Ratio of Changes:

How Real Estate Shocks Did Not Affect Corporate Investment

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Does an increase in collateral induce more investment?

Uses common corporate-finance specification:

\[
\frac{\text{capex}(i, t)}{\text{ppe}(i, t - 1)} = \beta \times \frac{\text{realestate}(i, t)}{\text{ppe}(i, t - 1)} + FE(i) + \ldots + e
\]

- capex (capital expenditures),
- real-estate (dollar value, mostly headquarter),
- ppe (property plant and equipment)
  - really just a scale adjustment
  - (titled) interest is about real-estate and capex
- CST add fixed effects (FE) for time and other controls.
Title: How real-estate shocks affect corporate investment

\[
\frac{\text{capex}(i, t)}{\text{ppe}(i, t - 1)} = 0.07 \times \frac{\text{realestate}(i, t)}{\text{ppe}(i, t - 1)} + \text{FE}(i) + \ldots + \epsilon
\]

→ CST emphasize coefficient magnitude
  → too much? a one-time shock on real-estate value stock will have a permanent effect on capex flow. Is the payoff on capex immediate?

→ CST emphasize shock aspect:
  → Somewhat generous on simul-timing.

→ T around 20 (3,000 firms, 15 years).
Time Falsification?

\[
\frac{\text{capex}(i, t)}{\text{ppe}(i, t - 1)} = 0.07 \times \frac{\text{realestate}(i, t)}{\text{ppe}(i, t - 1)} + \text{FE}(i) + \ldots + e
\]

\rightarrow (PS: I love time-falsification placebos.)

\[
\frac{\text{capex}(i, t)}{\text{ppe}(i, t - 1)} = 0.08 \times \frac{\text{realestate}(i, t+4)}{\text{ppe}(i, t+3)} + \text{FE}(i) + \ldots + e
\]

\rightarrow Shock (in title) is **not** empirically founded.

\rightarrow Presumably, managers did not invest in anticipation of real-estate gains four years into the future.

\rightarrow Shock (in title) is *only* theoretically founded.
More Real-Estate Collateral $\Rightarrow$ More Investment?

$$\frac{\text{capex}(i, t)}{\text{ppe}(i, t - 1)} = 0.07 \times \frac{\text{realestate}(i, t)}{\text{ppe}(i, t - 1)} + \text{FE}(i) + \ldots + e$$

Or perhaps merely variation in ppe?

Here, denoms in X and Y have 100% correlation.

But could be merely correlated, say, 1/ppe for Y and 1/assets for X.

Not shown: high variation in 1/ppe, relative to numerators.

Q: Does coefficient reflect primarily numerator associations?
What About The Constant 1.0?

\[
\frac{\text{capex}(i, t)}{\text{ppe}(i, t - 1)} = 0.07 \times \frac{\text{realestate}(i, t)}{\text{ppe}(i, t - 1)} + \text{FE}(i) + \ldots + e
\]

More 1.0 ⇒ More Investment?

\[
\frac{\text{capex}(i, t)}{\text{ppe}(i, t - 1)} = 0.13 \times \frac{1.0}{\text{ppe}(i, t - 1)} + \text{FE}(i) + \ldots + e
\]

More Real-Estate Collateral ⇒ More 1.0?

\[
\frac{1.0}{\text{ppe}(i, t - 1)} = 0.20 \times \frac{\text{realestate}(i, t)}{\text{ppe}(i, t - 1)} + \text{FE}(i) + \ldots + e
\]

→ Somehow real-estate and capex each increased (heterogeneously) in non-(FE)-controlled way.

→ Recipe for spurious association

→ PS: Coefs reflect T-stats and magnitudes fairly.
Chaney, Sraer, Thesmar (2020) Response

\[
\frac{\text{capex}(i, t)}{\text{ppe}(i, t - 1)} = 0.07 \times \frac{\text{realestate}(i, t)}{\text{ppe}(i, t - 1)} + \text{FE}(i) + \ldots + \epsilon
\]

\[
\frac{\text{capex}(i, t)}{\text{ppe}(i, t - 1)} = 0.13 \times \frac{1.0}{\text{ppe}(i, t - 1)} + \text{FE}(i) + \ldots + \epsilon
\]

→ Let’s “split” the difference?

\[
\frac{\text{capex}(i, t)}{\text{ppe}(i, t - 1)} = 0.05 \times \frac{\text{realestate}}{\text{ppe}(i, t - 1)} + 0.12 \times \frac{1.0}{\text{ppe}(i, t - 1)} + \ldots
\]

→ CST: Problem is now under control: 0.05 coef is still positive.

→ Me: Specification is still bad (“trended“): see 0.12 coef on constant.
Is Specification Under Control Now?

\[
\frac{\text{capex}(i, t)}{\text{ppe}(i, t - 1)} = 0.05 \times \frac{\text{realstate}}{\text{ppe}(i, t - 1)} + 0.12 \times \frac{1.0}{\text{ppe}(i, t - 1)} + \ldots
\]

→ 1. In Paper: Reasonable specifications under the null (of no association) still estimate similar coefficients in Monte-Carlo.

→ 2. Regression still contains uncontrolled denominator effects:

\[
\frac{\text{capex}(i, t)}{\text{ppe}(i, t - 1)} = -0.05 \times \frac{\text{realstate}}{\text{ppe}(i, t - 1)} + 0.05 \times \frac{1.0}{\text{ppe}(i, t - 1)} + 0.15 \times \log \left[ \frac{1.0}{\text{ppe}(i, t - 1)} \right] + \ldots
\]
The specification wrestles (badly) with shared variation in $1/ppe$ on both X and Y.

The specification is a bad crutch for the problem at hand.
Specification

→ The specification wrestles (badly) with shared variation in 1/ppe on both X and Y.

→ The specification is a bad crutch for the problem at hand.

What if there is a Better Alternative?

→ A specification that removes time-variation in denominator;

→ and thus removes the problem, once and for all.
Translate Fixed Effects to Changes

→ Familiar Transformation:

From ratios and fixed effects (R + FE):

\[
\frac{\text{capex}(i, t)}{\text{ppe}(i, t - 1)} = \beta \times \frac{\text{realestate}(i, t)}{\text{ppe}(i, t - 1)} + \text{FE}(i) + \ldots + e
\]

To changes of ratios (CoR):

\[
\Delta_t \left[ \frac{\text{capex}(i, t)}{\text{ppe}(i, t - 1)} \right] = \beta \times \Delta_t \left[ \frac{\text{realestate}(i, t)}{\text{ppe}(i, t - 1)} \right] + \ldots + e
\]

→ Identical in two periods.

→ Similar in more periods.
Care About Numerator?

→ Changes of Ratios (CoR, \(\Delta(v/z)\)):

\[
\left[ \frac{\text{capex}(i, t)}{\text{ppe}(i, t - 1)} \right] - \left[ \frac{\text{capex}(i, t - 1)}{\text{ppe}(i, t - 2)} \right] = \beta \times \left\{ \left[ \frac{\text{realestate}(i, t)}{\text{ppe}(i, t - 1)} \right] - \left[ \frac{\text{realestate}(i, t - 1)}{\text{ppe}(i, t - 2)} \right] \right\} + \ldots + e
\]

→ vs. Ratios of Changes (RoC, \((\Delta v)/z\)):

\[
\left[ \frac{\text{capex}(i, t)}{\text{ppe}(i, t - 1)} \right] - \left[ \frac{\text{capex}(i, t - 1)}{\text{ppe}(i, t - 1)} \right] = \beta \times \left\{ \left[ \frac{\text{realestate}(i, t)}{\text{ppe}(i, t - 1)} \right] - \left[ \frac{\text{realestate}(i, t - 1)}{\text{ppe}(i, t - 1)} \right] \right\} + \ldots + e
\]

→ By RoC, I mean ratio with a change in the numerator, not in the denominator.

→ What theory about numerators would not allow this?
Ratios of Changes

→ RoC:

\[
\frac{\Delta_t \text{capex}(i, t)}{\text{ppe}(i, t - 1)} = \beta \times \frac{\Delta_t \text{realestate}(i, t)}{\text{ppe}(i, t - 1)} + \ldots + e
\]

→ Denominator now does only what you need it for:

→ scale control across different firms.

→ All time-variation in ppe is removed by specification.

→ similar to rescaling the lagged variable by \( \text{ppe}(i, t - 2)/\text{ppe}(i, t - 1) \).

→ Not revolutionary:

“rate of returns”:

\[
\frac{(P_t - P_{t-1})}{P_{t-1}},
\]

not “differences in price-appreciations”:

\[
\frac{P_t}{P_{t-1}} - \frac{P_{t-1}}{P_{t-2}}.
\]
Ratio of Changes (RoC) Variables

→ This is about variables, not about regressions.
   → Doesn’t need to be in both X and Y.
   → CoR in either X or in Y can create trouble, too.

→ RoC and Cor variables can be very different:
   → ...obviously only when the denominator changes greatly.
   → Example: num=(19.9,20.0); denom=(100,200).
   → RoC = 0.2 − 0.1 = +0.1; vs.
   → CoR = −0.1/100 = −0.001

→ CST
   → correlation of Cor \(\Delta(v/ppe)\) with RoC \(\Delta v/ppe\) is low,
   → even the sign of Cor \(\Delta(v/ppe)\) vs RoC \(\Delta v/ppe\) changes often,
   → and disproportionately more for growing, volatile (small, non-RE).
Denominator-neutral RoC Regression:

\[
\left[ \frac{\Delta_t \text{capex}(i, t)}{\text{ppe}(i, t - 1)} \right] = -0.02 \times \left[ \frac{\Delta_t \text{realestate}(i, t)}{\text{ppe}(i, t - 1)} \right] + \ldots + e
\]

Not shown: bad CoR reg has positive coef, just like CST F + R

Not Shown:

In CST, one regression specification in which a different independent variable (REisPos \( \times \) repi) is not ppe normalized;

but with R + FE continuing for the dependent variable (capex/lagppe), the positive CoR coefficient turns negative in the RoC version, too.

Here spurious time corr problem is not mechanical, but empirical.

Why? The reason are differential trends of small vs large firms.

Same results when Great (Real-Estate) Recession data is added.
If you care about the numerator in a ratio, and you use the denominator primarily as a scale adjustment, and firms are different enough to require mean adjustments;
 Specifications

→ If you care about the numerator in a ratio, and
→ you use the denominator primarily as a scale adjustment, and
→ firms are different enough to require mean adjustments;

→ then do not use a fixed-effects level regression!
→ Use an RoC specification instead!
Simpler To Remember

Fixed-Effect Regressions With Ratio Variables are Dangerous

and there is an easy and safer alternative.
So What Went Wrong?

→ Usually, I do not speculate on motives of authors,
  ... but

→ CST are top-notch empiricists,
→ ... and I believe the answer is quite innocuous.
My Guess

CST merely used the most common “standard” specification in the literature, without giving it a second thought.

I am a little unfair to CST; they are not alone in using R w/ FE.

But other papers may not have as much variation in the denominator.

Needs more analysis.
What Would They Say Now?

I would guess that CST would no longer run and present the same regressions as sufficient evidence,

Even if they still believe that RE $\rightarrow$ Capex, they would now show you more and/or different evidence.

... but you would have to ask them.

We improve over time by learning from critics, not from friends,

just as my paper improved from their response to my first draft.

Unfortunately, unlike github, our journals are not good at allowing iteration towards better versions of our shared standard knowledge base.
Memes in Publications?

- R + FE specifications have a prominent role in finance/economics, to the point where they are standard in many contexts.
- They often deliver desired (possibly but not always spurious) results.
  - Whether inference remains or changes requires reexamination.
- Their common use may have thrived due to (evolutionary) publication pressures.
  - Like LLSV x-country regression methodology (Holderness (CFR 2016)).
  - Or the use of Debt/Assets (Welch (IRF 2011)).
  - They often give good results, sometimes surprising and exceptionally provocative and interesting, too. Great publication material.
  - And they are often correct, too—but, sometimes, just plain wrong.
I believe that reexamination by (and iteration over) every important paper by independent skeptical researchers is more important to our profession now than more “novel constructive” findings.

- Most CorpFin papers have never been reexamined (incl my own).
- The CFR plans to post a list of topics later in the year that will be like open quasi-solicitations.
- Help us help us firm up our foundation.
- There will be a painful transition period, as our profession gets used to less spectacular results, more caveats, and less holier-than-thou.