



More than half of China's CO₂ emissions are from micro, small and medium-sized enterprises

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HIGHLIGHTS

- Firm size and ownership information is crucial in analyzing China's carbon emissions.
- MSMEs produced 53%, induced 65% of China's CO₂ emissions along domestic supply chains.
- Private MSMEs in the non-metallic mineral sector should be the key for policy-making.
- Given the abundance of MSMEs, taxation is suitable for further emissions reduction.
- Reducing environmental externalities in China need more supply-chain based governance.

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ABSTRACT

To date, the burden of CO₂ emissions reductions has been largely confined to large enterprises in China. Using new data with firm ownership and size information included, we show that micro, small and medium-sized enterprises (MSMEs) produced 53% of China's CO₂ emissions in 2010. Detailed supply-chain analysis reveals that final demand for products made downstream by domestic-private MSMEs, along with exports made downstream by foreign-owned MSMEs, are the main drivers of China's CO₂ emissions. Most of these emissions occur upstream in the electricity and heat sector, which is mainly controlled by large, state-owned enterprises with the highest carbon intensity, and the non-metallic mineral sector, which consists of a very large number of domestic-private MSMEs with lower levels of enforcement of emissions regulations. Overall, MSMEs induced 65% of China's CO₂ emissions through their supply chains. Our conclusion is that understanding the role of firm size for China is important in developing emissions reduction policies: given the very high per-enterprise overhead of emissions trading systems, and the abundance of MSMEs, our results clearly favour taxation.

1. Introduction

In 2015, China submitted its Intended Nationally Determined Contribution (INDC), including targets to "...peak CO₂ emissions by

2030 at the latest, lower the carbon intensity of GDP by 60–65% below 2005 levels by 2030..." [1]. While all of these commitments were made by the central government, they must be implemented at the firm level following a top-down policy process. Given the immense size of China

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as well as various pressures from the requirement of sustainable development, it is unclear if policies should prioritise small or large enterprises, state-owned, foreign-owned, or domestic-private enterprises. This is a crucial issue since different types of firms may have very different production functions, even when they are allocated to the same economic industry, thus may give very different responses to the same environmental policy.

To date, the burden of emissions reductions in China has been distributed to the provincial and city level following a top-down administrative process, and implementation and enforcement is largely confined to key sectors and large enterprises [2]. For example, the “Notice of Issuance of the Thousand Enterprise Energy Saving Action Implementation Plan” published by the National Development and Reform Commission of China [3], was the most important arm for emission reduction policies, covering only about 1,000 large energy and emission intensive enterprises, most of them state-owned. The coverage of the implementation plan was expanded to 10,000 enterprises in 2011 [4], but still covered only large emitters, which represented a very small proportion of the 11.9 million officially registered enterprises in China in 2011 [5]. When using a policy that requires tailored application to individual firms, focussing on a relatively small number of enterprises significantly reduces the administrative burden (e.g. monitoring, reporting, and verification costs for emissions) compared with coverage of all enterprises. Such policies become prohibitively burdensome to scale up. As a result, most important environmental policy targets in China, such as the domestic emissions trading schemes, emissions monitoring and enforcement targets, and subsidies and financial supports for green investment, tend to cover large enterprises and is limited to key industries.

The current focus on large enterprises assumes that these large companies are the major contributors to emissions and therefore they have been considered a low-hanging fruit for emission reduction policies. However, the total number of enterprises with official registration records increased from 9.7 million at the end of 2008 to 19.3 million at the end of April 2015 [6,7], of which more than 99%¹ were micro, small and medium-sized enterprises (MSMEs). Meanwhile, MSMEs accounted for 65% of China’s GDP, 50% of the country’s taxation revenue, 68% of national exports, and provided more than 75% of total employment at the end of 2014 [9]. The importance of MSMEs in the Chinese economy has been emphasized in a substantial amount of literature both academic research and business practice, but very little scientific and systematic evidence has been provided to show how much of China’s CO₂ emissions are generated and driven by MSMEs at sector level and by firm type. This may directly influence environmental policy-making in China in which the importance of MSMEs in carbon emissions reductions has received little attention (e.g. [10]).

There have been only few studies on the measurement of CO₂ emissions and carbon footprints for China that explicitly consider firm heterogeneity exploring firm ownership and trading pattern information. Dietzenbacher et al. [11] showed that estimates of China’s carbon emissions as embodied in its exports are reduced by more than 60% when firms who conduct processing exports and normal exports are separated in the Chinese input–output (IO) table. A similar phenomenon has also been pointed out by Su et al. [12], namely, the estimate of CO₂ emissions embodied in China’s exports drops by 32% when the extended IO model with information on processing exports is used. As an extension, Jiang et al. [13] found that China’s CO₂ emissions responsibility for each Yuan of national income from foreign-invested enterprises’ exports, is actually higher than that attributable to Chinese

owned enterprises’ exports when using a recently developed environmental IO framework with firm ownership and trade mode information reported. Most recently, Liu et al. [14] further showed that ignoring firm heterogeneity causes embodied CO₂ emissions in Chinese exports to be overestimated by 20% at the national level, with huge differences at the sector level. They also pointed out that this overestimation is because different types of firm that are allocated to the same sector of the conventional Chinese IO table vary greatly in terms of market share, production technology and carbon intensity.

On the other hand, there is only limited research emphasizing the importance of firm size in studying energy efficiency and carbon emissions for China,² but most of these are at the sector level. For example, Teng and Gu [22] recommended that since half of China’s emissions and pollution come from small and medium sized enterprises (SMEs) with limited ability and resources, the government should provide special financial and capacity building support to SMEs. However, they did not provide relevant evidence to support this conclusion. Wang and William [23] found that a large number of SMEs operate nonferrous metals production facilities which rank low in energy efficiency and therefore are highly energy intensive per unit of output. Based on a survey, they found that encouraging recycling is considered one of the most important tools for policy makers to help SMEs increase energy efficiency. Kostka et al. [24] studied financial, informational and organizational barriers to energy efficiency investments for SMEs in China based on a survey of 480 SMEs in Zhejiang province. They found that informational barriers are the core bottleneck inhibiting energy efficiency improvements for China’s SMEs, and suggest that the Chinese government could play a more active role in fostering the dissemination of energy efficiency related information for SMEs. Wei et al. [25] performed statistical tests and found that large power enterprises in Zhejiang are less efficient in 2004, but became more efficient in 2008 than small power enterprises in terms of energy utilization and CO₂ emission based on the 2004 and 2008 Census data of Zhejiang province. Peng et al. [26] analysed the energy efficiency and carbon dioxide reduction in the Chinese pulp and paper industry in which 88.7% are SMEs. They found that this industry has further capabilities for energy-saving and carbon dioxide emission reduction by improving energy efficiency, and emphasize that policies for altering enterprise size are the most practical options to improve the energy efficiency of the pulp and paper industry at realistic levels. Cai et al. [27] evaluated the overall CO₂ emissions from cement industry based on the detailed information of China’s total 1,574 cement enterprises in 2013. They found that SMEs contributed 38.1% of the total emissions in the cement industry; the total emission intensity for small, medium and large sized cement enterprises were respectively 0.896, 0.822, 0.814 t CO₂/t clinker. Their conclusion suggests that ownership of cement enterprises should be carefully considered in policies; favorable policies could focus on medium-sized facilities and facilities in foreign-invested enterprises. However, all the above studies rely on production-based energy and emissions accounting using survey data of a specific industry, rather than give a national view covering all industries and all types of firms in terms of their ownership and size. In addition, these studies could not provide more detailed analyses about energy or carbon footprints from a consumption-based accounting perspective due to the lack of IO data with available firm heterogeneity information included.

In this paper, we use a novel database, an augmented Chinese IO table for the year 2010 [28], in which information about firm size and ownership are explicitly reported, to investigate which types of

¹ There is no relevant information about the number of large enterprises in SAIC’s statistics, but the number of large manufacturing enterprises based on the China’s National Statistics Bureau (NBS)’s definitions on “enterprises above designated size” was never more than 10,000 in the period of 1998–2015 [8].

² For other countries, concerning the study about energy efficiency with information of firm size, one can refer to Cagno and Trianni [15], Trianni et al. [16] for Italy, Meath et al. [17] for Australia, Thollander et al. [18] for Japan and Sweden, Paramonova and Thollander [19] for Sweden, Agan et al. [20], for Turkey, Henriques and Catarino [21] for Portugal.

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