AEA Papers and Proceedings 2021, 111: 396–400
https://doi.org/10.1257/pandp.20211072

Industrial Energy Regulation: The Role of Business Conglomerates in China[†]

By Qiaoyi Chen, Zhao Chen, Zhikuo Liu, Juan Carlos Suárez Serrato, and Daniel Yi Xu*

China has implemented a wide array of policies to curb energy use and reduce pollution. Because large firms account for a considerable fraction of overall energy use, government policies and regulations often target large firms. An open question is whether these firms are part of larger business conglomerates—a phenomenon that has attracted increasing attention in both the United States and China (e.g., Boller and Scott Morton 2020; Backus, Conlon, and Sinkinson forthcoming; Allen et al. 2020; Bai et al. 2020). This paper characterizes the importance of ownership networks of firms that are subject to a prominent energy regulation in China.

The program we study—the Top 1,000 Enterprises Energy-Saving Program—targets large firms in energy-intensive industries. The name of the program derives from the 1,008 regulated firms. These firms were selected because they each consumed more than 180,000 tons of coal equivalent in 2004. Together, these firms accounted for 47 percent of China's industrial energy use. The program aimed to improve the energy efficiency of these firms and save 100 million tons of coal equivalent. Based on government evaluations, the Top 1,000 program successfully met and even exceeded this target. This perceived success led to an expansion of the program in subsequent years.

*Chen: China Center for Economic Studies, Fudan University (email: joychen@fudan.edu.cn); Chen: China Center for Economic Studies, Fudan University (email: zhaochen@fudan.edu.cn); Liu: China Center for Economic Studies, Fudan University (email: liuzhikuo@fudan.edu.cn); Suárez Serrato: Duke University and NBER (email: jc@jcsuarez.com); Xu: Duke University and NBER (email: daniel.xu@duke.edu). We are very grateful for comments from Hunt Allcott, Lysle Boller, Ashley Langer, Chris Timmins, Shaoda Wang, and seminar participants at ASSA, UCSC, and Oxford. All errors remain our own.

[†]Go to https://doi.org/10.1257/pandp.20211072 to visit the article page for additional materials and author disclosure statement(s).

Given the prevalence of large conglomerates in the Chinese economy, one possibility is that the firms regulated by the Top 1,000 program are part of larger conglomerates that include unregulated firms. This possibility motivates us to ask two related questions. First, can regulated firms shift economic activity to unregulated firms within the same conglomerate? If so, is the extent of shifting limited by technological constraints? Second, would within-conglomerate reallocation of production impact the location of energy use and related emissions?

To answer these questions, we build on work in Chen et al. (2021) by characterizing the overall importance and geographic concentration of the business networks of regulated firms. We start by combining the list of regulated firms with detailed business registry data to map the conglomerate networks of regulated firms. Using data on industrial production and energy consumption, we then ensure that the business relations we study correspond to real economic activity in similar manufacturing industries.

Our first result is that—across all regulated industries—accounting for ownership networks significantly increases the fractions of output and energy use in firms that are potentially impacted by the Top 1,000 program. To ensure that our results are not driven by technological differences across industries, we study three prominent energy-intensive industries in more detail: iron and steel, chemical, and petroleum manufacturing. Even in these narrower industries, we continue to find that accounting for ownership networks significantly increases the share of output that is potentially affected by the regulation. Thus, while Top 1,000 firms were already very prominent, taking into account their business networks implies that these firms are even more important than previously understood. This result also raises the possibility that conglomerates may escape the burden of the regulation by moving production to related firms.

Our second main insight comes from studying the geographical dispersion of firms in a given conglomerate. One possibility is that conglomerates have far-flung affiliates that serve different geographic markets. Alternatively, individual firms may face barriers to expansion, such as limited access to crucial inputs or adequate infrastructure. To overcome these limits, conglomerates may operate different firms in nearby locations. Our data show that most related firms of Top 1,000 firms are located in the same province. This suggests that market access is a less important consideration for the ownership of additional related firms than other technological constraints. In addition, to the extent that regulated firms shift activity to related parties, this response to the regulation would not result in a significant geographical shift in the location of energy use or emissions.

Understanding the ownership networks of regulated firms is crucial for evaluating the impacts of government policies that target large firms. Our results highlight the importance of estimating the effects of the regulation at the conglomerate level as well as the possibility of using public information on ownership linkages to improve the design of energy regulations.

I. The Top 1,000 Enterprises Energy-Saving Program

A key motivation for understanding the role of business groups in China is that recent attempts to curb industrial energy consumption have targeted large industrial firms. The most important program of this kind is known as the Top 1,000 Enterprises Energy-Saving Program. This program was introduced in 2006 as part of the Eleventh Five-Year Plan (11FYP). The program targeted the largest industrial energy consumers in nine energy-intensive industries. The 1,008 firms in the program together used 670 million tons of coal equivalent in 2004, or 33 percent of China's total energy consumption.

The 11FYP aimed to decrease energy intensity by 20 percent and, through the Top 1,000 program, save 100 million tons of coal equivalent. Price, Wang, and Yun (2010) provide a detailed discussion of the program. While the program was meant to mirror "voluntary agreement" programs used in developed countries, in practice the most important aspect of it was the energy-saving target for regulated firms. The program was implemented by local officials who faced strong incentives to ensure compliance, as a failure to meet specific energy-use targets would make them ineligible for bonuses or promotions. According to official assessments, the goal of reducing consumption by 100 million tons of coal equivalent was achieved two years ahead of schedule, and more than 98 percent of firms met their energy-saving goals.

As with any regulation, the effectiveness of this policy depends on firm-level responses and on whether regulated firms account for a substantial share of the economic activity within a given industry. One concern is that ownership networks can partly determine the scope for firm responses and impact measures of industry concentration. Regulated firms could escape the burden of the regulation by substituting production to unregulated firms that are part of the same conglomerate. Similarly, ignoring ownership links may bias our understanding of whether the regulated firms influence a significant share of industrial activity. We investigate these channels using business registration data to map the ownership networks of Top 1,000 firms. These data capture the scope for firms to comply with the letter of the regulation while substituting production to related firms. To further understand how ownership networks impact measures of industrial concentration, we focus on three specific industries: iron and steel (smelting and pressing of ferrous metals; henceforth "iron"), chemical (manufacturing of raw chemical materials and chemical products; henceforth "chemical"), and petroleum and petrochemical (extraction of petroleum and natural gas and processing of petroleum; henceforth "petroleum"). Together, firms in these industries account for close to 60 percent of the energy use of Top 1,000 firms.

II. Mapping Business Conglomerates

Our analyses focus on firms in the Top 1,000 program (National Development and Reform Commission 2006). We obtain the list of regulated firms from the National Development and Reform Commission and use business registration data from China's Administrative Registration Database (CARD) (State Administration of Industry and Commerce 1949–2015) to characterize their business networks. These data measure firm age, location, and registration capital

as well as links to related firms and legal persons. We study four types of linkages: (i) affiliates, which are fully owned and controlled by regulated firms;[1] (ii) investment relations, that is, firms at which regulated firms have an investment stake; (iii) shareholders, which fully or partially own regulated firms; and (iv) shareholder investment relations, that is, firms that have shareholders in common. Online Appendix Figure 1 displays examples of these relations. In each panel, the firm shaded in gray is regulated as part of the Top 1,000 program, firms without shading are related firms that are in the same industry as the regulated firm, and the numbers denote the ownership stake.

We make three refinements to our measures of business networks. First, we include two levels of ownership layers. Second, we focus on firms that are related by at least 25 percent of ownership in each layer. Finally, to characterize the ability to substitute production output, we limit relations to firms in the same manufacturing industry.[2]

One concern is that some firm relations may correspond only to conduit or shell firms. To ensure that our business networks capture real economic activity, we merge two additional datasets. First, we use data from the Annual Survey on Industrial Firms (ASIF) (National Bureau of Statistics 2004) to measure firm output. Second, we use data from China's Environmental Statistics Database (CESD) (Chinese Ministry of Environmental Protection 2004) to measure energy use. The sampling of the ASIF ensures that we observe a census of firms above a size threshold of ¥5 million ($800,000). The sampling of the CESD differs in that it captures the main polluting firms in each county. Both datasets have very good coverage of Top 1,000 firms; we find 99 percent of firms in the ASIF and 80 percent in the CESD.

Restricting related firms to those in the same two-digit industry with data in the ASIF yields a total of 3,992 related firms. While Top 1,000 firms have an average of 4.0 related parties, we find considerable dispersion in the size of these conglomerates. Figure 1 plots the distribution of the number of related firms for each Top 1,000 firm with related parties. While some firms have many linkages, we also find that 435 Top 1,000 firms have no related parties in the same manufacturing industry.

III. The Role of Business Groups in Measures of Industry Concentration

We first measure the overall importance of Top 1,000 firms for the nine energy-intensive industries targeted by the regulation. The total number of firms in these industries in the ASIF is 94,183 in 2004. Top 1,000 firms account for 1.05 percent of these firms. Given their size, Top 1,000 firms account for 34.63 percent of output in these industries. Once we account for firms that are part of the same conglomerate, we find that the program impacts 3.04 percent of firms, which are responsible for 46.31 percent of output.[3] As an alternative measure, we use business registration data to calculate that the Top 1,000 firms account for 11.66 percent of paid-in capital in these industries and that this fraction increases to 34.93 percent when we include related firms.[4]

Accounting for business groups also impacts measures of industrial energy-use concentration. Using data from the CESD, we find that Top 1,000 firms account for 32.89 percent of energy use in these industries, a number that increases to 48.06 percent when including related parties.[5]

These statistics show that it is important to include business networks when measuring the contribution of Top 1,000 conglomerates to these industries. To account for technological differences across industries, we further study three of the largest industries in the Top 1,000

[1] Affiliated firms have no additional shareholders. Note that the CARD data does not include firm relations when Top 1,000 firms are themselves affiliates of other firms.

[2] We describe our data-cleaning process and provide examples of firm linkages in our companion paper, Chen et al. (2021).

[3] One potential concern is that our measures exclude smaller firms that are not part of the ASIF. Since the ASIF includes most medium and large firms, the excluded firms are unlikely to contribute a large fraction of output. Moreover, small firms would also impact the overall size of the industry, leading to ambiguous effects on our measures of concentration.

[4] Results are robust to adjusting capital by the GDP deflator.

[5] Measures of output concentration are robust to using CESD data: Top 1,000 firms correspond to 1.87 percent of the number of firms and 37.11 percent of output; these numbers increase to 3.98 percent and 43.72 percent when we include related parties.

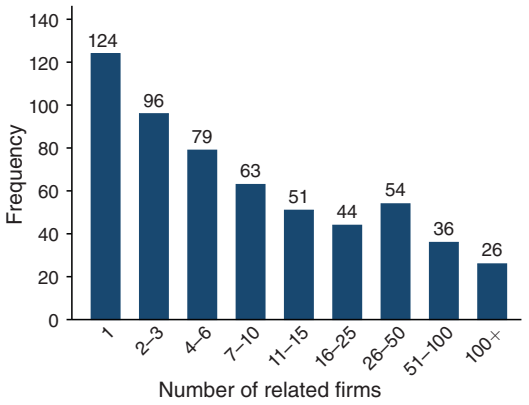

FIGURE 1. NUMBER OF RELATED FIRMS

Notes: Authors' calculations using data from ASIF and CARD. This figure describes the distribution of the number of related firms for each Top 1,000 firm with related parties (in the same two-digit industry).

program: iron, chemical, and petroleum. These industries include 563 Top 1,000 firms, which have 1,191 related firms in the same industry. The importance of conglomerates varies across these industries, with regulated firms in iron production having on average 1.7 related parties, those in chemical having an average number of 3.0 related parties, and those in petroleum having on average 0.8 related parties. In the iron industry, Top 1,000 firms account for 60.68 percent of the output, and this number increases to 67.78 percent when including related parties. In contrast, Top 1,000 firms in the chemical industry account for 25.18 percent of output, and 29.89 percent once we include related firms. Finally, Top 1,000 firms in the petroleum industry account for 80.89 percent of output, and 85.01 percent once we include related firms. Despite the differential concentration patterns in Top 1,000 firms, we consistently find that accounting for business networks leads to significant upward revisions of measures of industry concentration.

Conglomerates also matter when measuring the concentration of energy use. Accounting for business networks increases the fraction of energy use by Top 1,000 conglomerates from 77.39 percent to 79.92 percent in the iron industry, 43.03 percent to 47.89 percent in the chemical industry, and 59.88 percent to 62.42 percent in the petroleum industry.

IV. Business Groups in Space

In addition to impacting industry-level measures of concentration, Top 1,000 firms could also disproportionately impact economic activity in certain regions. Table 1 shows the number of Top 1,000 firms in selected provinces. Although most provinces have at least several Top 1,000 firms, provinces surrounding Beijing have a larger number. Specifically, the four provinces of Hebei, Shandong, Shanxi, and Henan account for around 40 percent of Top 1,000 firms.

Given the fact that Top 1,000 firms are mainly located in a few provinces, conglomerates may invest in affiliates to access different markets. While this may be a primary concern for service and retail firms, it may also influence the organization of industrial firms. Alternatively, firms may opt to invest in new affiliates when their growth prospects are otherwise limited by constraints in their input use, including land, managerial talent, or inadequate local infrastructure. We evaluate these hypotheses using CARD and ASIF data. We find that 74.49 percent of firms in conglomerates with a Top 1,000 firm operate in the same provinces served by related Top 1,000 firms. To take into account the fact that related firms are smaller than Top 1,000 firms, we also compute that 83.06 percent of the conglomerates' output is concentrated in the same province as the Top 1,000. Using CESD data, we find that 86.00 percent of the conglomerates' energy use is concentrated in the same province as the Top 1,000. This result is important, as it characterizes the scope for regional redistribution of pollutants. That is, since most of the energy use in a conglomerate is concentrated in the same province, if conglomerates were to respond to the regulation by moving production and energy use across affiliated firms, it is unlikely that this would result in a significant change in the location of pollution across China.

We now study whether these patterns differ across industries. For the iron industry, 91.04 percent of the firms and 98.08 percent of the output of a given conglomerate occurs in the same province as the Top 1,000. These numbers are lower for the chemical industry (85.35 percent of firms, 95.51 percent of output in the same province) and for the petroleum industry (83.33 percent of firms, 96.68 percent of output).

These results suggest that conglomerates do not primarily use related firms in the same industry to access new or distant markets. Instead, they suggest that individual firms face limits to growth or expansion that may be surmounted only by investing in a new affiliated firm.

V. Conclusion

This paper showcases the importance of accounting for business conglomerates when evaluating the effects of energy regulations. We document two important facts. First, the share of industry output that is directly or indirectly affected by the regulation increases from 34.63 percent to 46.31 percent when accounting for ownership networks. Second, conglomerates are geographically concentrated: 74.49 percent of firms in conglomerates are in the same province as Top 1,000 firms, and the share of output in the same province as the Top 1,000 firm is 83.06 percent.

These new facts raise important issues for understanding the effects of energy regulations. The large number of related firms suggests that regulated firms have significant scope to shift production to firms that are part of the same conglomerate. In Chen et al. (2021), we provide a full accounting of the effects of the policy on energy use and energy efficiency as well as how the ability to shift production to unregulated firms lowered the regulatory burden of the program.

Table 1—Top 1,000 Firms by Province

Province	All	Iron	Chem.	Petro.
Hebei	112	52	21	4
Shandong	103	14	32	11
Shanxi	90	23	17	0
Henan	82	14	14	4
Subtotal	387	103	84	19
Other	621	122	167	68

Note: This table reports the number of Top 1,000 firms for selected regions using data from CARD and ASIF.

REFERENCES

Allen, Franklin, Junhui Cai, Xian Gu, Jun Qian, Linda H. Zhao, and Wu Zhu. 2020. "Ownership Networks and Firm Growth: What Do Forty Million Companies Tell Us About the Chinese Economy?" Unpublished.

Backus, Matthew, Christopher Conlon, and Michael Sinkinson. Forthcoming. "Common Ownership in America: 1980–2017." *American Economic Journal: Microeconomics*.

Bai, Chong-En, Chang-Tai Hsieh, Zheng Michael Song, and Xin Wang. 2020. "Special Deals from Special Investors: The Rise of State-Connected Private Owners in China." NBER Working Paper 28170.

Boller, Lysle, and Fiona Scott Morton. 2020. "Testing the Theory of Common Stock Ownership." NBER Working Paper 27515.

Chen, Qiaoyi, Zhao Chen, Zhikuo Liu, Juan Carlos Suárez Serrato, and Daniel Yi Xu. 2021. "Regulating Conglomerates: Evidence from an Energy Conservation Program in China." Unpublished.

Chinese Ministry of Environmental Protection. 2004. "Chinese Environmental Statistics Database." Chinese Ministry of Environmental Protection.

National Bureau of Statistics. 2004. "Annual Survey on Industrial Firms." National Bureau of Statistics.

National Development and Reform Commission. 2006. *Notice on the Implementation Plan for the Top-1000 Energy Saving Program (Development, Reform, Environment and Resource No. 571).* Beijing: National Development and Reform Commission.

Price, Lynn, Xuejun Wang, and Jiang Yun. 2010. "The Challenge of Reducing Energy Consumption of the Top-1000 Largest Industrial Enterprises in China." *Energy Policy* 38 (11): 6485–98.

State Administration of Industry and Commerce. 1949–2015. "Chinese Administrative Registration Database." State Administration of Industry and Commerce.