Smoothing the impact of China's coal transition on employment and net fiscal revenues, with a focus on Inner Mongolia and Jing-Jin-Ji

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Overview

China is home to over half of global coal power generation capacity. In 2020, new coal power approvals accelerated, accounting for 75% of commissioned capacity and 85% of coal power under development in 2020 globally. In September 2020, President Xi Jinping announced a 2060 carbon neutrality target and a peak in emissions 'before 2030'. Reaching net zero by 2060 will require the unabated use of coal for electricity generation to be largely phased out in China by the mid-2050s under a 2C global warming scenario, or mid-2040s under a 1.5C scenario, with the remaining industrial and domestic use of unabated coal being removed by 2060.

The progressive mechanisation and centralisation of coal production has already been associated with a continuous decline in employment in the coal mining, washing, transport and combustion industries in China. Part of the challenge for China's government is confronting the scale of the 'stranded labour' problem coal phase-out will generate in the absence of effective planning. To realise its net zero ambitions, China will need to transition at least some workers with skill sets relevant to coal production, towards zero-carbon energy production and manufacturing. Short-term measures to replace lost tax revenues from coal may include dedicated transition funding from central or supranational governments, but in the longer-term governments must find ways of replacing these revenues without unnecessarily slowing the development of clean energy and production.

Climate policy aside, national statistics place the number of jobs in coal mining and dressing at a peak of 5.3 million in 2014, falling to 4.5 million in 2015, 2.85 million in 2019 and 2.68 million in 2020 (CEIC, 2020). This decline, of nearly 50% in six years, reflects a combination of small mine closures and falling labour intensity

Methods

To assess the potential employment and fiscal effects of a coal phase-out in China over time, a model was constructed to link employment in the coal power sector and coal mining industries to the building and retirement of plants from 2021 to 2060. The model accounts for every operating or planned coal power plant in China, using a composite dataset updated in February 2021. Coal consumption is estimated using 2019 estimated province-level utilisation rates to avoid pandemic-related distortions in early 2020 and corresponding coal consumption, which varies depending on the type of plant (subcritical, supercritical, or ultra-supercritical) and its operating efficiency.

Since data on coal trading between provinces and the type of coal produced in each province is not readily available for this project, we assume that each province produces the same ratio of thermal to non-thermal coal, satisfies its own internal demand for coal, and imports coal from other provinces to cover the shortfall according to the distribution of coal supplies remaining once each province meets its internal demand. In effect, this means that the three largest coal producers supply almost 97% of the interprovincial coal trade: Inner Mongolia (an estimated 379 million tonnes coal equivalent (mtce) in 2021, 38% of the total), Shanxi (401 mtce, 40%), Shaanxi (191 mtce, 19%). China imported 21% of coal consumed in 2019, which is used as the baseline year due to pandemic-related distortions. In 2017, thermal coal (for use in power generation) made up 69.4% of imports; this analysis assumes 70%. The proportion of thermal coal demand met domestically is thus 85.3%.

Associating coal plants with mines in this way makes it possible to link the operation (and retirement schedule) of specific plants with upstream mining jobs (both locally and externally to the province) and associated tax revenues. Since the labour intensity figures used here are dated from 2015, adjustments are applied to the most labour-intensive provinces to reflect changes in industry characteristics in the past five years. By 2050, the labour intensity of coal mining is assumed to decline linearly, starting in 2015, to converge on the Inner Mongolia figure of 1.7 jobs per 10,000 tonnes of production, the most labour-efficient of all provinces.

Income taxes and social security payments are then estimated based on total employees. Income taxes are calculated according to the Chinese government's income tax brackets. This analysis assumes 20% of gross employee salary is deducted from wages as social security payments, and 30% of salary value is paid by the employer. China introduced reforms to pollutant taxation in 2018 under the 'Environmental Pollution Tax' regulation, in which emissions of specific pollutants are taxed either at a fixed rate or within a range specified by each province. Additional fees are paid by coal mines in the form of royalties and specific charges, as well as volume-based resource taxes, and value-added tax. Total tax revenues to central government include income taxes, prospecting, and exploration fees, 20% of mining royalties, and VAT. Total revenues to provincial governments include environmental pollution taxes, resource taxes, and 80% of mining royalties.

It is not possible with available data to measure subsidies paid to the coal industry on a plant-level basis or in most cases to distinguish between subsidies benefiting coal power generation versus coal use in industry and heating, so an approximate aggregate national subsidy estimate is used as a point of reference.

Under the baseline scenario, each new plant operates for 30 years, implying that coal use in electricity generation will not quite be fully phased out by 2050. Currently operating plants more than 30 years old are assumed to operate for 35 years, plants more than 35 years old, for 40 years, and all plants more than 40 years old are assumed to retire the following year. In the first alternative scenario, 'R', the trajectory of accelerated plant closures is calibrated to correspond to match the projected rate of coal capacity decline between 2020 and 2030 in the low-cost renewable energy scenario in He et al. (2020), a power system model that optimises for cost given a set of energy technology prices and carbon constraints. In the second and third scenarios, 'C50' and 'C80', coal capacity declines in absolute terms by 2030 to meet power sector emissions constraints of 50% and 80% below 2015 levels.

Results

In the baseline scenario, employment in coal mines starts at a higher level (1.4 million) but follows a steep downward trajectory, declining almost 50% by 2035. Employment in plants (starting at 500,000) falls by less than 30% in the same period. This reflects the effect of declining labour intensity in coal mining and the slow pace of plant retirements up to about 2034. From this point onwards, overall job losses accelerate as the pace of plant retirements increases, slowing slightly again in the 2040s and declining to zero in 2054 as the wave of plants built in the decade to 2020 reach the end of their operating lifetimes. Total coal power industry employment is projected to drop below 1 million by 2036, 500,000 by 2042, and 250,000 by 2045.

The trajectory of fiscal revenues does not decline as sharply and in fact rises slightly in the short term. Income taxes and social security payments fall with the decline in employment, but total revenues rise initially since coal capacity does not peak until 2023 and taxes on capital (notably resource and environmental pollution taxes to local governments, and VAT to central government) are a greater proportion of total revenue. Fiscal revenues to central government decline slowly to ¥200 billion in 2030, before beginning to fall steeply around 2035 as coal retirements accelerate and capital-based revenues fall to ¥100 billion in 2040 and ¥20 billion in 2050. Revenues to provincial governments are roughly four times smaller, but follow a similar trajectory, as do social security payments. When compared to the estimated annual subsidy level of ¥300-350 billion annually, the total of approximately ¥260 billion in total tax revenue suggests the coal industry is already a net fiscal drain on Chinese government resources, and likely to become more so as the revenues associated with capital assets fall increasingly quickly.

The R scenario has relatively little impact on total employment, leading to just 100,000 fewer jobs in 2030 relative to the baseline. The differential between the two widens slightly to a maximum of about 300,000 in 2035, before narrowing and falling to zero in the late 2040s. Under the C50 scenario, which implies a coal phase-out by 2040, about 750,000 additional job losses would be expected by 2030, while under the C80 scenario, well over 1 million additional job losses would be expected by 2030, almost 90% of coal power industry employment at present, with the remaining jobs phased out by 2035. The fiscal picture is somewhat different for the first two scenarios. Total tax revenues remain relatively stable up to 2030 under the R scenario and decline rapidly thereafter following much the same trajectory as the baseline, but five years sooner, declining to zero in the late 2040s. In the C50 and C80 scenarios, the trajectory is similar after a sharp initial fall, with subsequent rates of decline tracking the baseline, but starting 11 years and 16 years sooner respectively.

Conclusions

For China, a total phase-out of unabated coal use by 2060 is effectively inevitable, and the pathways for doing so are increasingly clear in the power sector. However, the total number of mining and plant jobs at risk by 2050 is less than the total number of jobs shed from 2014-2020. Even under the most ambitious scenario (80% decline in 2030 emissions compared to 2015), coal employment does not fully disappear until 2035. The labour transition challenge facing China is therefore not unprecedented. The majority of tax revenues from coal flow to central government and are unlikely to decline until the 2030s. Coal-producing provinces like Inner Mongolia are more dependent on provincial tax revenues, both accentuating the need for diversification and making it more politically challenging to achieve.