

**Paper Title:**

Regulating Conglomerates: Evidence from an Energy Conservation Program in China

## 1 Summary

This paper examines the effects of China's Top 1000 policy on energy use, output, and energy efficiency, in the presence of close-nit conglomerate structures within the industries that are regulated. Difference-in-differences are used to examine the overall impacts of the policy, as well as the two spillover effects for unregulated firms inside the conglomerate and for unregulated, unrelated firms outside the conglomerate. These reduced form methods are followed by a relevant structural model of the conglomerate that helps explain and validate the reduced form results and extend the analysis to welfare impacts, policy analysis, and a robust confidence interval of policy effects by examining the various degrees of assumptions that can be applied. Some of the broader results are fairly limited to China, but as the authors argue, are still important updates of our understanding given China's role in global energy usage.

This paper is (a) a great example of policy analysis that can help inspire future researchers to employ similar methods; and (b) an important update of our understanding of this type of large scale energy reduction policy. This paper's main novel contribution is disentangling spillover effects impacting within and outside conglomerates using both simple (interpretable) diff-in-diff models and a structural model. This is a strong paper and should be published after addressing a two issues.

## 2 Key Issues to address

### 2.1 Missed opportunity to examine the role of policy uncertainty in the lack of energy efficiency investment

The policy being examined is about energy use and energy efficiency – the authors make clear that though energy efficiency was not directly regulated, it was the original purpose of the regulation. One of the important conclusions that the authors make is that the null result of energy efficiency improvements for regulated firms implies that these firms found it too costly to invest in energy efficiency. They mention in a footnote that policy uncertainty could play role in this lack of investment and they mention in a model extension that the investment in energy efficiency does not happen in the 5-year time frame but might happen in the longer run. The policy is announced to be a success and experiences a massive expansion in 2012. This would have the logical effect of decreasing policy uncertainty for the regulated firms (they would probably assume the policy is here to stay). They have the data up to 2018. Why do they not attempt to disentangle the role of policy uncertainty in the energy efficiency investment story by comparing the firms before and after the policy expansion? It seems to me that this is a low-hanging fruit to make the story of costly energy efficiency investment crystal clear. This is important to address because the claim "that regulated firms found it costly to increase their energy efficiency" is an important conclusion of this paper.

I think this could be addressed in two ways: (1) acknowledging policy uncertainty in a more prominent way to make it clear to the reader that short-run costs might be high but it might be cost-effective to invest in energy efficiency if the policy was more certain; or (2) using data after 2012 to see if the increase in policy certainty after the expansion of the program increase the level of energy efficiency. Though I prefer option two for the final clarity of the conclusions, it is possible that the second suggestion may be a significant ask of the authors and I would find it acceptable to publish if the first option was used.

## 2.2 Matching on more covariates

Both the main matching method and robustness check matching method (entropy matching) are matching exactly on industry and continuously on pre-policy output levels. The idea with this is to create a control group that matches the parallel pre-trends assumption. But matching only on pre-policy outcomes does not guarantee the removal of selection bias. Lindner and McConnell (Health Services and Outcomes Research Methodology, 2017) give a great explanation and suggestions for using matching with diff-in-diff.

The idea of matching is to create a control group that mimics a randomized control trial (or more specifically, a stratified randomized control trial). An important component of RCTs is covariate balance and showing covariate balance tables is standard practice in both RCTs and when using any matching method. Yet the authors make no mention of covariate balance or the strength of the matches (they do mention they drop the 5% worst matches). Without covariate balance tables comparing the treatment and control group, there is no guarantee of appropriate covariate overlap, meaning the spillover estimates would be invalid.

At bare minimum, covariate balance tables must be shown, ideally before and after matching (using the entire control group, then only the matched control group). If these are within acceptable ranges (see Stuart, Statistical Science 2010, section 4.1 for the appropriate diagnostics), it would be acceptable to publish. If these reveal that there is not acceptable overlap of covariates, the matching method must be addressed. Either mahalanobis matching or coarsened exact matching on covariates if feasible or follow the suggestions of Lindner and McConnell. Entropy balancing is still a useful tool here as well, but should be applied to more covariates to ensure covariate overlap in the follow-up regression.

Covariates to include: firm size, travel costs, and perhaps other covariates – Steward suggests any covariates that may be correlated with both the treatment and the outcome.

### 3 Suggestions

- (3.1) Footnote 2: The first sentence implies lowering emissions was part of the goal, but the second sentences contradicts that.