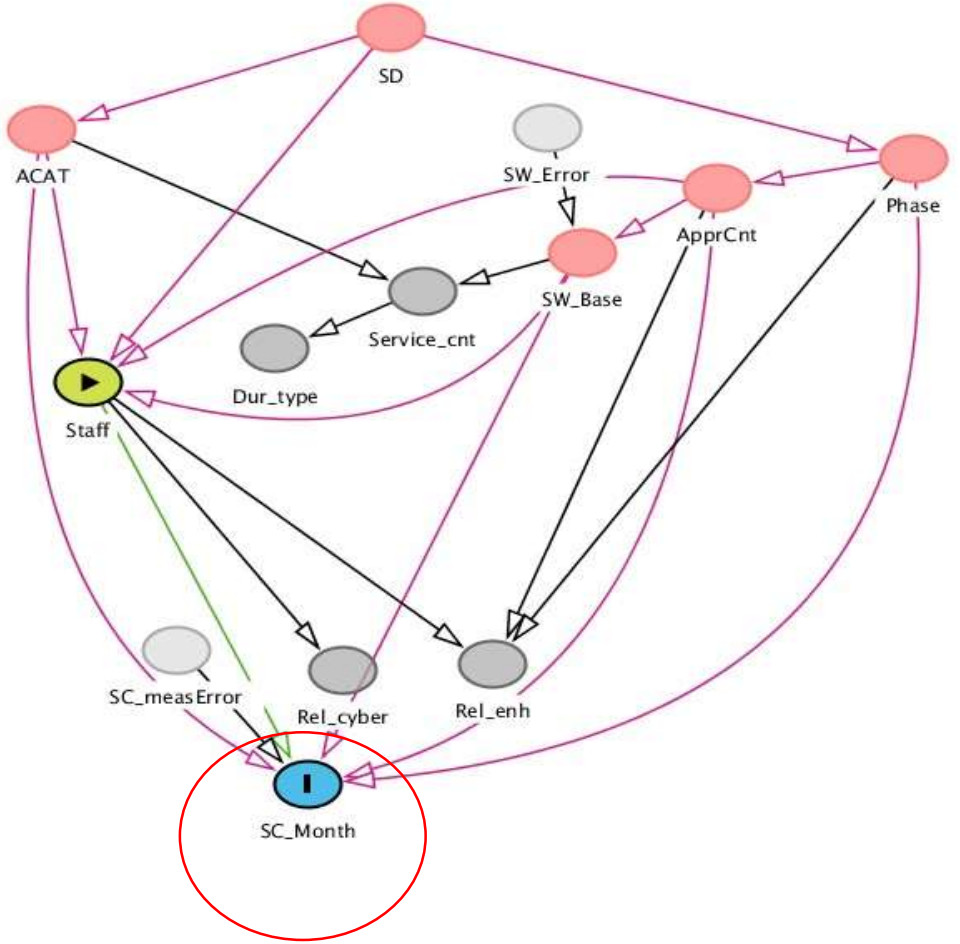


Month/hr (inverse staffing) effect requires multiple adjustments

“Throughput” structure differs with measure (SC vs NM)

Picture (optional)



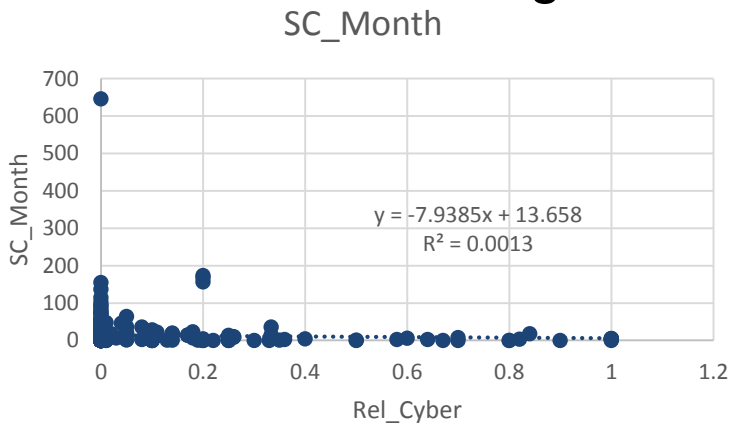


Measurement Risks - 1

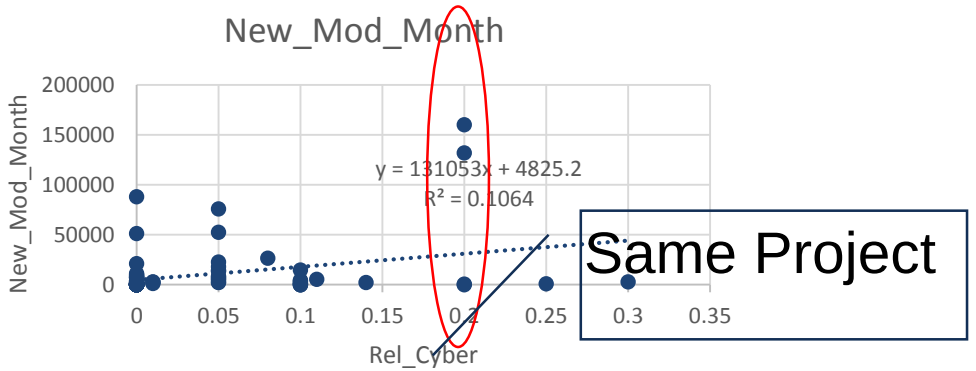
Picture (optional)

Systematic Bias associated with choices of measurement?

- Projects using Software Changes have a very different distribution of Relative Cyber work than those using New and Modified LOC.



Somewhat flat distribution

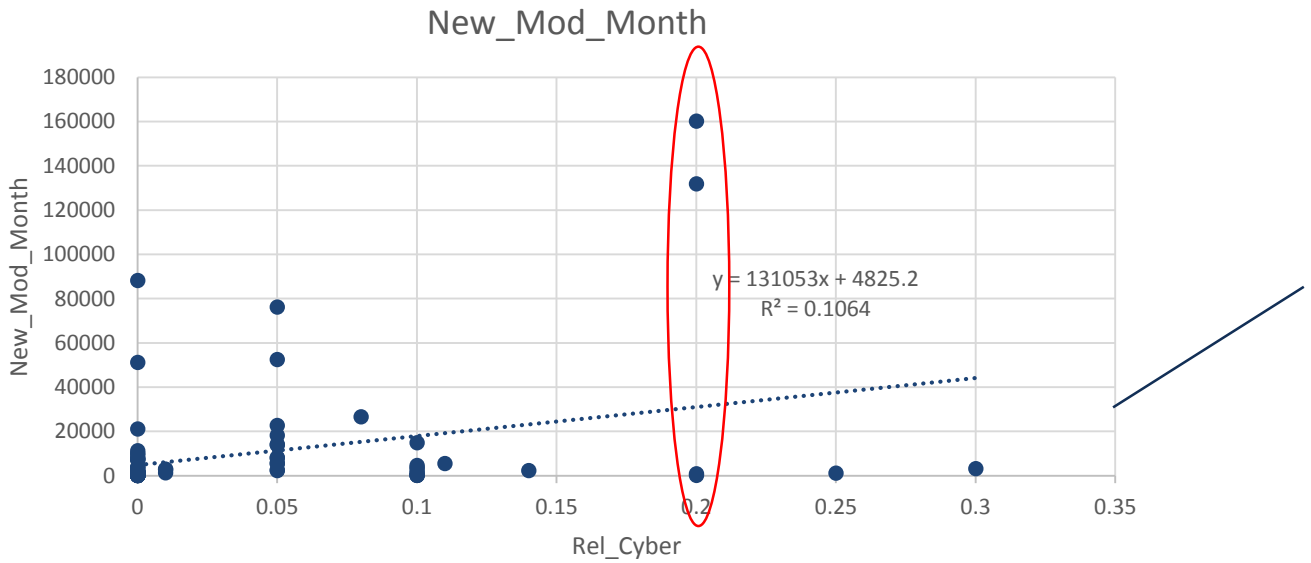


Highest value is 0.3

Differing Measurement scales

Measurement Risks - 2

Misrepresenting independence



Same Project different times

Measurement Risks -2

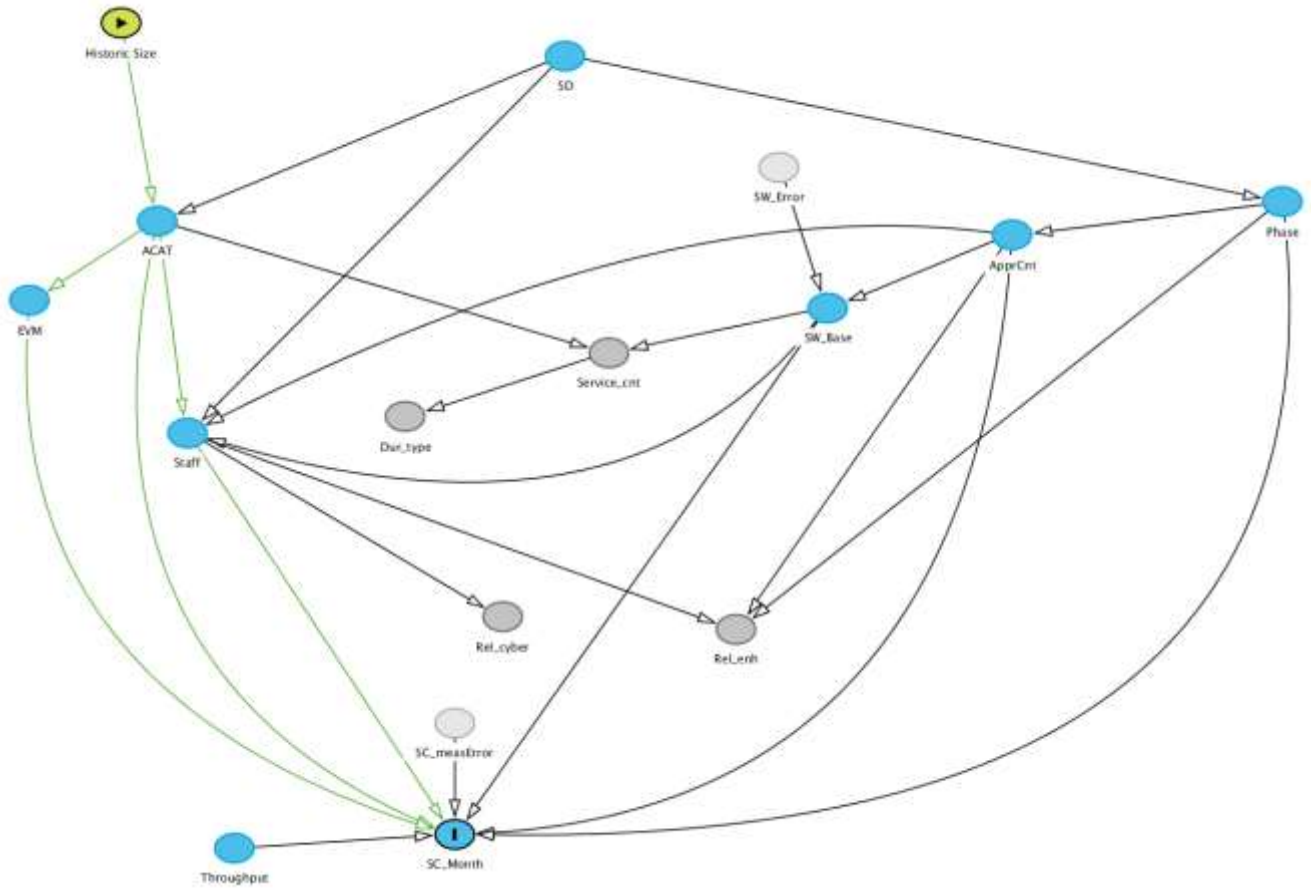
Differing Measurement scales between

- different meaning of “Software Change”
- Differing measurement of “New and Changed LOC”

Unmeasured confounders

- LOC based on different Programming Languages , or
- Technology stacks
- Part time vs full time staffing
- Accounting controls (EVM)

Does ACAT level introduce a confounder bias?



ACAT is caused by historic cost
ACAT causes EVM management

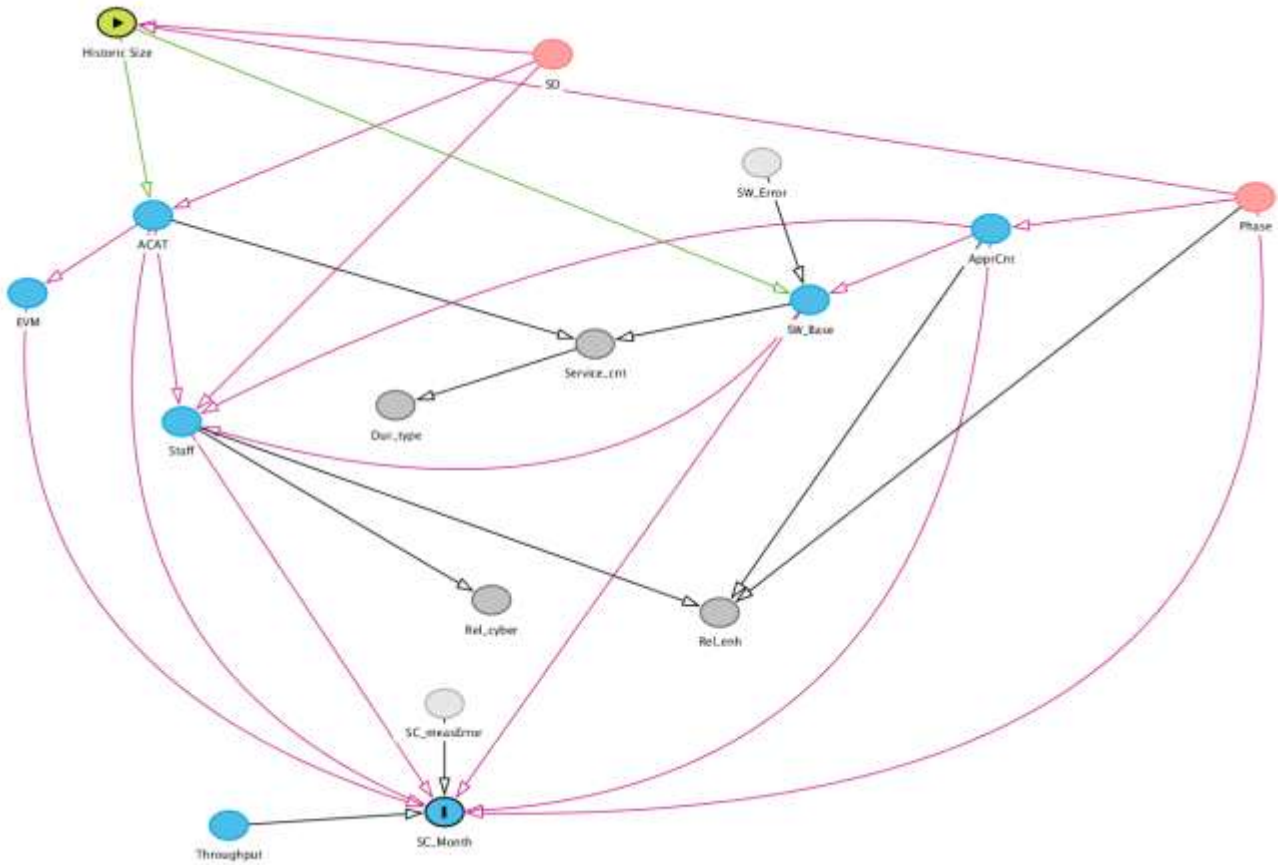
Options,
Stratify the data by ACAT
Decompose ACAT into additional elements

Historic costs,

- Total effect -“no adjustments”
- Direct effect, adjust for Superdomain (or equivalent block)

Hypothetical Effect of Decomposing ACAT

Picture (optional)

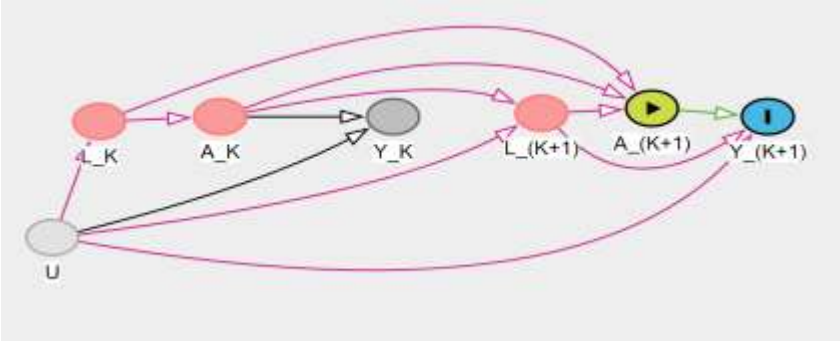


What if SD and Phase cause historic cost
If Historic cost causes baseline size?

Historic costs,

- Total effect –adjust for Phase and SD
- Direct effect- adjust for
  - sApprCnt, Phase, SW_Bae, Staffing

Future work, Treatment Confounder Feedback



K, K+1 :times
A_K: treatment at time K
L_K+1 : an outcome from treatment A_K

If a series of treatment levels depends upon outcomes from prior treatments, the confounding renders conventional adjustment methods ineffective.