Ratio of Changes:

How Real Estate Shocks Did Not Affect Corporate Investment

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Simplified Chaney, Sraer, Thesmar (AER 2012)

➔ Does an increase in collateral induce more investment?

➔ Uses common corporate-finance specification:

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

➔ 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.

! Positive Coefficient Interpretation !

Title: How real-estate shocks affect corporate investment

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

➔ 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?

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

➔ (PS: I love time-falsification placebos.)

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

➔ Shock (in title) is not empirically founded.

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

➔ Shock (in title) is only theoretically founded.

? Positive Coefficient Interpretation ?

➔ 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 $\Rightarrow$ 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 $\Rightarrow$ 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

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

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

➔ 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?

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

➔ 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:

$$\frac{\text{capex}(i,t)}{\text{ppe}(i,t-1)} = -0.05 \times \frac{\text{realestate}}{\text{ppe}(i,t-1)} + 0.05 \times \frac{1.0}{\text{ppe}(i,t-1)}$$
$$+0.15 \times \log\left[\frac{1.0}{\text{ppe}(i,t-1)}\right] + \dots$$

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.

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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 Tranformation:

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:

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

➔ 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": $(P_t - P_{t-1})/P_{t-1}$,

not "differences in price-appreciations": $P_t/P_{t-1} - P_{t-1}/P_{t-2}$.

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 Δ(v/ppe) with RoC (Δ v)/ppe is low,
  - ➔ even the sign of CoR Δ(v/ppe) vs RoC (Δ v)/ppe changes often,
  - ➔ and disproportionately more for growing, volatile (small, non-RE).

Back to CST 2012

➔ 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.

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;

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!

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.

Checking Memes and the Critical Finance Review

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.