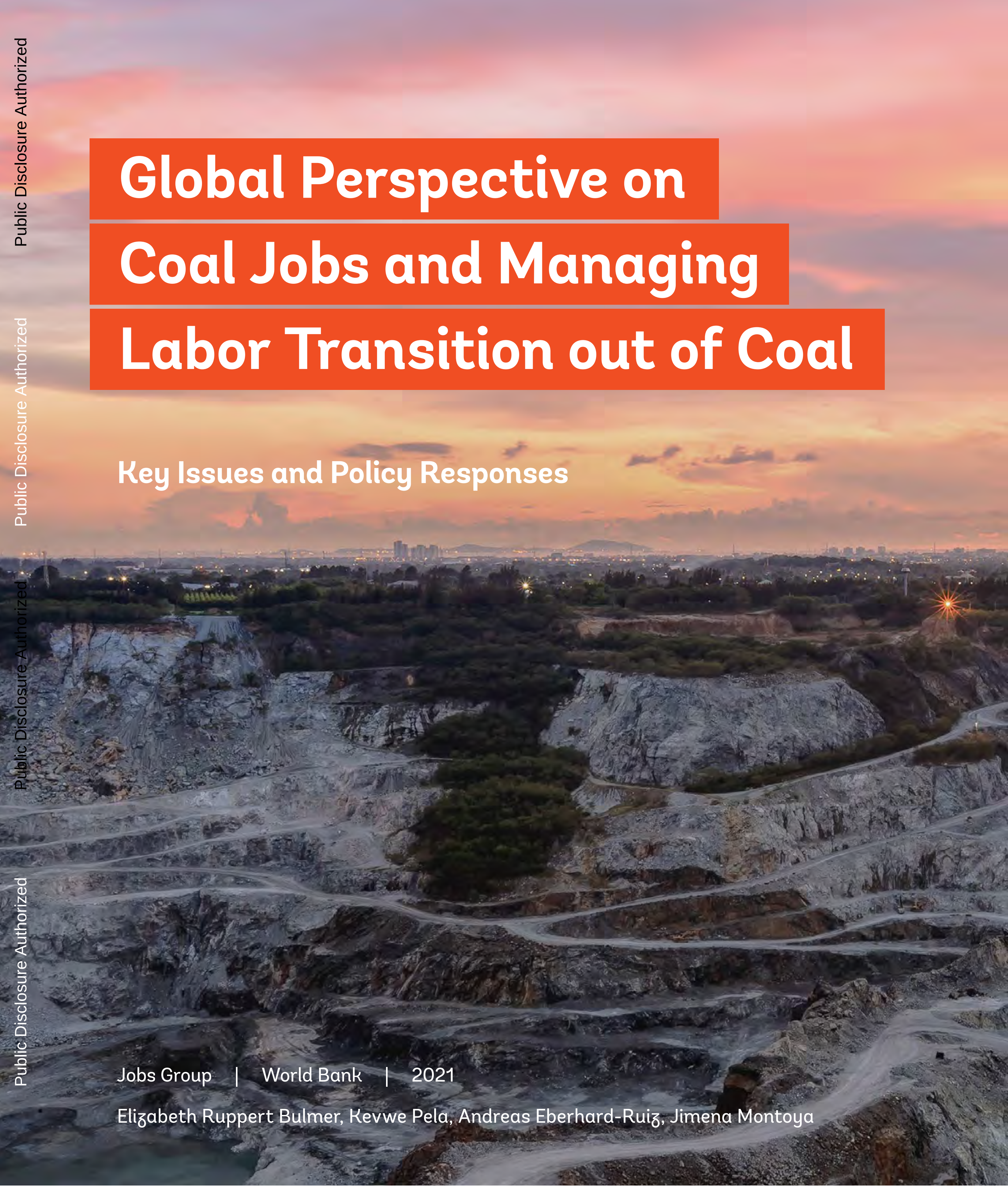

Global Perspective on Coal Jobs and Managing Labor Transition out of Coal

Key Issues and Policy Responses

Jobs Group | World Bank | 2021

Elizabeth Ruppert Bulmer, Kevwe Pela, Andreas Eberhard-Ruiz, Jimena Montoya

ESMAP Energy Sector Management Assistance Program

WORLD BANK GROUP

EGPS Extractives Global Programmatic Support

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Acknowledgments

This study was carried out by Elizabeth Ruppert Bulmer (Team Leader, Lead Economist), Kevwe Pela (Economist), Andreas Eberhard-Ruiz (Economist) and Jimena Montoya (Consultant), Jobs Group, World Bank. Excellent research assistance was provided by Ami Shrestha, consultant for the Jobs Group. The work was commissioned under the Global Support to Coal Regions in Transition (P171194), led by Michael Stanley (Lead Oil and Gas Specialist, Infrastructure, Energy and Extractive Industry Group). Strategic guidance was provided by Rohit Khanna (Practice Manager, Infrastructure, Energy and Extractive Industry Group) and Ian Walker (Manager, Jobs Group), under the senior leadership of Demetrios Papathanasiou (Global Director, Energy and Extractives) and Michal Rutkowski (Global Director, Social Protection and Jobs). The team expresses particular thanks to the many country team colleagues in Indonesia, South Africa and India who supported this extensive research effort. The team is grateful for thoughtful comments by Sheoli Pargal (IEEXS), Harshit Agrawal and Balada Amor (IEEXI), Abhinav Goyal (ISAE1), Franz Gerner, Mariano Salto and Frederic Verdol (IAEE3), Catrina Godinho (SCCDR), and Michal Hetmanski (energy.instrat.pl). The final report benefited from insightful feedback by peer reviewers Grzegorz Peszko (Lead Economist, SENGL), Achim Schmillen (Practice Leader, HEADR), Zuzana Dobrotkova (Senior Energy Specialist, IEEES) and Erik Caldwell Johnson (Senior Social Development Specialist, SCASO).

Financial support from the Energy Sector Management Assistance Program (ESMAP) and the Extractives Global Programmatic Support (EGPS) Multi-Donor Trust Fund is gratefully acknowledged. Through the World Bank Group (WBG), ESMAP works to accelerate the energy transition required to achieve Sustainable Development Goal 7 (SDG7) to ensure access to affordable, reliable, sustainable, and modern energy for all. The EGPS Multi-Donor Trust Fund helps resource-dependent developing countries manage their oil, gas, and mining resources to support poverty reduction and boost inclusive, sustainable growth and development.

Abbreviations

ALMP	Active Labor Market Policy
ARC	Appalachian Regional Commission
BP	British Petroleum
BPS	Badan Pusat Statistik
CO2	Carbon Dioxide
COP 24	Conference of the Parties 24
DMO	Domestic Market Obligation
ECA	Europe and Central Asia
EIA	Energy Information Administration
EU	European Union
EUS	Employment – Unemployment Survey
GDP	Gross Domestic Product
GLD	Global Labor Database
GHG	Green House Gas
GTAP	Global Trade Analysis Project
GWh	Gigawatt Hour
HIC	High-Income Country
IC	Intermediate consumption
IEA	International Energy Agency
IESR	Institute of Essential Services Reform
ILO	International Labour Organization
ILOSTAT	International Labour Statistics
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producer
Ktoe	Kilotonne of oil equivalent
LFS	Labor Force Survey
LIC/LMIC	Low-Income Country/Lower-Middle Income Country
MEMR	Ministry of Energy and Mineral Resources
MOSPI	Ministry of Statistics and Programme Implementation
MT	Million tonnes
NDC	National Determined Contribution
NEET	Not in Employment or in Education or Training
OECD	Organization for Economic Cooperation and Development
OHS	October Household Survey
PEG-CPR	Prayas Energy Group and Centre for Policy Research
PEP	Poland Energy Policy
PGE	Polska Grupa Energetyczna
PGG	Polska Grupa Gornicza
PLFS	Periodic Labor Force Survey
PLN	Polish currency (zloty)
PPU	Power Production Unit
PSE	Polskie Sieci Elektroenergetyczne
QLFS	Quarterly Labor Force Survey
RUEN	National General Plan on Energy
SA	South Africa
STEM	Science, Technology, Engineering and Mathematics
TJ	Terajoule
TWh	Terawatt Hour
UK	United Kingdom
UMIC	Upper Middle-Income Country
UNFCC	United Nations Framework Convention on Climate Change
US	United States
WDI	World Development Indicators
WWF	World Wildlife Fund

Glossary of Terms

Coal mining sector
The industry category established in the UN's International Standard of Industrial Classification of All Economic Activities (ISIC) Revision 4, classified under code 05, the 2-digit category for coal and lignite mining, which falls under the 1-digit category for mining and quarrying.

Coal mining job
Any type of employment (formal or informal) within the coal and lignite ISIC sector classification.

Coal sector
Economic activity along the coal value chain, including coal and lignite mining, coal-fired power plants, coal transport, steel production, etc.

Direct coal mining job
Job at a mine or for a mining company whose activity falls under the ISIC sector classification. Includes mining occupations and non-mining management, administrative and support occupations within a mining company.

Indirect jobs linked to coal
This category comprises: (i) jobs related to the coal supply chain, such as transporters of coal, or jobs that provide goods or service inputs for the extraction of coal or its downstream industrial uses, including in power plants; and (ii) jobs induced by coal activity, such as jobs that produce goods and services consumed by coal mine workers and their families (often referred to as "induced" jobs).

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Executive Summary

The widely-shared objective of transition to cleaner energy and reduced dependence on coal presents tremendous challenges, not only to coal sector producers and workers, but because of the broader implications for other sectors in coal-producing nations. A large proportion of energy infrastructure is built around coal-fired power plants (even in non-coal producing countries), economic production structures are energy-intensive, and coal value chains are long. In regions where coal mining takes place, the effects of transition cut very deeply, especially in small, remote mining communities where the local economy depends on coal. The transition can create multiple disruptions: to jobs – both direct and indirect, to household incomes, to local economies heavily tied into the coal supply chain, to community well-being and social capital, and to local and regional government capacity and fiscal solvency.

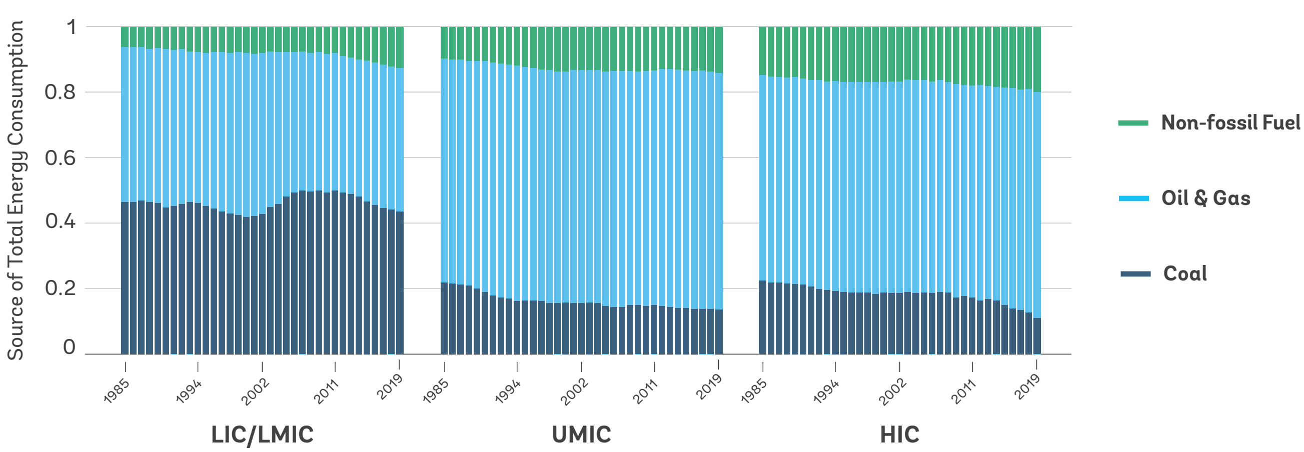
This issues paper analyzes the status of coal phase-out around the world, the magnitude and character of coal mining jobs and their spillovers in local economies, and the challenges associated with future labor transition. The analysis exploits differences in transition stages to draw lessons from countries that have experienced coal mine closures in the past, and uses these lessons to inform policy responses in the context of future decarbonization, with particular attention to facilitating the transition of directly and indirectly affected workers – whether formal or informal – into alternative employment.

This report is part of a broader multi-sector effort by the World Bank to support coal regions confronting the realities of decarbonization and help lay the groundwork for achieving a just transition for all. The World Bank framework of support comprises three pillars: institutional governance, people and communities, and environmental remediation and repurposing land and assets. By focusing on pillar two, this paper deepens existing analysis and extends the policy discussion beyond issues related to displaced mine workers to consider the wider implications for local labor markets and sustainable recovery of regional economies. The policy framework articulated in this global report is intended to guide future country-specific engagements through which detailed policy recommendations could be developed to address a particular country or sub-regional context.

At the global level, coal-based energy production has risen steadily over the past 40 years, to a large degree driven by rising energy demand in the industrializing economies of the world. Many countries undergoing rapid structural transformation since 1991 depend on coal. As former coal powerhouses in Europe as well as the U.S. transitioned away from coal and shifted their priorities toward alternative sources of power generation, they have been replaced by rapidly scaling coal extraction in other regions of the world. Increased electricity consumption is the main component of this energy demand, and coal is the largest fuel source for electricity worldwide. The developing world more than doubled its per capita electricity consumption since 1990.

Figure 0.1

Energy consumption by source (1985-2019)



Note: Country income classification on the basis of 1991 WB classification

Source: Author's calculations based on BP Statistical Review of World Energy

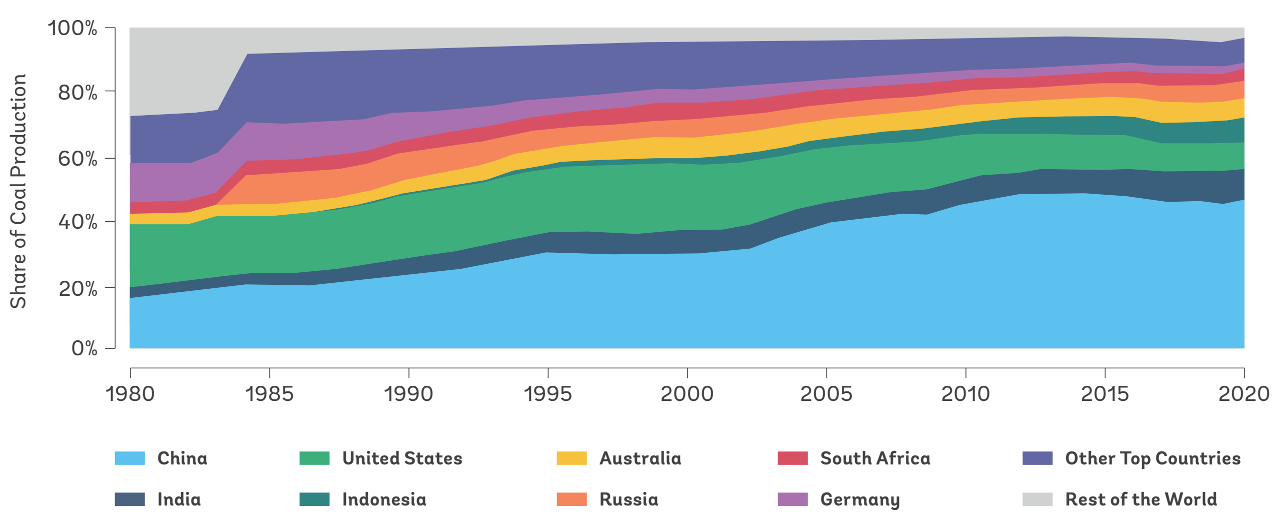
Inexpensive coal-based energy has played a prominent role in many countries' economic development, especially in the early stages of structural transformation. Structural transformation occurs as jobs shift from low-productivity primary sectors into higher productivity industry and ultimately into more skilled services sectors. As low and lower-middle income countries industrialized, they increased both their coal consumption and their coal dependence. Part of this is due to higher electricity demand and the prevalence of coal-fired power generation, but part stems from the use of coal-derived products other than electricity in many manufacturing subsectors, such as the steel industry. And in countries that are coal producers, these effects are magnified, suggesting that access to inexpensive energy helps to accelerate industrialization. In upper middle-income and especially high-income economies that are in more advanced stages of structural transformation, we observe a decline in coal dependence, due to increasingly services-centered economies and an accelerating shift to cleaner and more sustainable sources of energy and electricity generation. Coal meets nearly half of low and lower-middle income countries' energy needs and more than half of their electricity consumption, but coal-intensity declines as country incomes rise.

The world's increasing demand for coal is being met by a shrinking pool of large coal producers. China is dominant – it accounts for about half of global production and consumption – but other countries are increasingly exploiting their coal deposits, and have ramped up coal production activities. Six countries supply four-fifths of the world's annual coal consumption, marking a dramatic change since 1980, when the U.S., Germany, Poland and Former Soviet Union countries were much bigger suppliers.

This shift in coal production is reflected in heterogeneous patterns at the country-level, and is the result of various factors. There are countries that rapidly expanded coal production, others that saw tepid contraction,

Figure 0.2

Global coal production shares



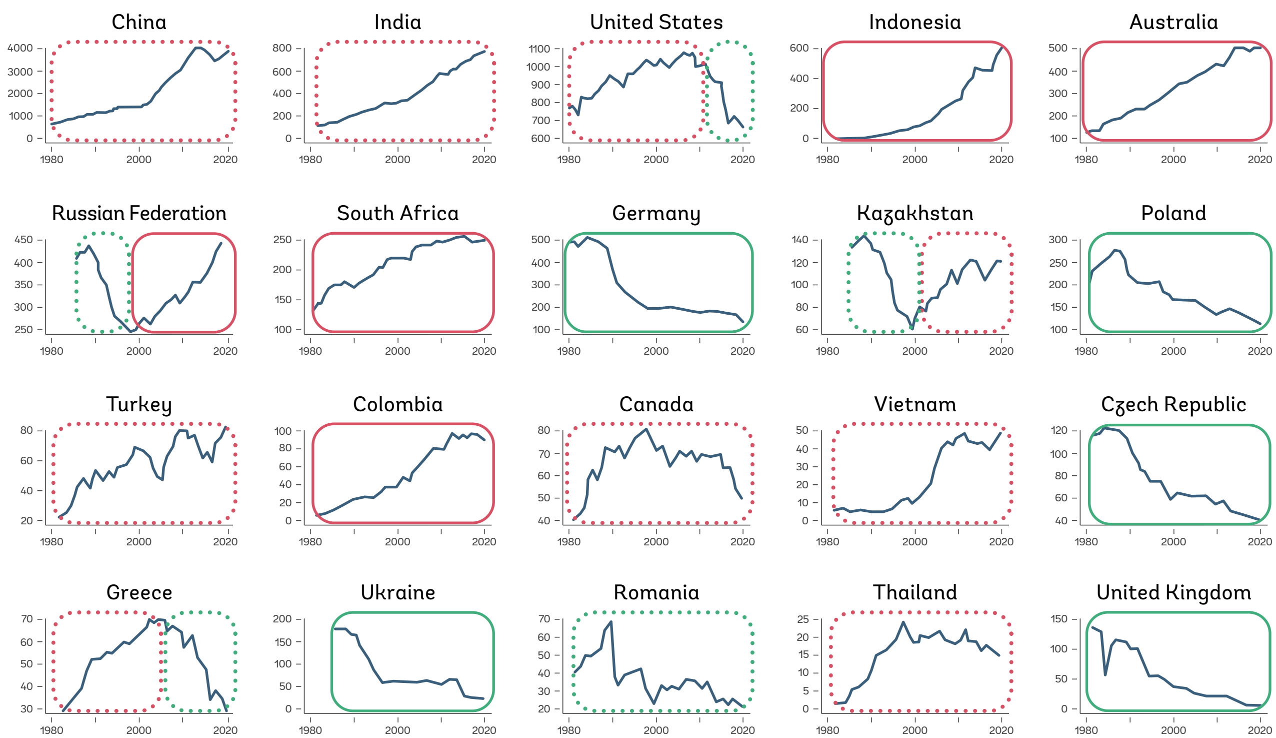
Source: BP Statistical Review of World Energy June 2020

and still others that experienced periods of sharp fluctuations in both directions. Some coal producers faced stiff competition from oil and gas, or headwinds from tighter government regulations to curb carbon emissions. Some countries were motivated by technology-induced productivity increases, or strategic national objectives related to energy security or local employment preservation. Some countries pursued new export markets as the global coal landscape shifted. Some countries expanded production of coking coal used in steel production and other chemical manufacturing processes.

The world's top 20 coal-producing countries share some common features, and can be categorized into 4 groups: advanced coal transitioners (denoted by a solid green line in Figure 0.3), partial transitioners (dotted green), accommodators of rising domestic demand (dotted red), and expanding coal exporters (solid red). Some countries have phased out of coal mining, or at least to a significant degree, reflecting a commitment to transition (with the caveat that "commitment" may not be perfect or may experience setbacks or fluctuating political will). This group includes the United Kingdom, Germany, Poland, Czech Republic, and Ukraine. Other countries have more recently moved in the direction of a cleaner energy mix, notably Romania, Canada, Greece, and the U.S. The reasons for the delayed shift appear linked to internal rather than external factors, including recent declines in domestic coal demand. The tremendous production increases in China

Figure 0.3

Coal production trends in the top 20 coal producers 1980-2020 (million tonnes)



Source: BP Statistical Review of World Energy June 2020

and India were primarily driven by the rising energy needs of their large and fast-growing domestic economies, whereas Indonesia and Australia, among others, have been motivated by export opportunities.

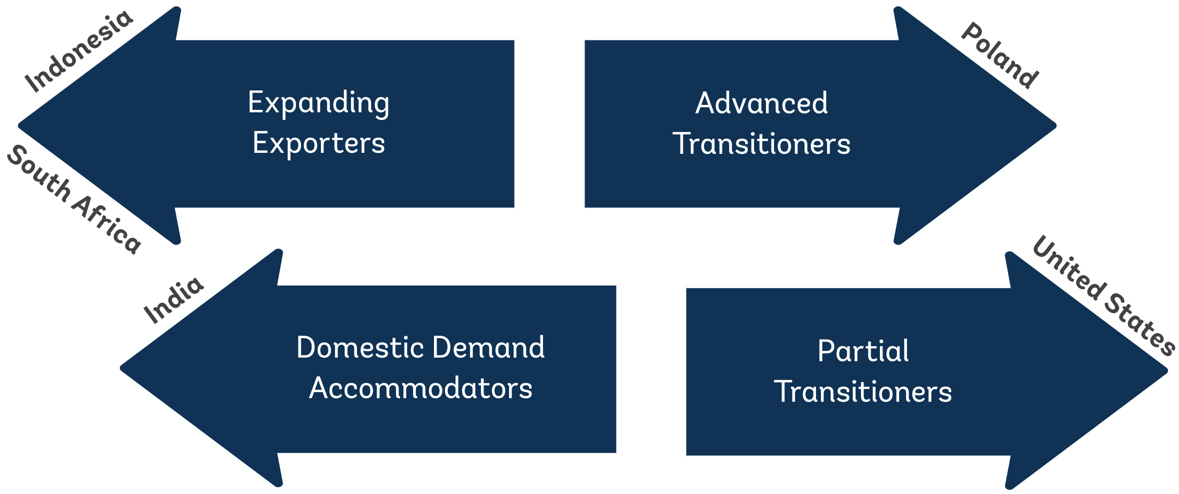
The total number of workers directly engaged in coal and lignite mining is currently 4.7 million globally, accounting for a very small and declining share of total employment, even within the major coal producing countries. Despite expanding coal production, coal jobs are being shed; over 2 million coal mining jobs have been lost in the last decade. This aggregated picture reflects coal phase-out in some countries, expansion in others, and sector productivity gains in most countries, as extraction technology has become more capital-intensive. Not surprisingly, China accounts for the largest number of jobs in the coal mining sector, numbering around 3.2 million in 2018, more than double the sum of coal mine jobs in all other countries combined. India is the next largest coal employer, at 416,000 direct coal mining jobs, followed by Indonesia (240,000) and Russia (150,000). Several countries' coal employment levels are in the range of 75,00-110,000 – specifically South Africa, Poland, Vietnam, and Ukraine – while Australia, Colombia, Turkey, and the U.S. each employ nearly 50,000. Note that these data do not reflect employment in the coal sector value chain beyond mining.

Whereas the level of coal mining jobs is modest, they generate significant indirect jobs across economic sectors and have a disproportionate influence on local labor markets. Although not easily measured using available data, coal mining jobs have a positive impact through high job spillovers in other sectors due to increased economic activity along the coal supply chain (e.g., in complementary activities) as well as through indirect demand for local goods and services by coal mine workers and their families (often referred to as induced effects). On the other hand, the high wages earned by mine employees – much higher than most other sectors, both on average and when controlling for individual characteristics – can distort local wages in other sectors, effectively crowding out economic activity and depressing labor demand. In addition, the boom and bust cycles typical of extractives industries tend to limit economic diversification in coal regions, making local economies vulnerable to large demand swings that undermine long-term growth. These natural resource curse effects are well-documented in the literature, and are illustrated in this report's country-level analysis. Evidence from Indonesia shows the distorting impact of coal mining jobs, namely that well-paid coal jobs spurred job creation in other sectors and pulled up their wages to some degree, but at the same time these positive spillovers were in fact smaller in very coal-intensive districts, which also experienced relatively slower wage growth in non-coal sectors.

The report examines five countries in detail to understand how their coal production patterns link to coal employment patterns, and some of the factors behind the observed country-level differences. These deep-dives examine the effects of coal jobs on local labor markets and in the broader national labor market context, exploring the extent to which coal employment contributes to or works against better job outcomes and stronger economic development. The analysis sheds light on the complexities associated with past and present coal production and employment outcomes in different country contexts. The selected countries – Poland, U.S., Indonesia, South Africa and India – represent the four different categories of our typology of coal producers.

Figure 0.4

Five country studies



The country case studies illustrate that many coal mining jobs are of good quality, but not all. The types of occupations, contract terms, compensation and working conditions can vary widely between formally and informally employed coal mine workers. Formal coal mining jobs tend to be highly paid and well-regulated, due to their hazardous nature, and in some countries are highly unionized and/or in the public sector. They tend to involve semi-skilled production and machine operation occupations, which in other sectors are remunerated substantially less. Even large formal mining companies employ workers on informal contracts, however; these could be deemed semi-formal from the perspective of occupation or pay, even if they do not benefit from labor code protections, union representation, or access to severance/pension benefits or social insurance. Indonesia's coal sector saw a proliferation of small mine operations concentrated in rural districts with limited opportunities for waged employment; coal mining jobs were a relatively attractive option. In addition to this segment of coal employees, there are many informal own-account and micro-enterprise workers engaged in the sector who lack written contracts or other protections, earn very low incomes and are highly vulnerable to demand fluctuations. The case study on India highlights this segment of informal coal sector workers. The significant segmentation evident in coal sector employment implies quite disparate outcomes with respect to job quality, and calls for differentiated policy interventions in the context of future transition associated with coal phase-out.

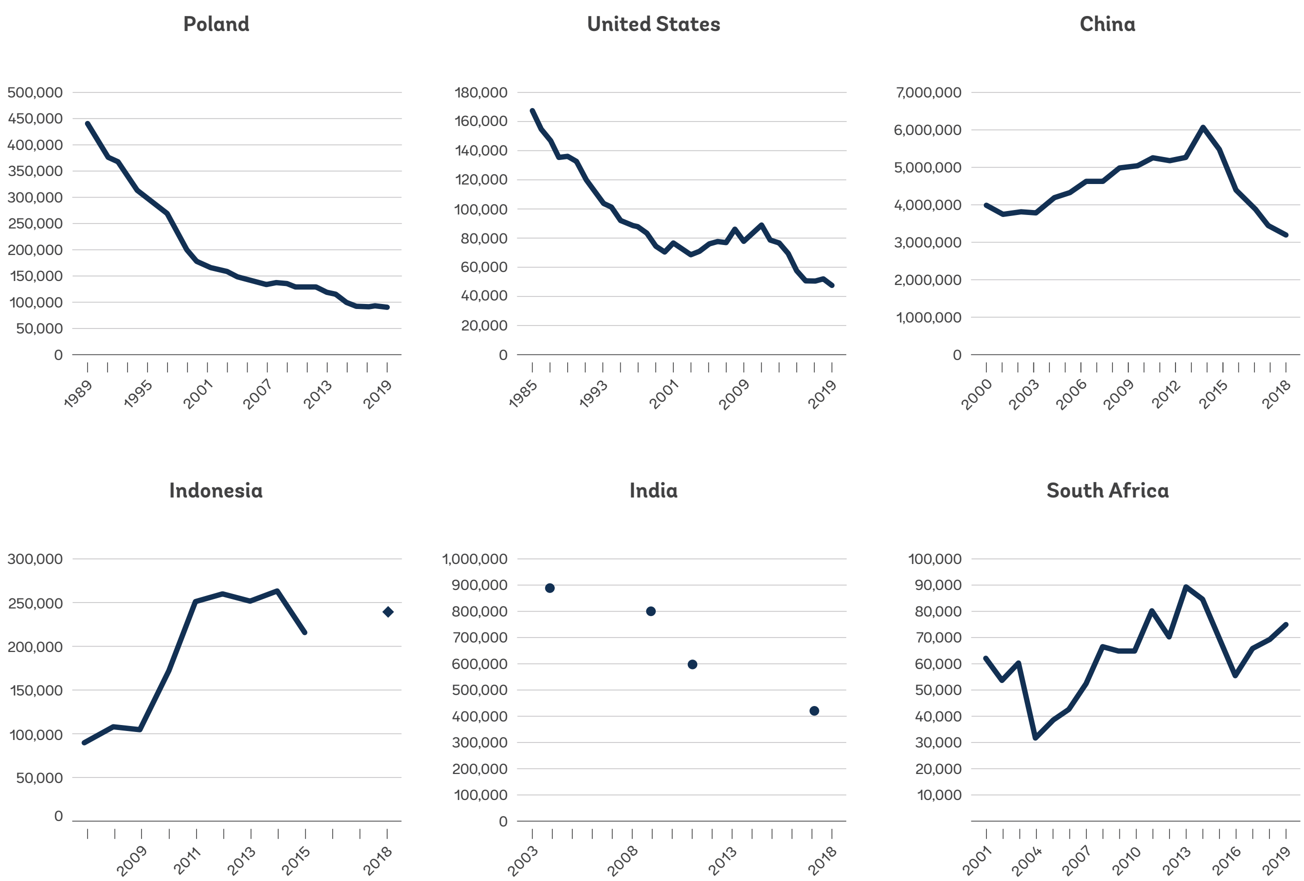
Two-thirds of the world's top coal producing countries shed coal mining jobs in the last decade, including countries with rising coal output. Similar to the heterogeneity observed in coal production patterns, coal employment manifests disparate trends across countries and over time. Differences in coal type, extraction methods and technologies affect the size and skills-mix of the coal sector labor force in each country. Non-coal factors also affect the size and nature of coal sector jobs, such as the skills composition, wages and availability of alternative work opportunities in other economic sectors, mining operators' agility to adjust to demand fluctuations, the relative mobility of workers to shift between different jobs, and governments' policy stance toward transitioning away from coal. It is notable that even in countries that aggressively expanded coal production – for example, China and India – productivity gains in the coal industry have resulted in significant labor shedding.

Past episodes of coal transition in Poland and the U.S. provide some useful lessons for policymakers and local authorities who anticipate future coal phase-out. Although many of these experiences were negative, they are nevertheless informative.

- **Transition takes a long time.** When many workers, businesses and communities are implicated, fundamental change to an industry cannot happen quickly, even with the best advance planning and post-closure transition policies in place.

Figure 0.5

Coal mining employment trends in 6 countries



Note: Employment level measured on the y axis. Employment data includes formal and informal workers employed in the coal and lignite mining sectors.

Sources: Poland data from energy.instrat.pl; US Bureau of Labor Statistics; China Coal Technology & Engineering Group; Indonesia LFS (Sakernas); India EUE and PLFS; South Africa LFS.

- **Transition requires a comprehensive approach** with complementary initiatives, policies and incentives to sway the many actors along the coal value chain, including those with vested interests like utility monopolies and manufacturers of mining equipment.

- **The timing and speed of transition are subject to political economy dynamics.** Uncertainty around commodity prices makes it difficult for communities to transition because prices affect both willingness and capacity to diversify toward other industries. Where actors are public (e.g., Poland), governments have the power to act quickly but risk the future support of the electorate. Where actors are private but unions are strong and/or regulatory authority is weak or captured by private interests (e.g., the U.S.), boom/bust cycles can be exacerbated, which could create obstacles to both the design and implementation of effective transition policies.

- **Transition assistance programs targeting formal mine workers fall short of meeting the needs of informal workers in and around the mines.** Even large mine operators employ a significant share of their workforce on temporary and/or informal contracts. Informal coal sector workers are at greater risk than their formal counterparts and less equipped to weather income shocks.

- **Remoteness and small market size are mutually reinforcing impediments to transition.** When communities are not connected to larger markets, workers cannot access jobs elsewhere and local businesses are limited by their small local client base.

- **The advantages of inducing voluntary job separations through generous compensation packages are offset by the risk of inflicting long-term damage on local economies.** High reservation wages dampen local labor demand and economic recovery through diversification, which can undermine public fiscal health.

- **Severe social dislocation and local economic viability may pass a point of no return.** The risk is higher where long-term dependence on coal has delayed acceptance of transition.

- **Economic diversification is essential and requires help from both local and higher level government with respect to planning and financial resources.** Advance planning, investment in infrastructure, addressing environmental degradation and attracting private investment are key ingredients of economic diversification, requiring significant local and regional institutional capacity and coordination.

Recent developments in the coal industries of Indonesia, South Africa and India share some common themes, and especially some common factors affecting the path and speed of transition. These include: rising market demand for coal – whether domestic (India) or external (South Africa, Indonesia) – to meet electricity needs; costly replacement of coal-based technologies with renewable sources; limited economic diversity in coal communities; weak regulation and capture by vested interests; political economy pressures that shape government decision-making; and the potentially disruptive impact on livelihoods and the economic viability of coal communities.

Even among countries committed to transitioning away from coal, the marginal cost of continued coal extraction to power electricity generation is much lower than the cost to replace installed generation capacity.

The outsized impact of coal mining jobs in small and/or remote communities makes them vulnerable to significant dislocation in the event of mine closure, which poses a risk of destabilizing local economies. Energy transition in coal regions will impact workers directly engaged in mining operations and along the coal supply chain, but also workers with indirect connections to coal activity, such as retail, restaurants, and recreation service providers to coal miners and their families. In this context, government planning will be essential to mitigate the negative effects on livelihoods and the sustainability of local economies. Where coal is an important employer, political considerations can delay the energy transition and resulting mine closures, but delays may in fact increase existing distortions and exacerbate segmentation, making future transition even more challenging.

Addressing these challenges effectively requires a solid understanding of the scope and nature of the potential impacts of transition. Policymakers need to understand the ways in which a future transition away from coal may affect the livelihoods of both coal and non-coal workers and their surrounding communities, in order to implement policies and programs for managing transition effectively. Policy design is further complicated by the fact that informal workers – an important segment of the coal sector value chain – fall beyond the reach of many policies. The World Bank's three-pillar framework for supporting energy transition in coal regions articulates labor policies to help displaced coal mine workers navigate the lay-off process and access retraining and other assistance to ease the transition to alternative employment. In the present paper, we use the lessons from past transitions together with the case study findings on coal-related labor market challenges in Indonesia, South Africa and India to motivate the design of a comprehensive, multi-channel policy framework for managing coal transition. The policy framework presented here extends the World Bank (2018a) framework by incorporating a broader group of affected workers, such as informal coal mine workers, those employed in coal supply chains, and those within coal communities that may suffer negative economic shocks due to mine closure.

To achieve an effective and just transition for all, it will be necessary to address the informal and formal segments of the affected workforce through a combination of local and national policies and programs. The concept of "just transition" extends to national priorities of inclusive, sustainable and broad-based economic growth. Understanding the potential welfare losses by workers is only part of the challenge; weighing the trade-offs and risks of prioritizing some stakeholders over others is the fundamental task of strategic policy design. Given the complex systems of implicit- and cross-subsidy of energy generation and its links to industrial sector production and jobs, it is important to understand who currently benefits from these existing systems, and the economic and fiscal costs and benefits associated with these systems. A just transition is one in which the costs and benefits are shared more equitably.

Traditional labor policy instruments that support the transition of displaced workers to new jobs are necessary but not sufficient. In addition to extending the World Bank's coal transition policy framework to address all types of affected workers, this paper also incorporates complementary policies for ensuring a sound environment that fosters economic diversification. Income support is an effective tool for smoothing consumption in households affected by job loss; it also helps to sustain demand for local goods and services and the businesses that provide them. Temporary income support such as through the national safety net should be the minimum policy response for affected informal workers. Although income support can address immediate and short-term needs, longer-term interventions are needed to help workers move into alternative employment – whether local or elsewhere – and to create an environment conducive to business development and private job creation.

There are five main channels through which public policies and programs can facilitate workers' transition:

(i) Temporary income support (e.g., employer severance pay, national social safety net)

(ii) Increasing workers' capacity to qualify for jobs in new sectors (e.g., through skills or entrepreneurship training)

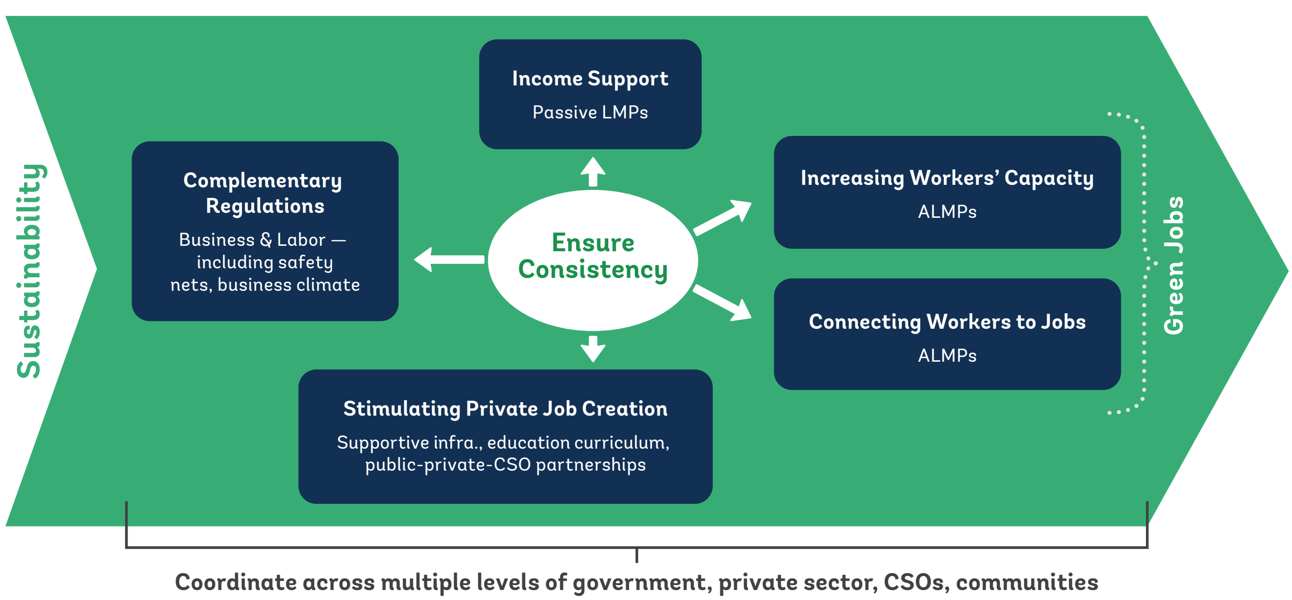
(iii) Connecting workers to potential employers (e.g., through job search assistance, mobility grants)

(iv) Stimulating private sector labor demand and local or regional business development (e.g., through investment incentives aligned with strategic national, local and/or regional priorities, matching grant programs); and

(v) Ensuring the business environment and labor regulations are conducive to private sector investment and job creation.

Figure 0.6

Five policy channels to support transition

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A sustainability lens could be added to these policy channels to ensure that workers displaced from coal sector jobs do not simply transition to alternative but equally unsustainable sectors. Introducing sustainability criteria would also support the parallel objective of stimulating green economic transition.

These policy channels are relevant across different phases of the transition; the policy framework developed in this report is organized into four phases, ranging from before the mine closure decision is taken through to the period following layoffs and closure. The motivating objectives of this framework are to enhance the welfare of affected workers and promote the medium-term viability of local and/or regional economies.

Phase 1 focuses on broader economic development planning to lay the groundwork for absorbing the negative economic shock of mine closure. This entails measures to enhance the capacity and resilience of the local economy through diversification toward new economic sectors and occupations, and requires upstream planning, significant investment, close coordination with national authorities, and partnership with a range of local, regional and national CSOs and private sector organizations.

Phase 2 comprises pre-closure analysis of the labor situation, including the number and profiles of workers likely to be affected, and assessing existing programs available to affected workers, including safety net coverage and qualifying criteria for passive and active labor market policies. Any safety net or ALMP program adjustments or regulatory reforms need to be implemented prior to the announcement of layoffs.

Phase 3 begins with the announcement of mine closure and layoffs, and requires communicating the various types of assistance that will be made available to workers and providing support services such as benefit eligibility advice or career counseling, with the goal of empowering individual workers to prepare for and shape their own post-layoff transitions.

Phase 4 comprises the delivery of post-layoff assistance including temporary income support to displaced workers and implementation of active labor market programs. A key aspect will be monitoring program take-up and effective job placements to enable timely program adjustments to improve effectiveness.

Government's role in the transition process needs to be multi-faceted and proactive. A well-planned and systematic process of coal mine closure and layoffs is essential for supporting the reallocation of affected workers to alternative jobs and at the same time mitigating the economic, social and political costs of transition. Governments do not have to deliver everything themselves, but they do need to provide strategic direction and leadership, coordinate across stakeholders, arbitrate competing interests, and mobilize adequate financing that represents an investment in transition.

Figure 0.7

Policy framework for managing labor transition

1 Economic Development Strategy (Pre-closure decision)	• Foster diversification through business climate reforms, entrepreneurship initiatives • Invest in supportive physical and digital infrastructure incl. enhanced connectivity • Align education and training curricula toward emerging economic sectors (national not just local; STEM plus soft skills) • Establish partnerships and strategic oversight bodies comprising national/regional and local government officials, academic institutions, private sector associations, civic organizations and other community groups • Strengthen oversight of and partnership with mine operators (to minimize disruption post closure re: worker protections and land/infrastructure repurposing) • Partner with unions and/or employer organizations to design and deliver staff re-skilling for post-coal economy
2 Analysis & Planning (Pre-closure)	• Identify workers likely to be directly and indirectly affected by the mine closure process, profile existing skills and potential mismatch with current labor demand • Review social protection and ALMP programs and labor regulations related to layoffs • Assess eligibility for unemployment benefits and other social services (distinguishing by worker characteristics such as age, household income), identify coverage gaps, estimate potential needs for assistance • Revise income support programs, ALMPs and productive inclusion interventions to accommodate a systemic shock and build capacity of service provider agencies • Begin communications/community consultations, accompanied by positive cultural signaling around a new social contract not centered on coal
3 Announce Layoffs & Assistance	• Issue advance notification of layoff • Inform mine workers and community members of assistance options, offer packages targeted to mine employees and to other workers (e.g., productive inclusion, public works) to encourage self-selection into the best fit to facilitate reallocation into new jobs. Requires government to scale up its outreach • Help workers clarify their benefit entitlement with mine operator, union • Establish a network of worker advocates to promote assistance and steer workers to appropriate programs • Begin provision of certain services (e.g., career counseling, psycho-social outreach, job search assistance)
4 Post-layoff Assistance	• Provide temporary income support • Implement active labor market policies in phases/based on screening; ALMPs can include job search/technical/softskills/entrepreneurship training, job search grants, wage subsidy, business incubator, mobility grants • Monitor assistance take-up and job placement; adjust program parameters to improve effectiveness • Consider auxiliary services in response to community needs

Source: Authors' extension of the (formal) labor policy approaches developed in Fretwell (2017), World Bank (2018a) and Cunningham and Schmillen (2021)

CHAPTER 1

Introduction

The objective to move toward a cleaner energy mix is widely shared by policymakers, civil society organizations and households worldwide. There are multiple motivating factors behind this objective, including the increasingly urgent climate crisis, national and local pollution concerns, declining competitiveness of the coal industry, fiscal efficiency considerations, and the long-term viability of fossil fuel-dependent jobs.

Despite broad support for this objective, the best path to achieve it is unclear, nor is there agreement on the optimal speed of travel. The transition away from fossil fuels, and coal in particular, will create dislocation and require adjusting current structures of production. Understanding the scope and scale of the transition challenge is an essential first step but is in itself daunting. The complexity of the challenge contributes to inertia by policymakers, as do the large implied economic and social costs. But the costs of inaction are likely to be much greater in the medium term.

The challenges implicate all sectors in coal-dependent nations, because of energy infrastructure built around coal-fired power plants, economic production structures that are energy-intensive, and national supply chains related to coal use. For coal-producing regions themselves, the effects of transition cut very deeply, especially when coal mining regions are small, remote and dependent on coal. The transition can create multiple disruptions: to jobs – both direct and indirect, to household incomes, to local economies heavily tied into the coal supply chain, to community well-being and social capital, and to local and regional government capacity and fiscal solvency.

Although some economies have moved away from coal, notably the United Kingdom, Spain, South Korea and to a lesser degree Poland and the US, there has been limited success in addressing the associated regional labor market disruptions. Moreover, these disruptions had persistent negative impacts on social, human and institutional capital that in some cases undermined local economic sustainability. The perceived risks related to future mine closures are slowing the decarbonization process. And yet as coal-dependent regions across the globe are waking up to the realities of the climate crisis and governments are committing to mine closures, policymakers and communities are eager for guidance on the best ways to approach this complex and sensitive agenda to achieve sustainable transition.

At the global level, the rationale for transition is well recognized and accepted. Environmental and health concerns stemming from mining activities – toxic for workers, community residents, and natural assets – have long been acknowledged, although the local nature of the most easily observed impacts are easy to ignore at the national level. The accumulating scientific evidence on human-induced climate change and extreme weather has finally crystallized international attention, but policy action has lagged. The 2007 Intergovernmental Panel on Climate Change (IPCC) report made the case that human actions were the main contributor to global warming (IPCC 2007). The 2014 IPCC report laid out in stark terms the urgency of drastically reducing CO2 and other greenhouse gas (GHG) emissions, which would require fundamental changes to the way we live and the way we do business (IPCC 2014). The rationale for decarbonization becomes clearer every time an extreme weather event damages infrastructure or physical assets or disrupts economic activity or livelihoods. The frequency of these events is increasing. Even without the urgency of climate change, the economic costs of carbon-dependence are large and projected to become untenable.

Mine closure can have potentially large (negative) demand spillovers in surrounding communities and regional economies. Energy transition in coal regions will impact workers directly engaged in mining operations and along the coal supply chain, but also workers with indirect connections to coal activity, such as retail, restaurants, and recreation service providers to coal miners and their families. In this context, government planning will be essential to mitigate the negative effects on livelihoods and the sustainability of local economies. Where coal is an important employer, political considerations can delay the energy transition and resulting mine closures, especially in settings with high union membership.

This paper analyzes the status of coal mining phase-out around the world, describes the magnitude and character of jobs in the coal mining sector[1] – both globally and in five detailed country studies, and identifies key challenges associated with future labor transition. Structured as an issues paper, it takes a global perspective on recent coal sector trends and the associated coal mining jobs created or destroyed, considers the drivers of coal production in various country contexts, and the implications of past and future transition and coal mine closures on workers and on local labor markets. Although the extent of coal activity may be relatively limited within the overall national economic context, it may still have significant direct and indirect effects on local economies. Understanding the size and nature of these effects will therefore be important for managing an effective economic transition following coal mine closures. The measurement challenge is non-trivial, however, given data limitations, especially at the local level, which in the case of coal regions, tend to be rural and not well captured in national labor force surveys.

The analysis in this report exploits differences in transition stages to draw lessons from countries that have experienced coal mine closures in the past, and uses these lessons to inform policy responses in the context of future decarbonization, with particular attention to facilitating the transition of affected workers into alternative employment. This report is part of a broader multi-sector effort by the World Bank to support coal regions confronting the realities of decarbonization and help lay the groundwork for achieving a just transition for all. The World Bank framework, elaborated in the 2018 report "Managing Coal Mine Closure: Achieving a Just Transition for All" (World Bank 2018a), comprises three pillars: institutional governance, people and communities, and environmental remediation and repurposing land and assets. Focusing on pillar two, the analysis below deepens existing work and extends the policy discussion beyond issues related to displaced mine workers to consider the wider implications for local labor markets and sustainable recovery of regional economies. The policy framework developed here is intended to guide future country engagements through which detailed policy recommendations would be developed to address a specific country or sub-regional context.

[1] Note that throughout this paper, the term "coal mining job" refers to employment in the coal and lignite mining sector as classified under International Standard Industrial Classification (ISIC) Rev.4 industry code 05. This category is also defined to include non-mining occupations (e.g., management or support functions) within a mining company, and excludes employment in coal-fired power generation and other industry categories that may be part of the coal value chain (e.g., coal transport, steel production). These latter activities are considered indirect coal sector jobs.

The remainder of this report is organized as follows. Chapter 2 provides a description of coal sector trends at the global level, characterizing the top coal producing countries based on their patterns of coal production and consumption, and describing the associated levels of coal mining employment in coal-producing countries. Chapter 3 explores the role of coal in economic structural transformation during the last two decades through a demand-side lens, related to both energy demand and manufacturing processes involving coal and its derivative. Chapter 4 presents five detailed country studies examining the evolution of coal mining employment within their country-specific labor market settings. And Chapter 5 concludes with some lessons from past coal transitions and a proposed policy framework for managing labor transitions in the context of future mine closures.

CHAPTER 2

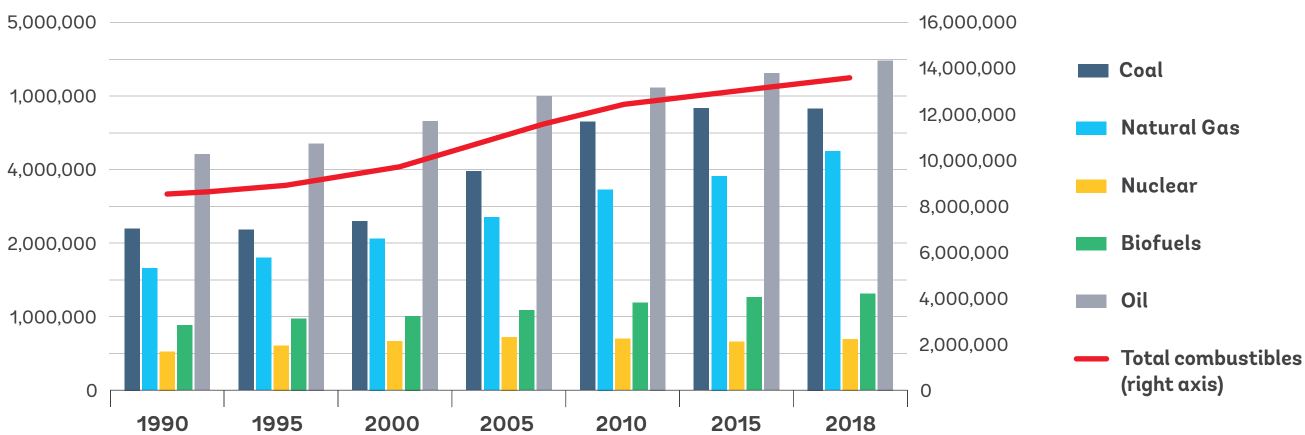
Global Coal Trends: A Mixed Picture

2.1 Coal Production and Consumption Trends

Global energy production has climbed steadily over the past four decades, and coal has played an increasing role. As global GDP rises and the population grows, economies consume more energy in their economic activities and as well in their household activities. Rising per capita incomes compounds this effect through higher living standards, driving increased residential demand for electricity, heat and air conditioning. The global demand for energy grew by an average 1.8 percent annually between 1990 and 2018, and global per capita energy supply climbed from 1.7 to 1.9 toe in the same period. After oil, coal (including lignite)[2] accounts for the second largest share of global energy supply (Figure 2.1). Global production and consumption of coal posted robust growth over this period – especially between 2000 and 2010, during which its share of the total energy market surpassed 28 percent, before ebbing slightly in the past decade (Figure 2.2).

Figure 2.1

Global energy supply from combustible sources (ktoe)

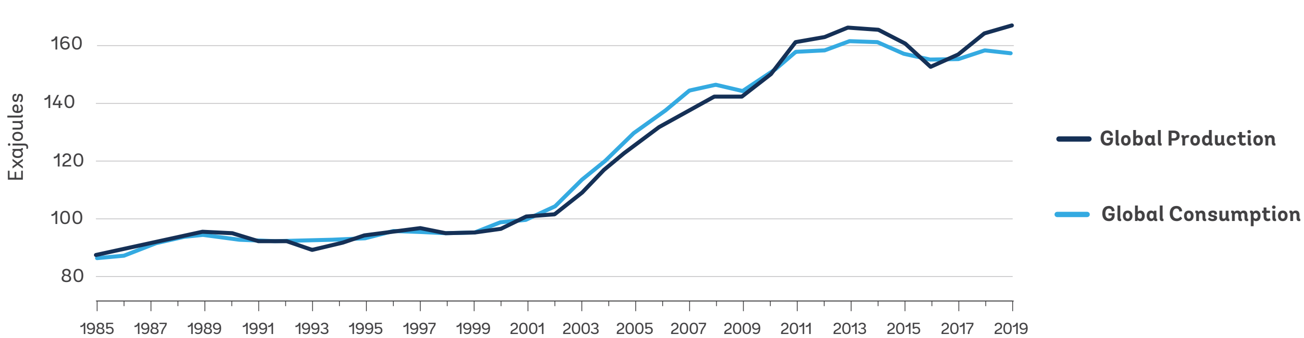


Note: Data excludes electricity and heat trade

Source: IEA data

Figure 2.2

Global coal production and consumption



Source: Authors' calculations based on BP Statistical Review of World Energy

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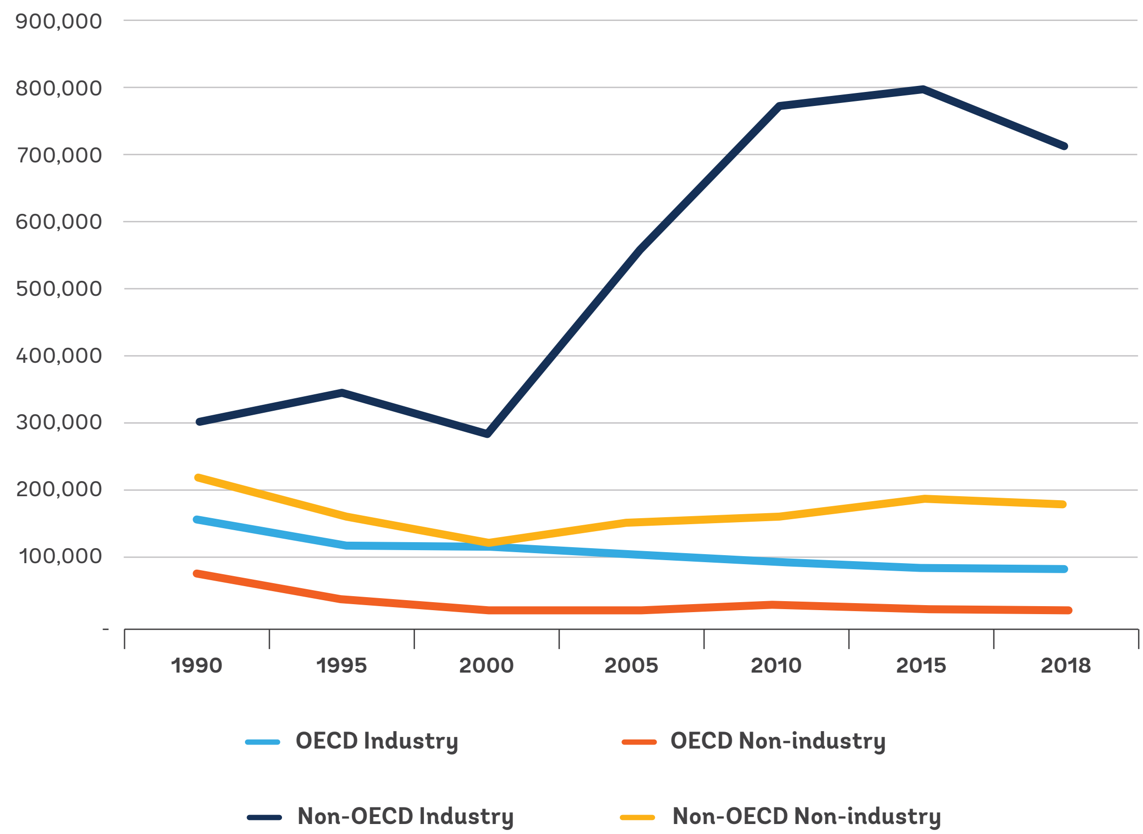
[2] Throughout this report, we use the general term "coal" to include lignite as well.

Economic activity and industrialization across the developing world have been the key impetus behind rising coal demand. In most countries, the industry sector is the largest consumer of coal (final use, excluding electricity), accounting for 60 percent on average in 1990, compared to 20 percent for residential use and significantly less for other sectors such as commerce, public services and agriculture. The last four decades have seen a slowdown in OECD coal demand, but a rapid expansion of coal use by non-OECD industrial sectors (Figure 2.3). By 2018, industrial demand for coal had increased by 75 percent globally, and more than doubled in non-OECD countries, while coal demand from other sectors declined.

Figure 2.3

OECD vs. Non-OECD final coal consumption (ktoe)



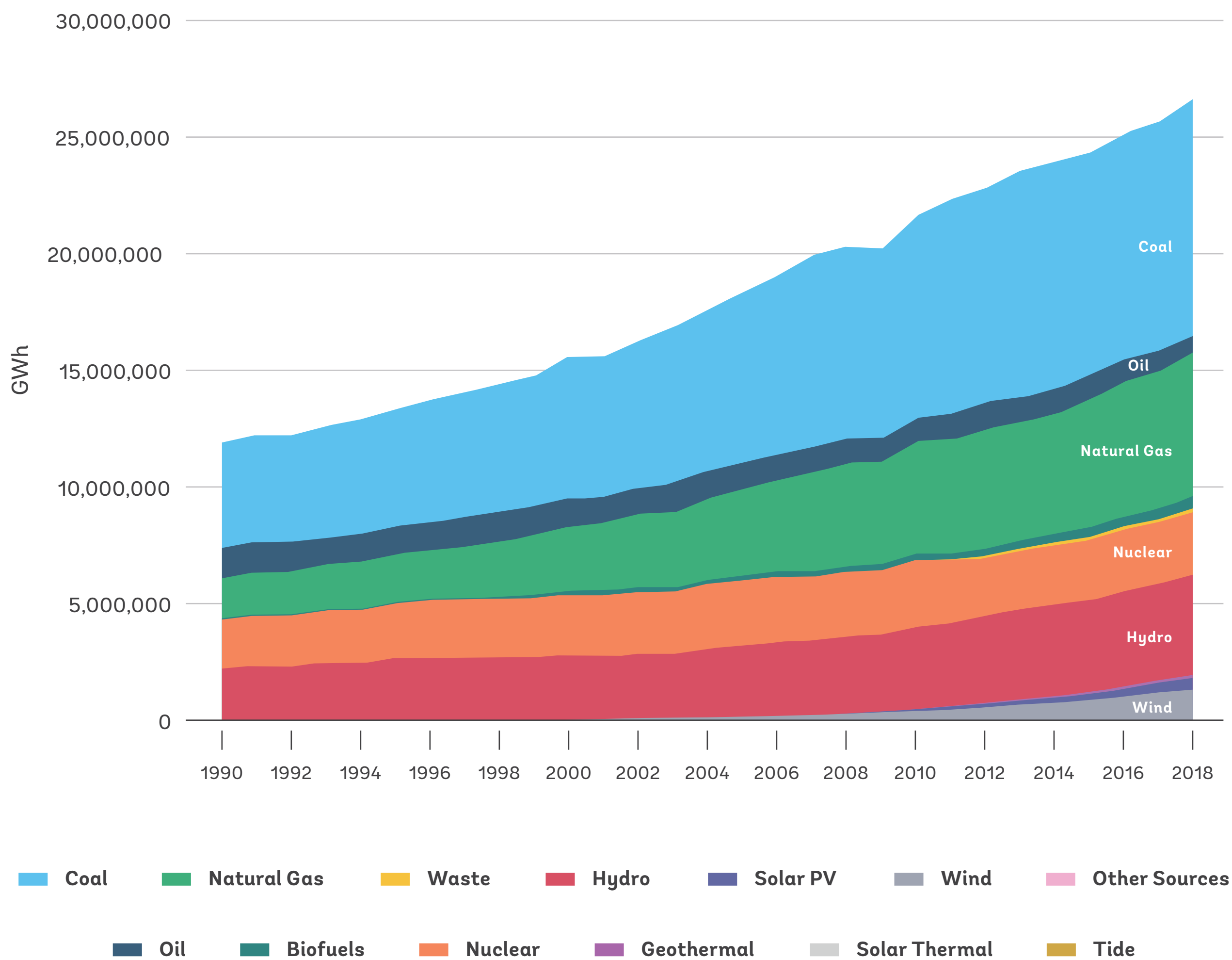
Source: IEA data

Electricity represents a major part of total energy consumption, and coal is the largest fuel source for electricity worldwide. According to IEA data, nearly two-fifths of global final energy consumption is attributable to oil products, followed by electricity (one-fifth), natural gas (16 percent), bio-fuels and coal (10 percent each).

With respect to electricity, coal has been the traditional fuel source for power plants, and remains dominant, despite recent inroads from natural gas, and to a lesser degree hydro, wind and solar PV generation (Figure 2.4).

Figure 2.4

Global electricity generation by source (GWh)

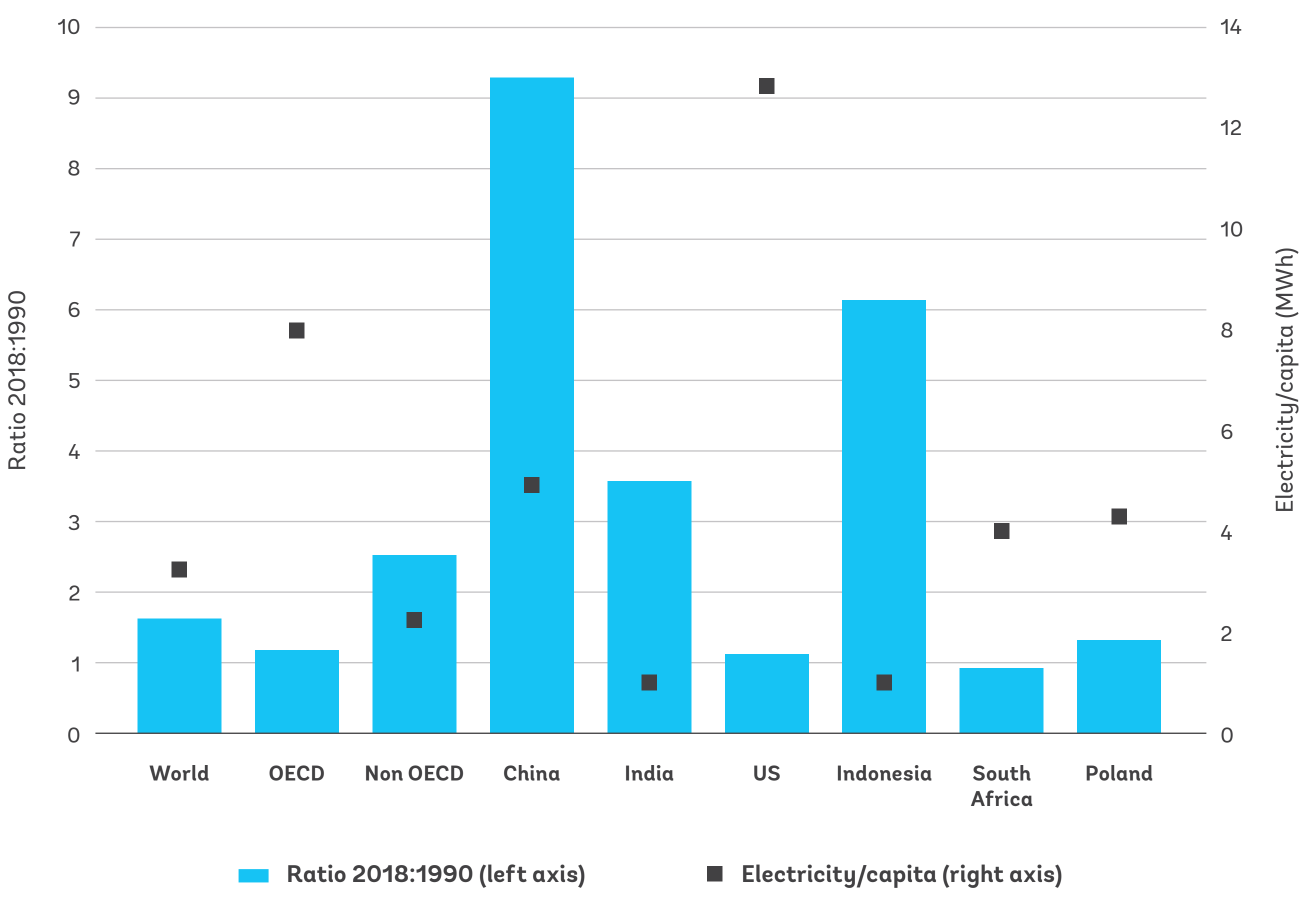


Source: IEA data

Developing countries – and particularly China – have been the main drivers of rising electricity consumption. Average global per capita electricity consumption has increased by 60 percent since 1990, although less developed countries experienced much faster gains (Figure 2.5). China's per capita consumption increased nine-fold in the space of four decades, reaching 4.91 MWh per person in 2018, compared to an average 8 MWh per capita in the OECD This remarkable expansion in both access and demand is the primary factor driving the global results, given China's very large economy and population of 1.44 billion. India – population 1.37 billion – also played an outsized role, as it more than tripled its per capita electricity consumption. The US, by contrast, has much higher electricity consumption on a per capita basis, four times the global average and 2.6 times higher than China (IEA data). Together, these three countries dominate electricity consumption and production (Figure 2.6).

Figure 2.5

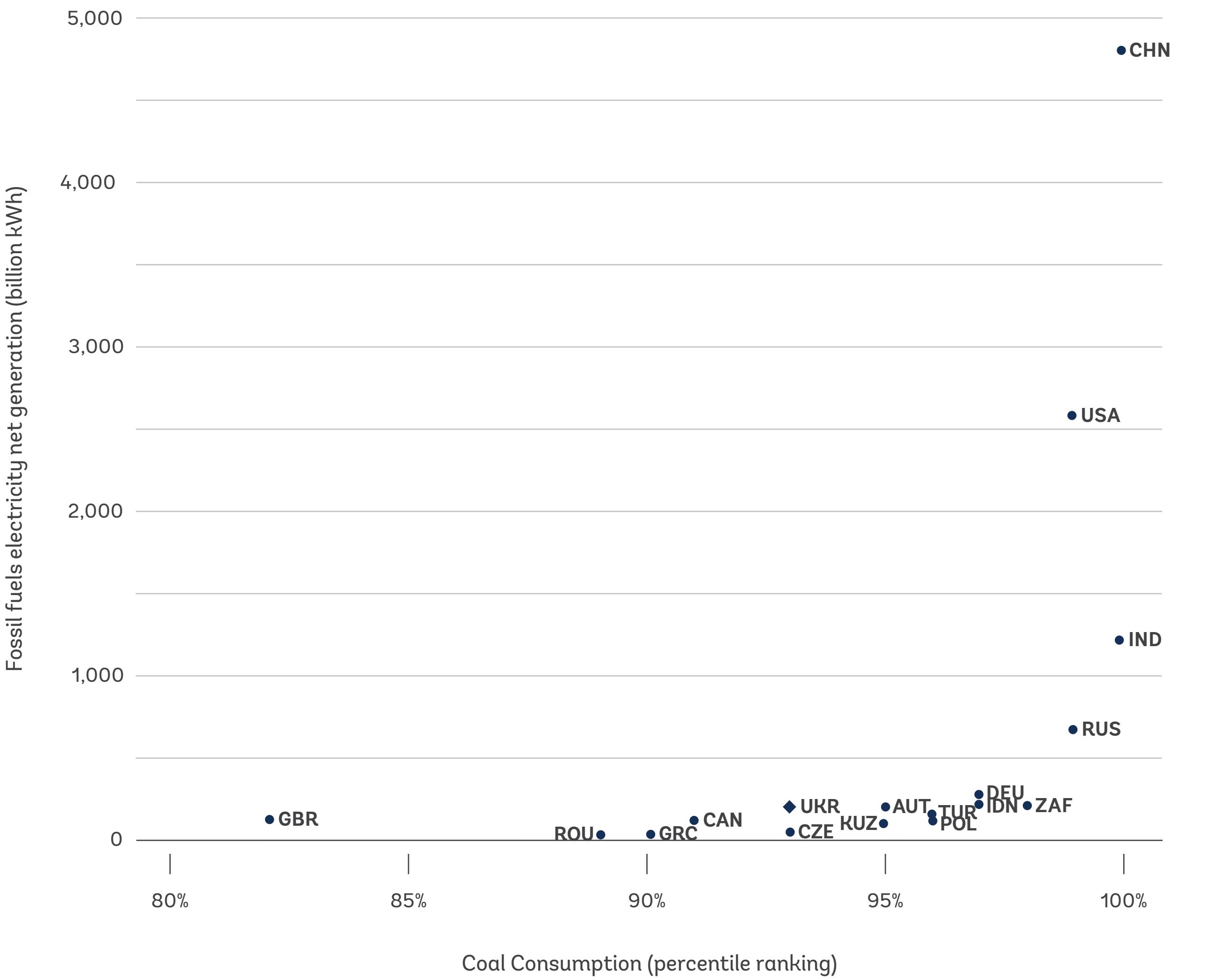
Ratio of per capita electricity consumption 2018:1990



Source: IEA data

Figure 2.6

A few countries dominate electricity production and coal consumption



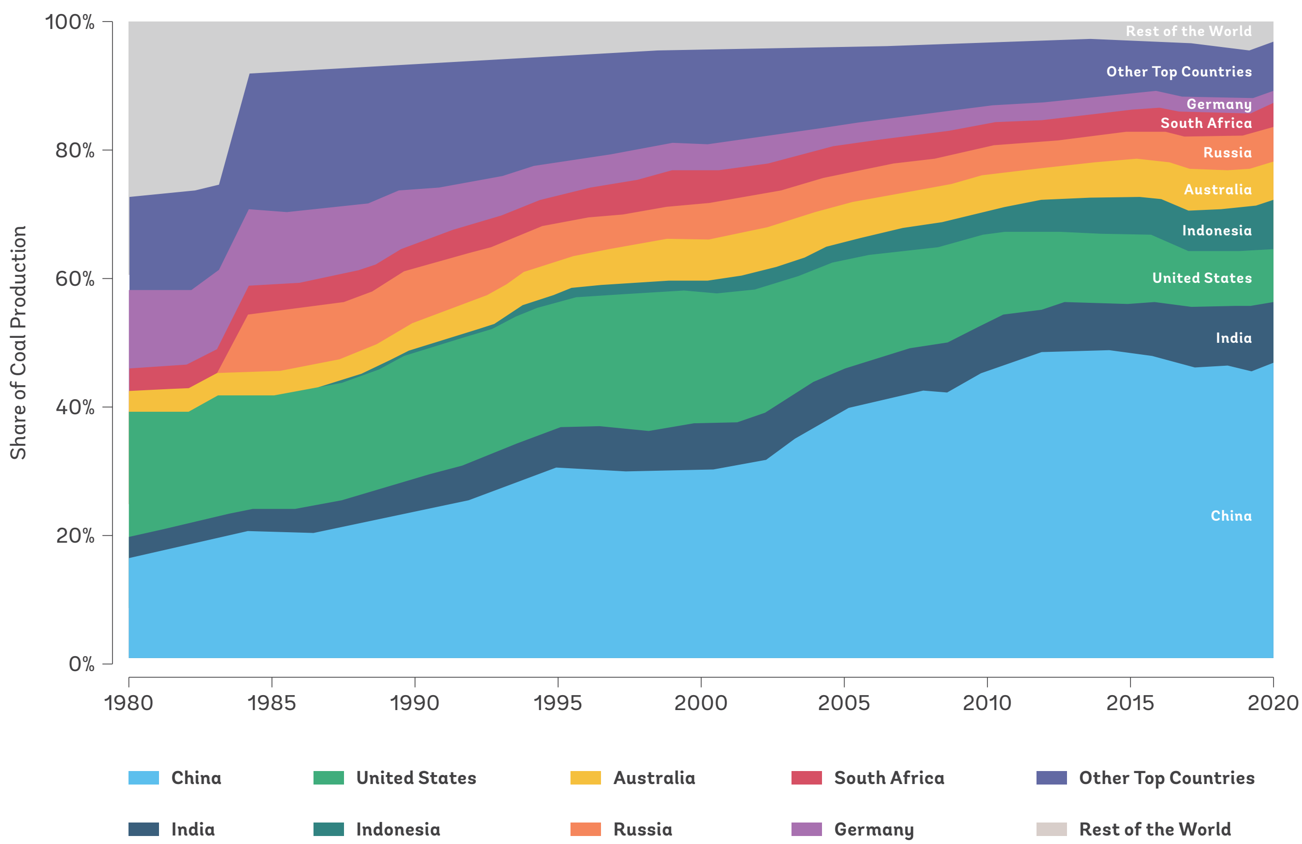
Source: BP Statistical Review of World Energy June 2020

Coal production is shifting its regional profile and becoming increasingly concentrated in a small number of countries. Whereas China is a big part of the global coal story, other countries are also pushing into the extraction and export markets with enthusiasm. The ECA region and North America, home to the dominant coal producers of the last century such as Germany, Poland, UK, and US, account for a shrinking share of global production, squeezed out by East Asia and the Pacific – notably China, but also Australia, Indonesia, Vietnam and Thailand – and by India. Only ten countries account for 90 percent of global production, reflecting an increasing concentration of the coal market (Figure 2.7).

Looking at individual countries reveals significant heterogeneity within regions and over time. Figure 2.8 provides a snapshot of the wide-ranging patterns of country-specific coal output since 1980, reflecting cases of rapid expansion, tepid contraction, as well as instances of sharp fluctuations in both directions in some countries. Some coal producers encountered periods of stiff competition from natural gas or faced headwinds from tighter regulation as governments responded to negative pollution externalities or global warming concerns. Some countries expanded production of coking coal used in steel production. In many countries, coal mining expanded

Figure 2.7

World coal production is dominated by few countries

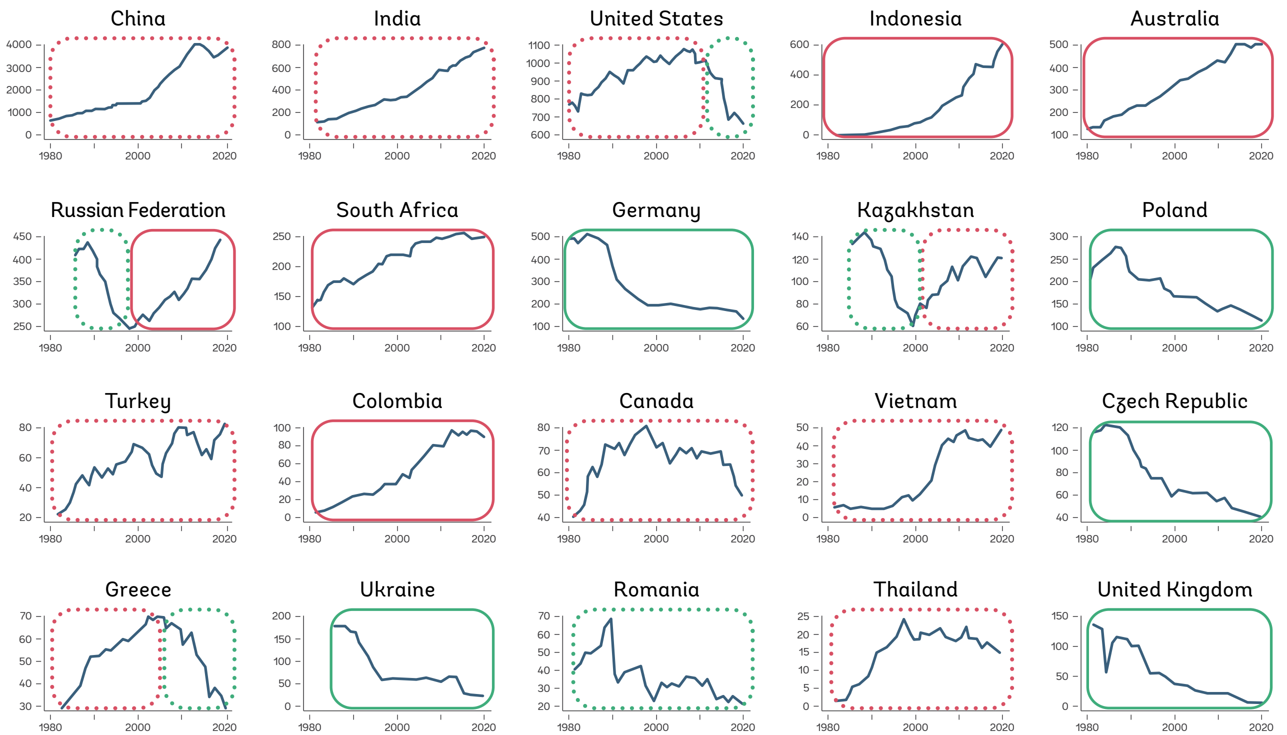


Source: BP Statistical Review of World Energy June 2020

during periods of surging global demand, such as during the oil-crisis of the late 1970s when coal prices became more attractive, or as coal deposits were identified. Other motivating factors include technology-induced productivity increases, strategic national objectives around domestic industry targets[3] or the coal export market[4] or local employment preservation[5], weak institutional settings, or a combination of these factors.

Figure 2.8

Coal production trends in the top 20 coal producers 1980-2020 (million tonnes)



Note: Production data from BP Statistical Review of World Energy June 2020. Country classifications defined by the authors as follows: green solid line indicates an advanced stage of transition to coal phase-out; red solid line indicates expanding coal exporters; dashed line means production responds to local demand; red dashed line means increasing production to meet rising domestic demand; green dashed line indicates partial transition that either stalled or reflects very recent transition in response to declining local demand.

Source: BP Statistical Review of World Energy June 2020

[3] E.g., China's massive domestic industrialization agenda.

[4] E.g., Indonesia's and Australia's entry into the rapidly expanding East Asian and South Asian markets.

[5] E.g., state-owned coal mining firms in Eastern Europe that have scaled back production without significant job cuts, or politically connected private coal companies like Murray Energy in the US, which lobbied for government support in exchange delaying mine closure (insideclimatenews.org 2019).

Despite differences, production trends in the top 20 coal producing countries nevertheless share some common features. Coal producing countries can be categorized into 4 general groups: advanced coal transitioners, partial transitioners, accommodators of rising domestic demand, and expanding coal exporters. Figure 2.8 uses color coding to denote each category: solid green denotes advanced transitioners, solid red denotes expanding exporters, and dashed lines indicate those falling in the intermediate categories. This organizing framework may not perfectly capture each country's experience, and sometimes the distinctions between categories are fuzzy, but the framework provides insight into key drivers of country-level trends. Some countries have effectively phased out of coal mining, or at least to a significant degree, reflecting a commitment to transition (with the caveat that "commitment" may not be perfect or may experience setbacks or fluctuating political will). This group includes the United Kingdom, Germany, Poland, Czech Republic, and Ukraine. Other countries have more recently moved in the direction of a cleaner energy mix, notably Romania, Canada, Greece, and the US. The reasons for the delayed shift observed in these countries appear linked to internal rather than external factors, including relatively recent declines in domestic coal demand associated with energy efficiency gains and increasing adoption of renewable energy (Box 2.1 describes the range of competing market-related factors underlying coal production patterns in the US over the past hundred years). The tremendous production increases in China and India were primarily driven by the rising energy needs of their large and fast-growing domestic economies, whereas Indonesia and Australia, among others, have been motivated by export opportunities.

Coal export patterns are especially revealing in explaining coal production trends. Whereas China and India have sharply expanded their coal production, both have become large net importers in response to their rapidly increasing internal electricity demand. Vietnam and Thailand also consume far more than they produce, and continue to expand coal production to accommodate domestic demand. These patterns contrast sharply with the small but powerful group of expanding exporters, most notably Australia, Indonesia, and Russia, which together account for seven-tenths of global exports. Between 2000 and 2019, Australia doubled its coal exports, Indonesia's coal exports quadrupled, and Russian coal exports grew by a factor of five (Figure 2.10). South Africa meets about a quarter of the Africa region's total import demand, but focuses more intensively on the large India market. Less dominant but still important in export markets are the US (exporting mainly to Europe), Colombia (exporting to Europe and Latin America) and Canada (targeting Asia).

Box 2.1

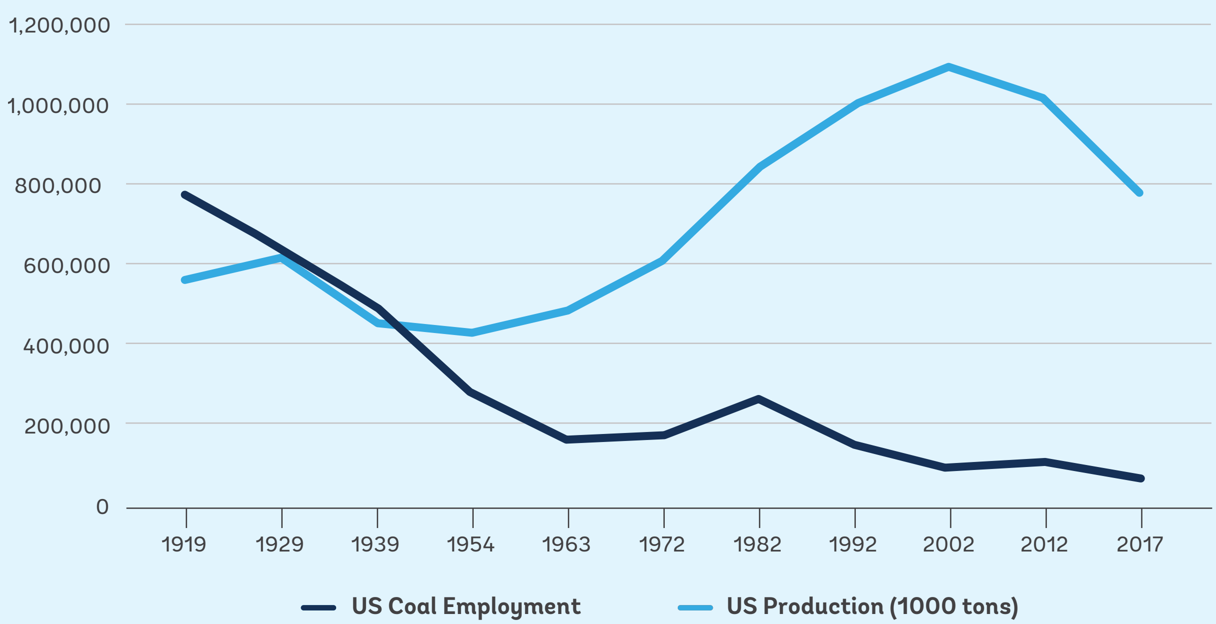
A Century of Coal Production in the US: Market Drivers of Gradual Change

Coal's dominance in the US energy mix a century ago has undergone a series of changes over time, reflecting both headwinds and tailwinds that affected coal demand and production levels. During the Great Depression through the mid-1950s, coal production contracted as demand shifted toward less expensive oil. Appalachian coal – primarily from the Pennsylvania/Ohio/West Virginia/Virginia/Kentucky corridor – gained competitive advantage during this period due to falling transport costs and proximity to population centers on the east coast. The economic boom period of the late 1950s through the 1960s saw a sustained increase in energy demand and coal production, and this was followed by a rapid shift toward mining in the western US, concentrated in the Powder River Basin in Wyoming and Montana. Technology advances, higher-quality coal, and the lower production costs associated with western strip mining provided the main impetus behind the geographical shift away from Appalachia, and a significant and steady decline in coal mining employment (Figure 2.9). Wyoming coal mines had 8 times the labor productivity of the average Appalachian mine (Lobao er al. 2021). Moreover, coal from the Powder River Basin is less polluting than Appalachian coal, due to its lower sulfur, mercury and arsenic content, making it a more appealing fuel source under the environmental regulations introduced during this period, notably the 1972 Clean Water Act, the 1970 Clean Air Act, and the 1990 Clean Air Act.

By the mid-2000s, the emergence of fracking contributed to a natural gas boom and very low energy prices, disrupting the coal market as consumers and power generators substituted toward natural gas. This coincided with the end-of-life phase-out of many coal-fired power plants, although expanding global demand for coal helped to sustain US mining jobs. US coal exports grew three-fold between 2002 and 2012, as the share of US coal exports in total US coal production rose from 5 to 15 percent (BP Statistical Review of World Energy 2020). By the mid-to-late 2010s, renewable energy had become increasingly accessible and affordable, and is likely to soon surpass coal-fired electricity (EIA 2020).

Figure 2.9

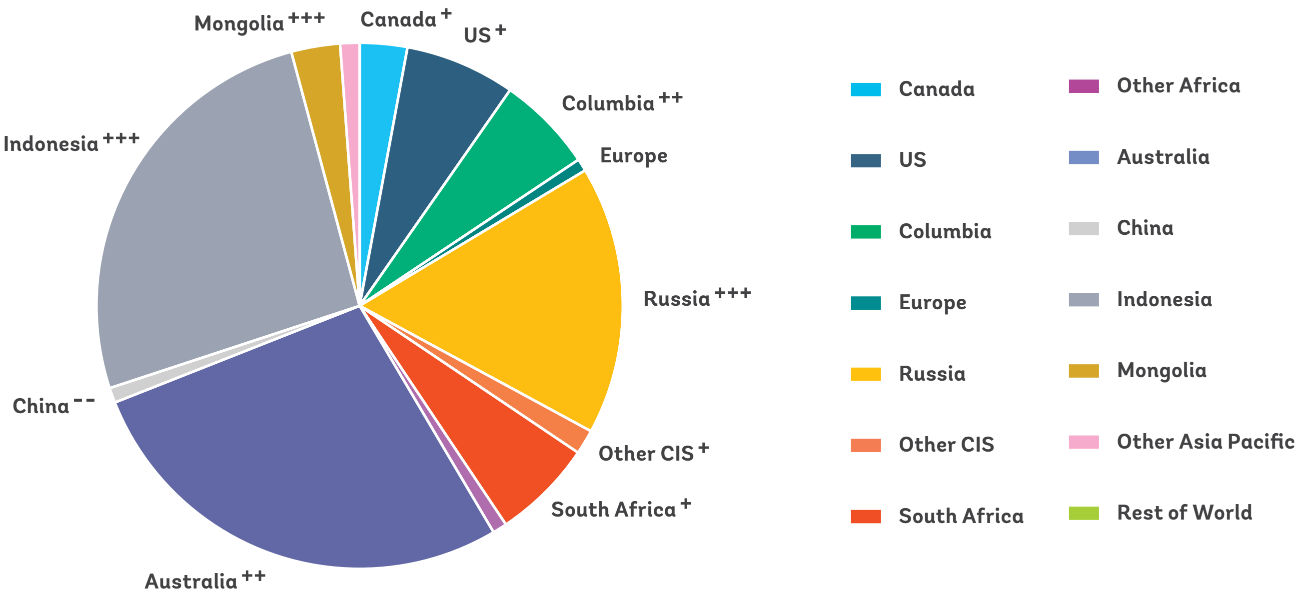
US Coal Mining Employment and Production: 1919-2017



Source: U.S. Census Bureau, Census of Mineral Industries, as presented in Lobao et al. (2021)

Figure 2.10

Coal exporters (2019)



Note: + indicates increased exports between 2000 and 2019; ++ indicates more than doubled coal exports between 2000 and 2019; +++ indicates more than quadrupled coal exports between 2000 and 2019; -- indicates reduced exports by more than half between 2000 and 2019.

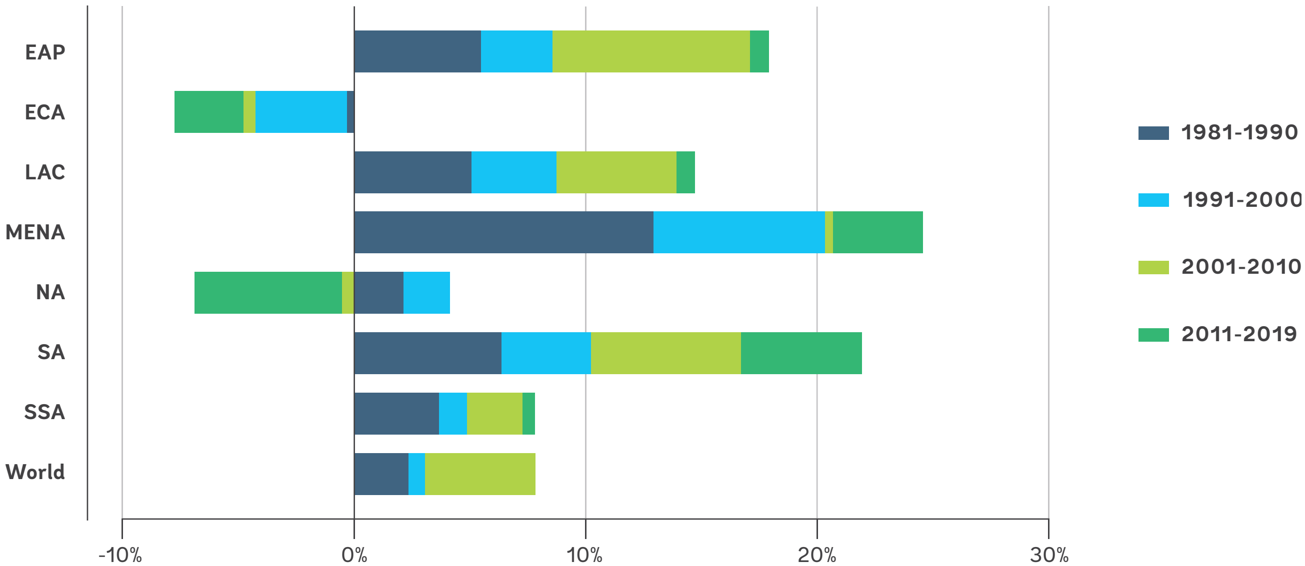
Source: Data from BP Statistical Review of World Energy June 2020

2.2 The Winds of Change Affect the Pace of Transition

The situation is changing, but not to the extent needed to mitigate the intensifying climate crisis. Although coal consumption has expanded in most regions since 1981, ECA and North America saw net contractions, and the remaining regions at least slowed the rate of increase in the most recent decade (Figure 2.11). In contrast to these positive trends, however, is evidence of expanding coal-fired power generation, even among countries signaling a commitment to transition away from coal dependence. China and India are by far the biggest actors, together adding 1.15 million MW of coal-fired power generation between 2000 and 2020 (four-fifths of the global total). Indonesia has steadily ramped up its generating capacity over the last decade and a half, adding 27,000 MW. The US also installed new power plants – especially between 2009 and 2013, adding over 25,000 MW of coal-fired generation through 2015 but zero thereafter. South Korea and Japan were not far behind, adding 25,000 and 24,000 MW respectively, including new construction as recently as 2019 and 2020 (Global Energy Monitor). It is important to note that the rate at which old power plants are being retired has accelerated over the last decade, such that in net terms, coal power additions are declining, although still positive (Figure 2.12).

Figure 2.11

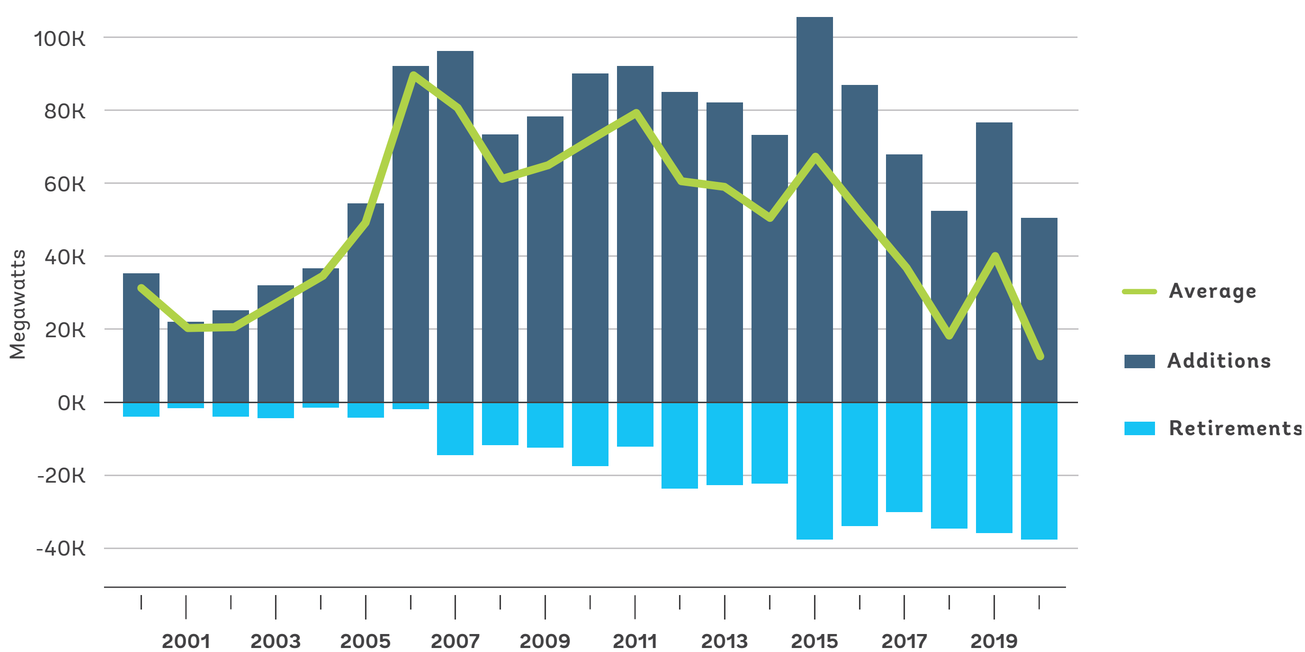
Coal consumption growth by region



Source: BP Statistical Review of World Energy June 2020

Figure 2.12

Coal power plant additions and retirements



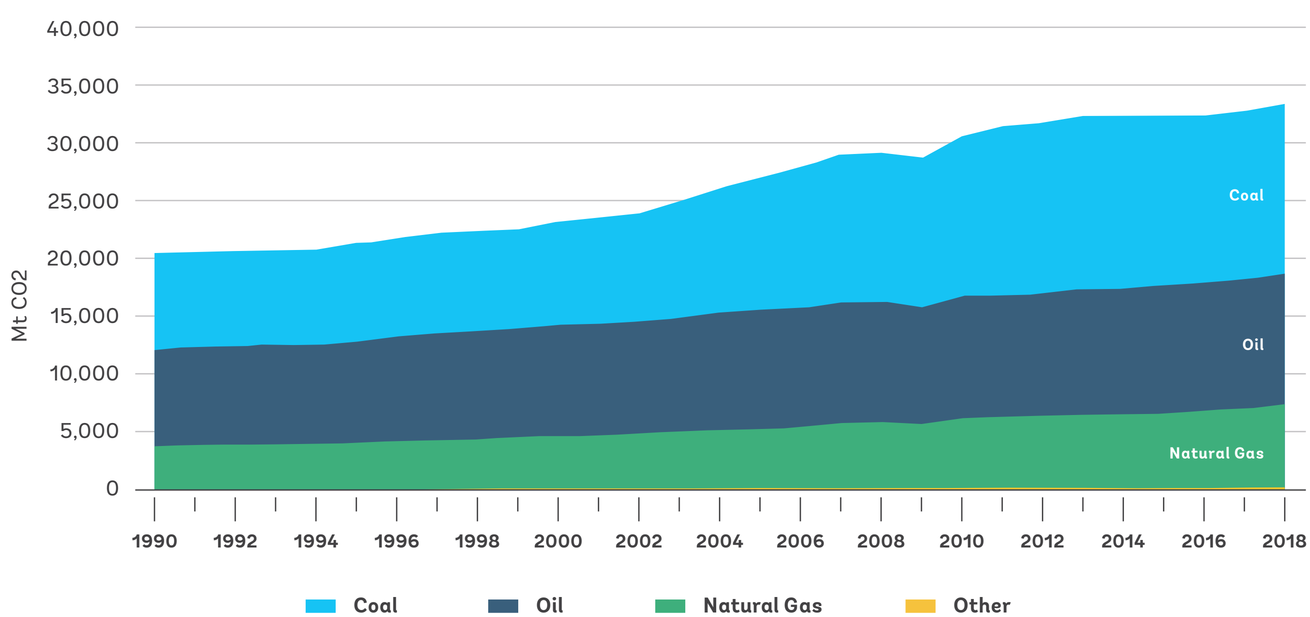
Note: Line represents net added MWs.

Source: Globalenergymonitor.org

Coal activity is a main contributor to greenhouse gas (GHG) emissions and pollution that exacerbate climate change and damage human health. Nearly half of all CO2 emissions stem from coal, two-thirds of which through electricity and heat generation. CO2 emissions have climbed steadily over the past three decades (Figure 2.13), during which time the emissions from coal-fired electricity and heat generation doubled. China earns top billing as the world's largest emitter, accounting for a quarter of global GHG emissions (Climate Watch data). The US and EU (27) rank second and third, followed by India, Russia, Japan, Brazil, Indonesia, Iran and Canada (Figure 2.14). Despite the significant reduction in coal mining activity in much of the EU, and especially Poland and Germany, the negative health effects remain evident today. Air pollution from Europe's coal-fired power plants together are estimated to cause nearly 23,000 premature deaths[6] per year across Europe, stemming disproportionately from Poland and Germany, and with significant cross-border effects (WWF European Policy Office et al. 2016). Additional health impacts are measured in increased incidence of chronic bronchitis, asthma attacks in children, and pollution-related hospital admissions. There are numerous other negative externalities associated with coal mining that are not addressed here, such as land degradation and destabilization, and ecosystem disruption, among others. Together, these inflict serious and lasting damage on human and environmental health that will be costly to remediate.

Figure 2.13

Global CO2 emissions by energy source (Mt)

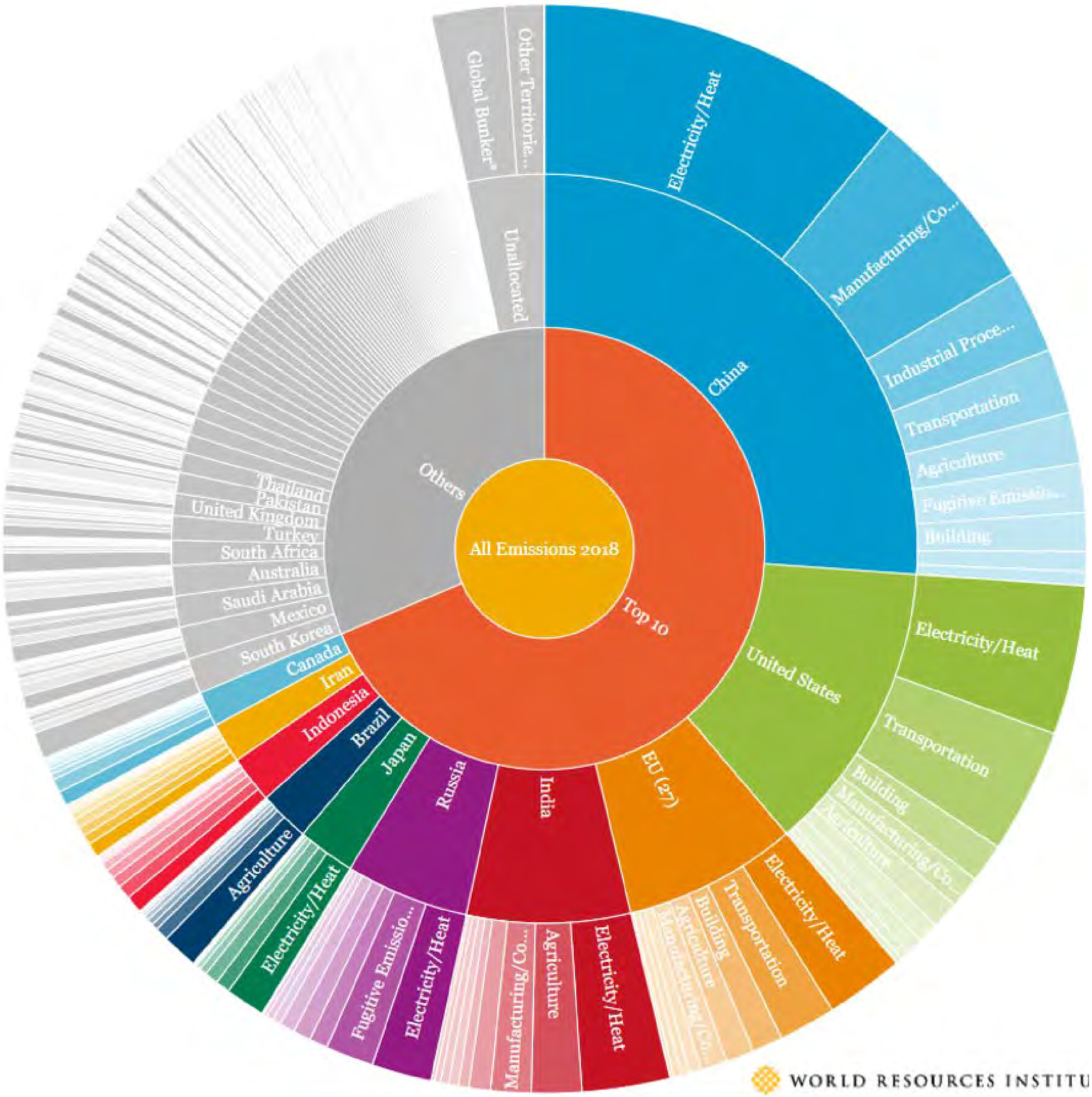


Source: IEA data

[6] Air pollution – and specifically particulate matter – increases deaths attributed to stroke, heart disease, lung cancer and respiratory diseases. WHO (2016) estimates that 4.5 million deaths per year are due to ambient (outdoor) air pollution.

Figure 2.14

Top 10 GHG emitters contribute over two-thirds of global emissions (2018)



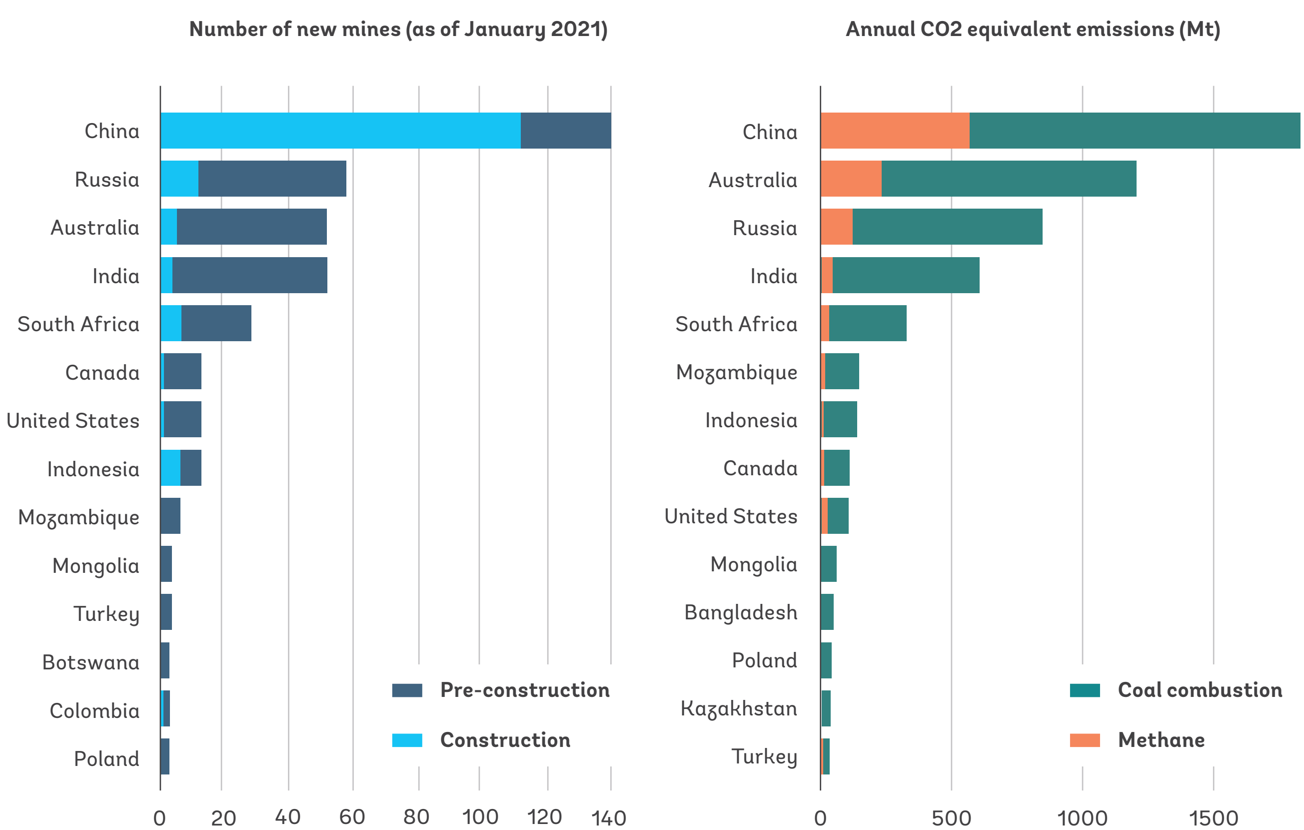
Note: Preliminary global greenhouse gas emissions data for 2018 excludes land-use change and forestry (LUCF).
Source: climatewatchdata.org (graphic by Johannes Friedrich)

Future prospects for global coal production are uncertain but are unlikely to change quickly. In the short-term, coal consumption levels are not likely to decline significantly, given the country-level consumption and export patterns described above. China and India's growing economies will continue to demand coal, whether for electricity or as a manufacturing input (e.g., steel), and many new coal mines are either planned or under construction in both countries (Figure 2.15, left panel). Russia, Australia and South Africa are also actively planning for additional coal mines, which will exacerbate CO2 emissions into the future (Figure 2.15, right panel).

Despite the heightened awareness of the negative environmental and health externalities associated with coal production and coal-fired energy generation, various factors impede a faster pace of transition. These include the high upfront costs to replace or retrofit installed coal-fired power plants with renewable energy, and the incentive to wait until the lifespan end of existing power plants. Strong global coal demand has spurred countries like Australia, Indonesia, and Russia to invest in additional coal production to increase their export market shares in the still-strong European market (as the supply of European-sourced coal wanes) and the

Figure 2.15

Proposed new coal mines and their annual CO2-equivalent emissions



Note: Methane emissions based on 20-year horizon.
Source: Globalenergymonitor.org

rapidly expanding East and South Asian markets. Producers of steel and other coal-derived products have to balance domestic industry interests within the broader context of a globally declining coal market. Energy security considerations may be inducing some countries to adopt a longer timeframe for their national transition strategies.[7] Policies that explicitly or implicitly subsidize coal or electricity provide a competitive advantage over other energy sources and induce over-consumption and over-production. The direct and indirect costs associated with these subsidies – calculated as the difference between the price that consumers pay for coal and for electricity and the real supply cost of coal and electricity, taking into account environmental costs and foregone tax revenue – are extremely high, globally accounting for over US$2 trillion in 2015 (equivalent to 2.8 percent of global GDP; Coady et al. 2019). Whereas the direct "pre-tax" coal and electricity subsidies (using IMF terminology) are negligible in most countries, the "post-tax" subsidies are orders of magnitude greater; and for coal, the largest share of these indirect costs is due to air pollution, followed by global warming. Coady at al. (2019) estimate that China's coal subsidies approached US$1.3 trillion in 2015, compared to around US$200 billion in Russia, the US, and India.

Forces for change are gaining traction. Each coal-consuming country faces different constraints and choice sets shaped by a range of domestic and external factors, and this heterogeneity in turn affects the timing and pace of coal transition in each. Some common threads are starting to emerge, however. Market forces in terms of innovation, scaling and competitive pricing of renewable energy technologies have made green alternatives accessible to a large and increasingly global market. Policies and regulations that sanction industrial pollution – including power plant emissions – are being adopted more widely, although their effectiveness is undermined by weak compliance and large implicit subsidies. The intensification of the climate crisis is stimulating more aggressive policy effort, but countries' carbon reduction targets reflected in their voluntary nationally determined contributions (NDCs) under the Paris Agreement are neither sufficient nor are they being met, according to the UN's recent NDC Synthesis Report (UNFCCC 2021). Financing of carbon-intensive or carbon-dependent investments continues, despite nominal commitments by international financial institutions and global investment banks to end future financial support. The widespread economic disruption caused by the COVID pandemic lockdowns in 2020 and 2021 highlighted the vulnerability of economies dominated by informal jobs or low-productivity service sector employment, as significant shares of workers lost their jobs, small businesses went bankrupt, and global economic production fell by up to 10 percent. The resulting abrupt albeit temporary reduction in pollution and congestion during lockdown raised awareness of the damaging effects of our carbon-dependent economic structures; it is possible that this shock may create momentum and political will to allocate significant public resources to sustainable and resilient recovery.

[7] Peszko et al. (2020) explore potential climate strategies for countries dependent on fossil fuels.

2.3 Snapshot of Coal Employment Trends

Coal production is an important source of employment in the top coal-producing countries, although modest compared to other economic sectors. On the basis of national employment data for the largest coal producers , the total number of workers currently engaged in the coal mining sector is 4.7 million globally (see Box 2.2 for a discussion of data sources and challenges).[8] This level represents a very small share of total employment, averaging 0.24 percent across the 20 top coal producing countries. Not surprisingly, China accounts for the largest number of coal mining jobs, numbering around 3.2 million in 2018, more than double the sum of coal jobs in other countries combined. India is the next largest coal employer, at 416,000 coal mining jobs, followed by Indonesia (240,000) and Russia (150,000) (Figure 2.16). Several countries' coal employment levels are in the range of 75,00-110,000 – specifically South Africa, Poland, Vietnam, and Ukraine – while Australia, Colombia, Turkey, and the U.S. each employ close to 50,000 (figures reflect 2019 or most recent data available; Table 2.1).

Over the last decade, 2.4 million coal mining jobs have been lost worldwide in net terms, reflecting coal phase-out in some countries, expansion in others, and sector productivity gains in most. Downscaling due to significant productivity gains in China resulted in 1.8 million lost coal mining jobs between 2008 and 2018, and coal mining jobs in India declined by half. On the other hand, coal mining employment increased in many of the other top coal producing countries, notably in Indonesia, but also in Australia and South Africa. Even in countries that significantly expanded coal production, employment growth did not keep pace, reflecting large productivity gains (denoted by the black data points in Figure 2.16).

Box 2.2

Data challenges for measuring coal mining employment over time

Global datasets on employment do not have a very long period of coverage compared to datasets on economic production and population statistics. As governments increasingly standardized their household-level survey instruments to the international standards established under the leadership of the ILO, and as countries carried out more frequent labor force surveys, more complete coverage became available. The ILOSTAT database contains sector-level employment information for most countries beginning in 1991, but aggregated at the 1-digit ISIC industry code level. This means that coal and lignite activities are reported in combination with other mining and quarrying activities.

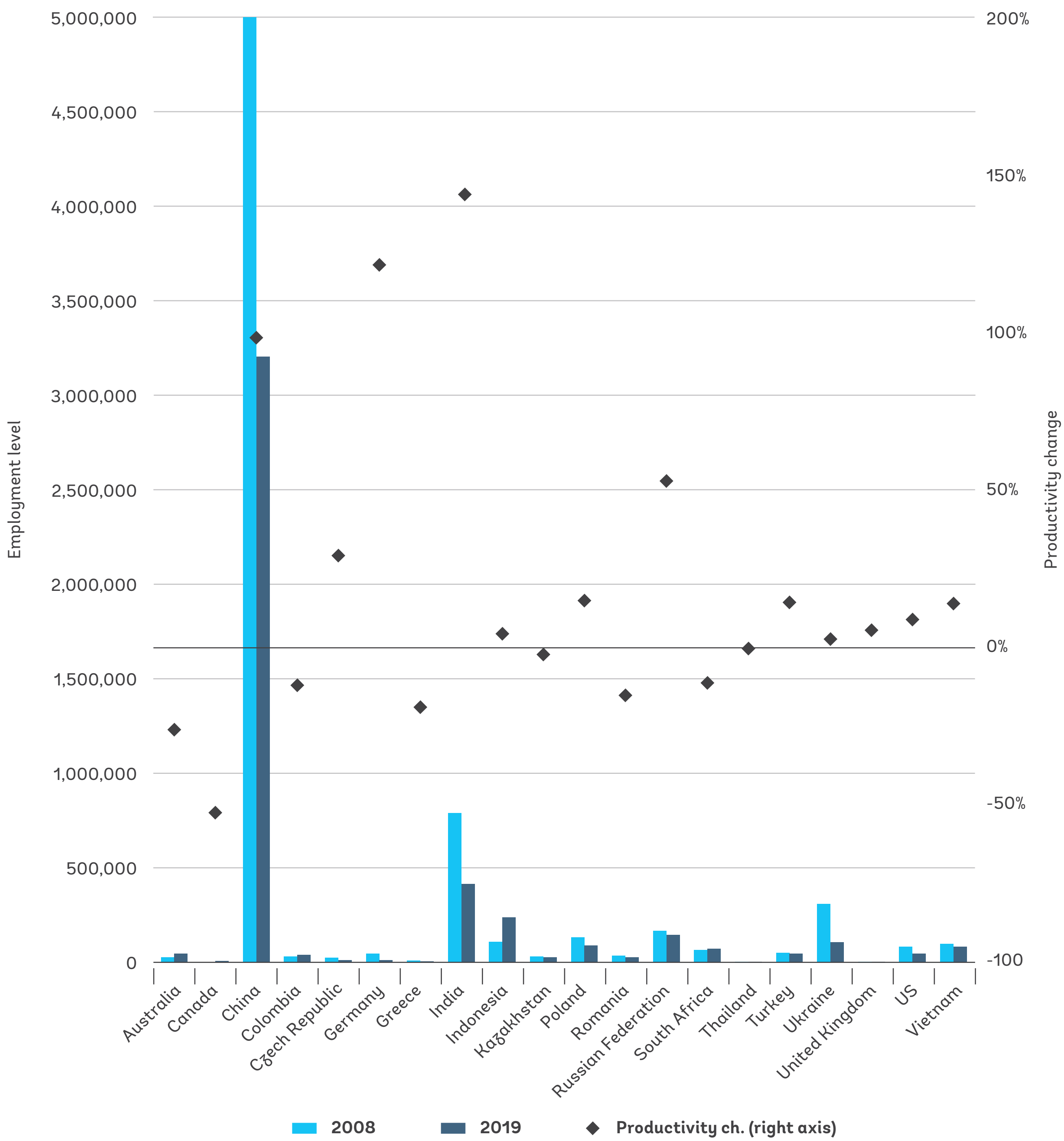
Beginning around 2008, ILOSTAT data reports coal and lignite mining activities separately from other mining and quarrying. Coal-sector disaggregated data for European countries became available in the mid-2000s, reported by the European Commission's Euro Stat, and subsequently also collected by UNIDO, but these data are not perfectly consistent with ILOSTAT figures, even in later years.

In order to consider longer time trends, it is necessary to rely on country-specific micro datasets on labor outcomes (as we have done for Indonesia, South Africa and India; see Chapter 4) or on alternative administrative or secondary sources, which tend to be available only for the historically large coal producers.

[8] This figure captures coal and lignite mining employment in the top 20 coal-producing countries; data are for 2019 or most recent available (2018 for China and Indonesia; 2017 for Czech Republic, India, Ukraine and Vietnam; 2016 for Kazakhstan and Thailand). Employment data include formal and informal workers.

Figure 2.16

Coal mining employment and sector productivity change by country (2008-2019)



Note: Data are from 2008 and 2019 or closest year available. Productivity measured as coal production (in thousand tonnes) per coal sector worker; percent change compares 2019 to 2008.

Sources: Labor data from Australian Bureau of Statistics, Statistics Canada, Colombia's Gran Encuesta Integrada de Hogares, MINSTAT, ILO, India EUE and PLFS, Indonesia LFS (Sakernas), Poland data from energy.instrat.pl (coal mining company employment), ROSSTAT (Russian Federation Federal State Statistics Service), South Africa LFS, UK Department for Business, Energy and Industrial Strategy, US Bureau of Labor Statistics; production data from BP Statistical Review of World Energy 2020

Coal accounts for a declining share of total mining activities, even in countries with rapidly expanding coal production. Total mining and quarrying employment in our 20-country sample was around 12 million in 2019, but coal's share of these mining and quarrying jobs fell from 24 percent in 2008 to only 17 percent today (excluding China[9]; Table 2.1). Extractive industries expanded their share of total output in the mid-to-late 2000s, as coal gained importance in the mineral-coal-natural gas-oil extractives mix. But in the years since, coal's share in total extractives output returned to the historical levels of the mid-1990s (WDI data).

Table 2.1

Coal employment in top 20 coal-producing countries

	Coal & Lignite Employment		Mining & Quarrying Employment		Coal & Lignite/ Mining & Quarrying	Coal & Lignite/Total Employment
	2008	2019	2008	2019	2019	2019
Australia	30,142	50,368	180,812	251,659	20%	0.4%
Canada	5,095	7,845	55,105	74,245	11%	0.0%
China	5,000,000	3,209,000	5,400,00	4,140,000	78%	0.4%
Colombia	34,620	44,338	167,512	182,293	24%	0.2%
Czech Republic	24,024	15,064				0.3%
Germany	47,626	14,932	107,460	71,607	21%	0.0%
Greece	6,852	3,496	16,953	11,064	32%	0.1%
India	795,176	416,240	2,849,133	1,828,969	23%	0.1%
Indonesia	108,210	240,041	1,077,800	1,690,150	14%	0.2%
Kazakgstan	34,035	29,686	201,990	279,531	11%	0.3%
Poland	136,608	92,601	229,227	206,086	45%	0.5%
Romania	38,143	27,055	102,076	64,356	42%	0.3%
Russian Federation	168,800	150,100	1,331,573	1,651,398	9%	0.2%
South Africa	66,206	74,827	339,833	418,994	18%	0.5%
Thailand		861	59,995	73,242	1%	0.0%
Turkey	51,950	47,955	113,478	152,607	31%	0.2%
Ukraine	305,867	110,822	618,132	448,384	25%	0.6%
United Kingdom	6,157	699	132,235	135,088	1%	0.0%
US	86,300	47,700	626,656	623,717	8%	0.0%
Vietnam	102,541	86,399				0.2%

Note: China data from 2008, 2018; Colombia 2009, 2019; Czech Republic 2010, 2017; India 2009, 2017; Kazakhstan 2012, 2016; Russian Federation 2010, 2019; Thailand 2016; Turkey 2009, 2019; Ukraine 2012, 2017.

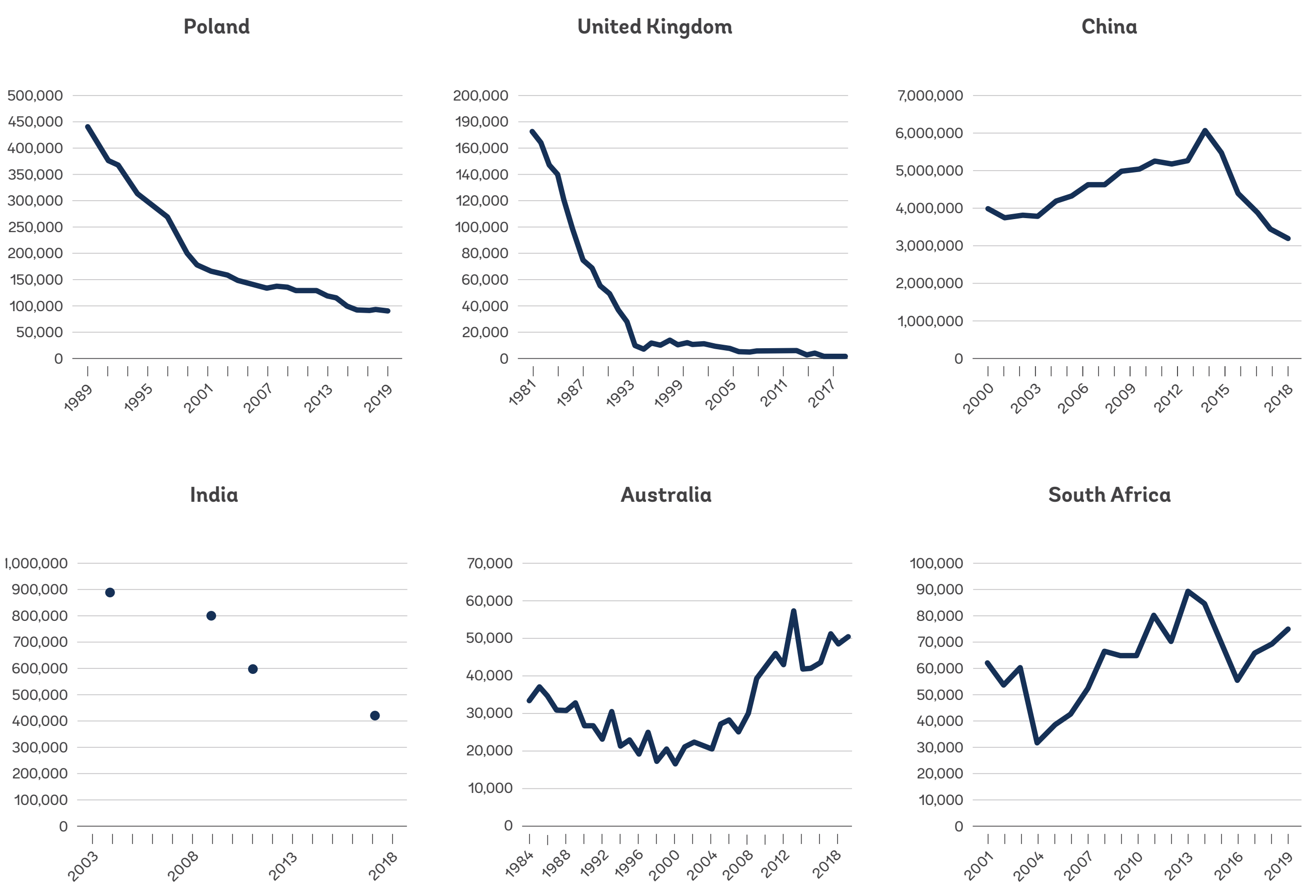
Sources: Coal employment data as Figure 2.17; mining and quarrying employment data (unless available in original source listed in Figure 2.17) from ILO; total employment data from ILO (except Colombia)

[9] Coal accounts for about three-quarters of employment in China's mining and quarrying sector (mining and quarrying employment data is from China's National Bureau of Statistics; coal employment data is from China Coal Technology & Engineering Group).

Countries that have transitioned away from coal production – namely, the advanced transitioners – experienced significant coal mining job losses long before the recent contraction in the last decade. Looking back to the 1980s, coal mining employment was over 416,000 in Poland, 365,000 in Germany, and 172,000 in the UK; in these countries, governments took aggressive phase-out measures to close mines and shed a significant share of workers (Figure 2.17). Today, the UK employs less than a thousand in the sector, Germany's coal mining employment is under 15,000, and in Poland, where mining activities are ongoing, total coal mining employment is around 93,000. The US trajectory has been relatively gradual, dictated more by market forces, disperse private ownership, and new open-pit investments in the western region which displaced labor-intensive underground mines in Appalachia. The move to alternative energy sources has not heretofore generated

Figure 2.17

Long-term coal mining employment trends in selected countries



Sources: Australian Bureau of Statistics, China Coal Technology & Engineering Group, India EUE and PLFS, Poland data from energy.instrat.pl, South Africa LFS, UK Department for Business, Energy and Industrial Strategy significant absorption of displaced coal workers, in large part due to skills and geographical mismatch between coal mining activities and wind/solar/natural gas supply and generation.

For countries that continue to expand coal production, some have had productivity improvements that reduced demand for labor inputs, while others increased labor demand. The degree to which the demand for labor in coal and lignite mines has increased or decreased varies by country, as does the labor-intensity associated with different types of coal and the extraction methods used. China, for example, added two million coal mining jobs between 2000 and 2013, but subsequently shed nearly 3 million jobs while tripling its productivity. Coal mining jobs in India fell from 890,000 in 2004 to 416,000 by 2017, and productivity more than doubled. In Australia, by contrast, a period of steady decline in the 1980s and 1990s reversed direction in 2000, after which nearly 34,000 jobs were added to the coal mining sector. In South Africa, coal sector contraction in the early 2000s gave way to robust job creation; over the past 15 years, 43,000 coal mining jobs have been added and productivity declined by 50 percent.

This rather mixed snapshot of coal mining employment at the global level suggests significant country-level heterogeneity; coal employment dynamics therefore need to be analyzed at the country level – and even at the sub-national level – to gain a more comprehensive understanding. Like coal production trends, coal employment manifests disparate trends across countries and over time. Heterogeneity in types of coal and extraction technologies affects the size and skill-composition of the coal sector labor force in each country. Other non-coal factors are also determinant, such as the composition of economic sectors and the distribution of employment across these sectors, the size of the coal sector relative to other sectors, and governments' commitment to and progress toward a post-coal transition. In Chapter 3, we consider the role of coal in observed patterns of structural economic transformation, and in Chapter 4, we present detailed analysis of coal mining employment within specific country labor markets for five country examples.

CHAPTER 3

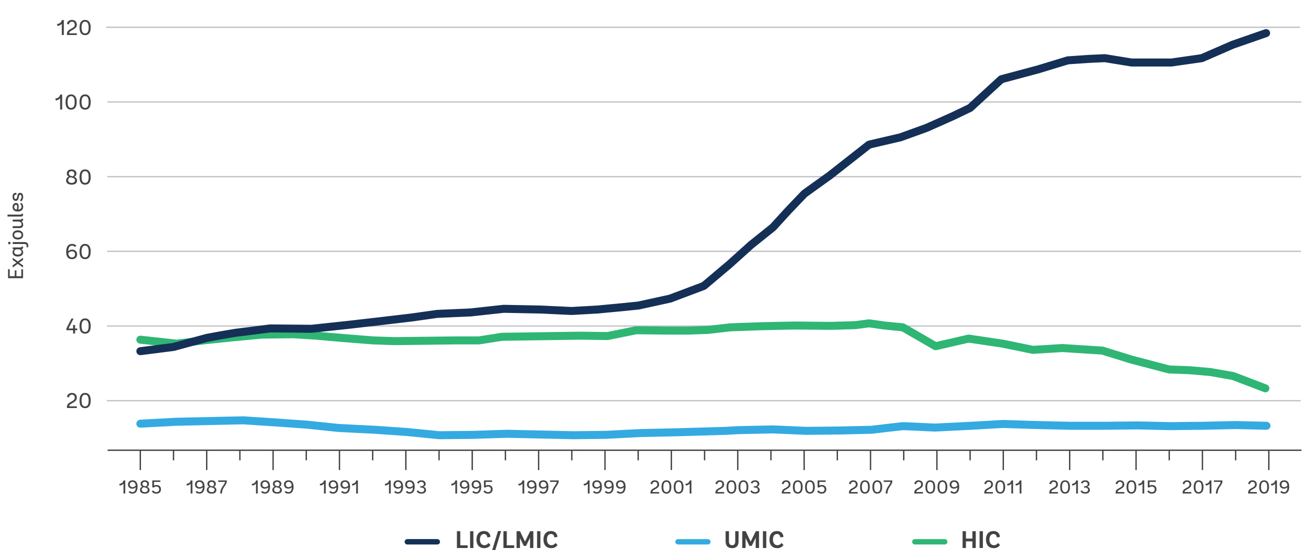
Coal's Role in Structural Transformation

3.1 Coal Consumption Patterns Change with Economic Development

Coal's share of global energy consumption has remained steady in recent decades, but increased strongly in emerging economies. And the pattern is similar with respect to coal-fired electricity. Coal consumption patterns were relatively flat from 1985 to around 2000, both in aggregate and across countries at different levels of development. But the last two decades saw a sharp rise in coal consumption by low income and lower-middle income countries concurrent with rapid GDP growth rates,[10] while higher income coal demand stagnated or declined (Figure 3.1). As upper middle-income and especially high-income economies transitioned to cleaner and more sustainable sources of energy and electricity generation, low and lower-middle income countries not only increased their coal consumption; they also increased their coal dependence. Figure 3.2 illustrates that coal meets nearly half of low and lower-middle income countries' energy needs, compared to less than twenty percent in richer countries. Much of this is due to LIC/LMIC investments in increasing coal-fired electricity generation capacity to meet rising electricity demand of their large and expanding populations and their growing economies. At the same time, higher income countries have been phasing out coal power plants in favor of alternative sources; UMICs have largely shifted toward oil and gas sources, and HICs are increasingly investing in non-fossil fuel power generation (Figure 3.3).

Figure 3.1

Coal consumption by country income group (1985-2019)



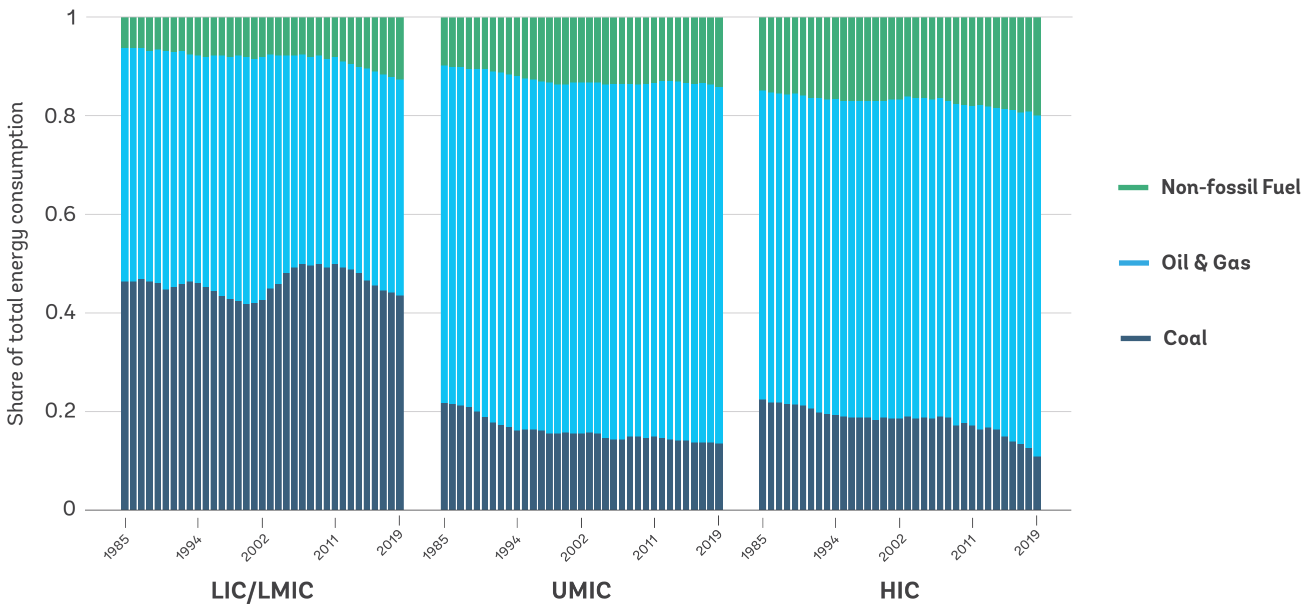
Note: Country income classification on the basis of 1991 WB classification

Source: Authors' calculations based on BP Statistical Review of World Energy

[10] Note that because country income classifications are based on 1991 incomes, countries such as China, Chile, Ecuador, India, Malaysia, Romania, Peru and Turkey fall under the LIC/LMIC category. In total there are 18 countries that had transitioned from LIC/LMIC status to UMIC or HIC status by 2019.

Figure 3.2

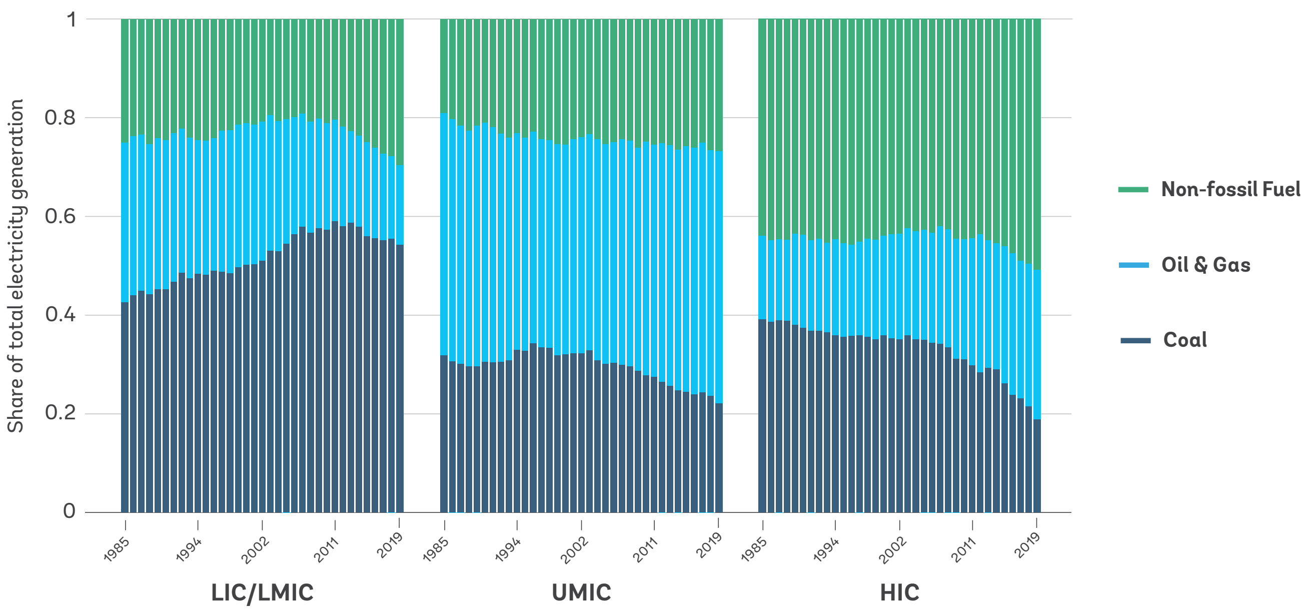
Source of energy consumption by country income group (1985-2019)



Note: Country income classification on the basis of 1991 WB classification
Source: Authors' calculations based on BP Statistical Review of World Energy

Figure 3.3

Electricity fuel sources by country income group (1985-2019)

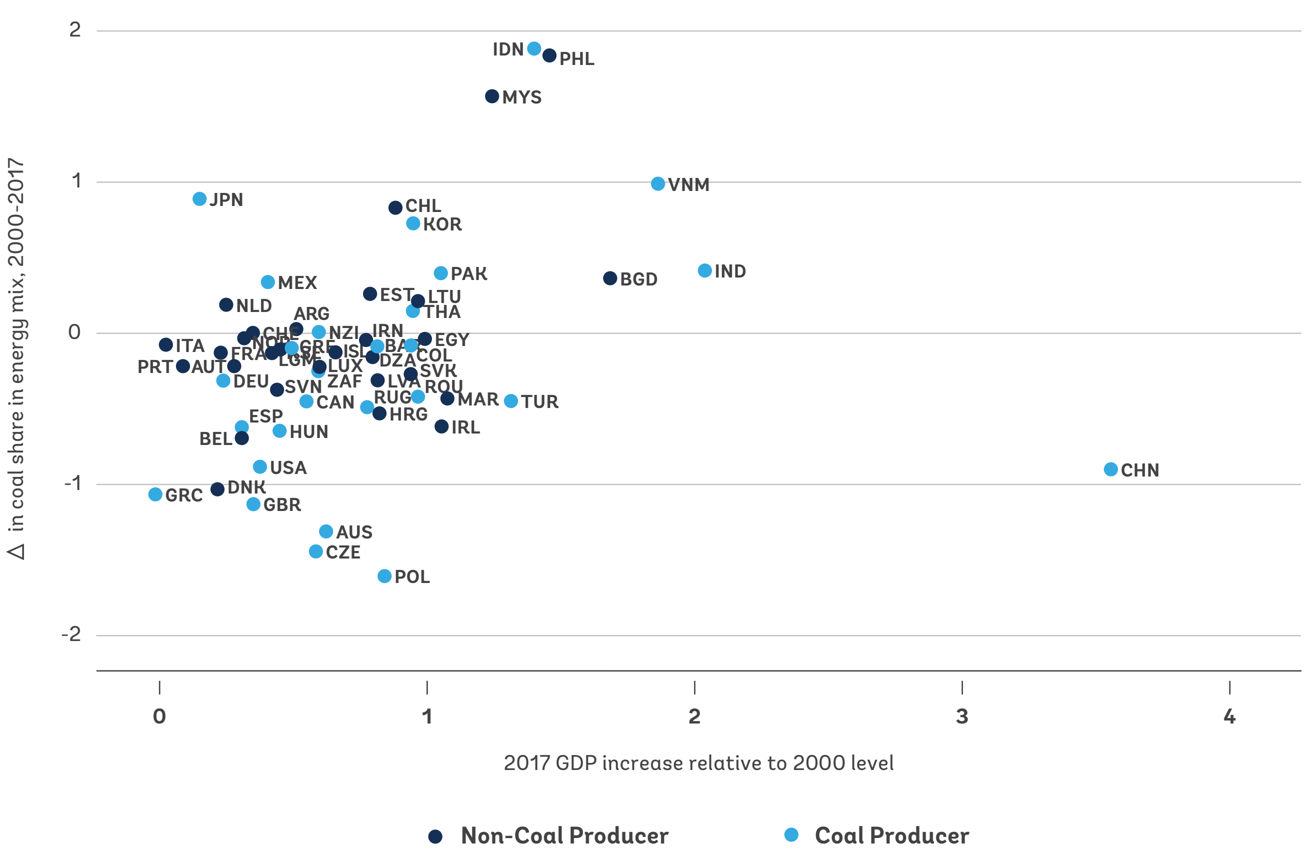


Note: Country income classification on the basis of 1991 WB classification
Source: Authors' calculations based on BP Statistical Review of World Energy

Countries experiencing faster GDP growth since 2000 tended to increase their dependence on coal during the same period. We observe a positive (non-causal) correlation between GDP growth rate and rising coal intensity, and this relationship holds for both coal producing countries and non-coal producers (Figure 3.4). India, Vietnam and Indonesia were the fastest-growing coal producing economies between 2000 and 2017 (when we exclude China), and each saw an intensification of coal energy dependence. Greece, Spain, Great Britain, and the US posted the lowest GDP growth during this period while shifting away from coal-based energy. In several fast-growing economies – namely Vietnam, Indonesia, and Pakistan – coal consumption grew faster than GDP. Note that China is an outlier both for its rapid GDP growth and because its coal intensity fell between 2000 and 2017 as oil intensity increased. There are many factors underpinning the observed positive correlation between GDP growth and coal-intensity, which we do not analyze here; rather, we examine *how* the role of coal changes during the process of structural economic transformation, and the concurrent impact on jobs.

Figure 3.4

Correlation between GDP growth and coal-intensity of energy consumption



Source: Authors' calculations based on BP Statistical Review of World Energy and WDI data

In broad terms, structural transformation occurs as jobs shift from low-productivity primary sectors into higher productivity industry and services sectors. As economies develop from low per capita income levels and low-productivity structures of production to higher value-added activities, they shift away from primarily agriculture-based production in unpaid or own account work toward more capital-intensive production based in firms and employing waged labor. Subsistence producers become more market-oriented, selling their surplus production and/or transforming it into processed goods sold to consumers. As firms specialize and become more productive, they expand operations to meet a wider client base, invest in capital and hire more labor that is increasingly specialized and skilled. Industrial activity requires services as inputs to production, and at the same time, wage workers in industrial sectors consume services that they did not require as subsistence producers. As the share of the labor force engaged in agriculture declines, the share of wage employment rises.

Transformation also occurs as jobs within the same sector become more productive. Firms upgrade production technology and product quality, while new firms may enter the same industry, introducing innovations. Both of these are examples of within-sector productivity gains. Labor mobility is essential for workers to change sectors and move between firms within the same sector, and this labor flow drives down productivity differences.[11] Firm-based wage jobs are of better quality[12], and higher productivity jobs pay more. The emergence of increasingly sophisticated government services and regulations adds the formality dimension, which brings labor protections, better working conditions and social insurance coverage in formal wage employment.

Most economies that experienced rapid structural transformation in the period since 1991 were relatively coal-intensive. For a sample of 91 countries, we compare the rate of economic transformation by decomposing labor productivity gains into within-sector productivity gains and across-sector productivity gains as employment shifts into higher productivity activities. We consider the rate of change over three separate periods: 1991-2000, 2000-2009, and 2009-2018. Some countries made faster across-sector productivity gains (shown in the bottom right quadrant of Figure 3.5), others made faster within-sector gains (upper left quadrant), and those that had both types of gains (in the upper right quadrant) are considered to be the fastest transformers, benefiting from the dynamic interaction of the two. There are more growth episodes falling into this upper right quadrant, especially among coal-intensive countries (defined as those where coal contributes over 20 percent of total energy needs). Some of these are coal producing countries that benefited from the availability of cheaper energy, but many are not coal producers. When we consider only LIC countries[13], the pattern is even stronger: coal-intensive countries (denoted

[11] See Jobs Diagnostic background note "Structural change, growth and labor market dualism in developing economies" (Jobs Group, World Bank, forthcoming) for a more extensive discussion.

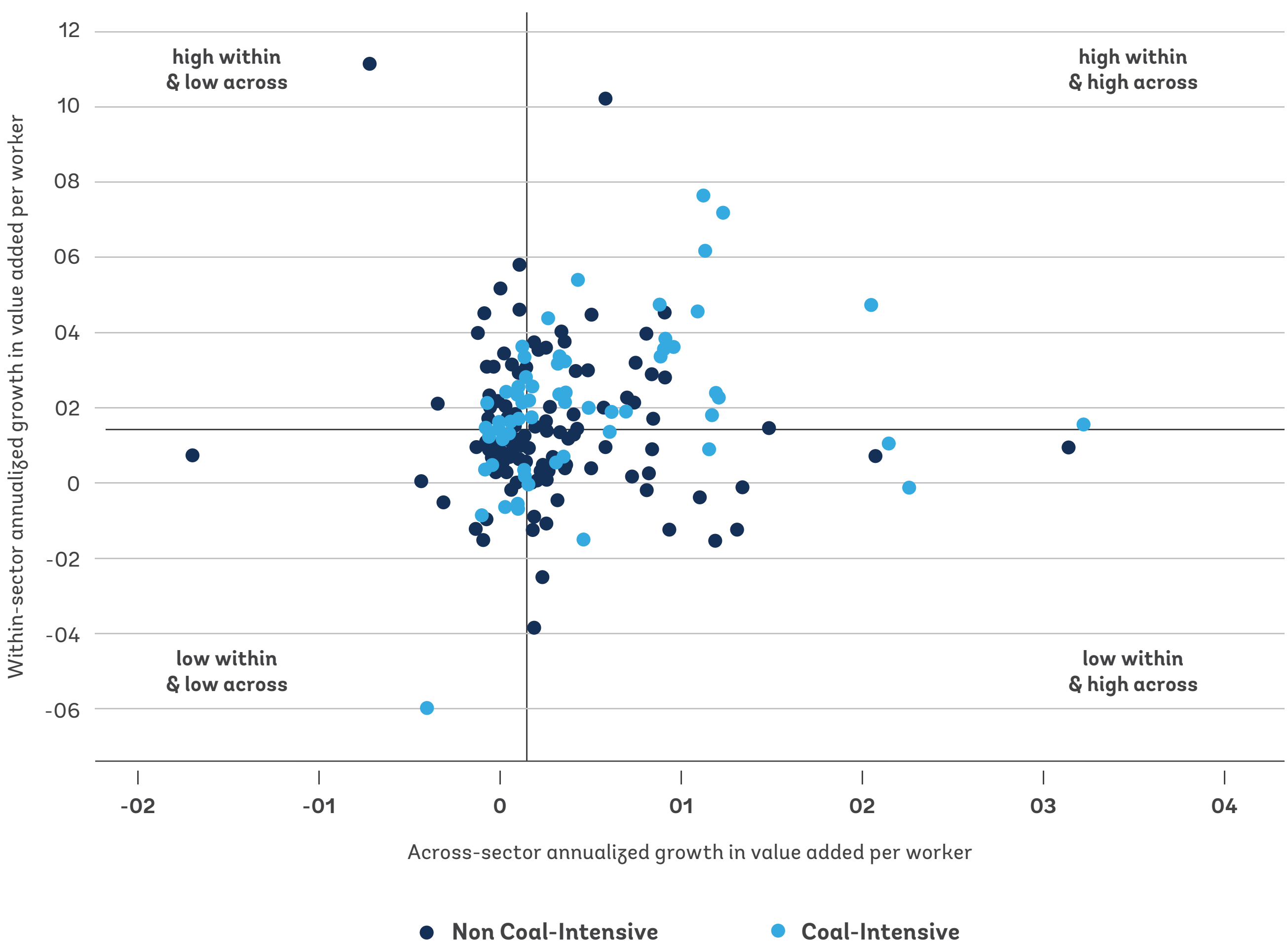
[12] That is, when traditional measures of quality are used, such as compensation and worker protections; this may not be the case when large negative environmental or social externalities are present.

[13] Country income category defined based on 1991 status.

by light blue dots in Figure 3.6, panel a) had more high-high growth episodes compared to non coal-intensive-countries. A similar pattern emerges when comparing structural transformation in coal producing countries to non-coal producers; LICs that were also large coal producers[14] experienced relatively faster structural transformation (Figure 3.6, panel b). Note that we also observe many coal-intensive and non coal-intensive countries in the low-low category.

Figure 3.5

Decomposing structural transformation patterns in 91 countries, 1991-2018



Note: High/low thresholds defined on the basis of above/below median productivity gains for within- and across- components respectively between 1991 and 2018. Countries defined as 'coal-intensive' when coal contributes more than 20% of total energy needs at start of episode.

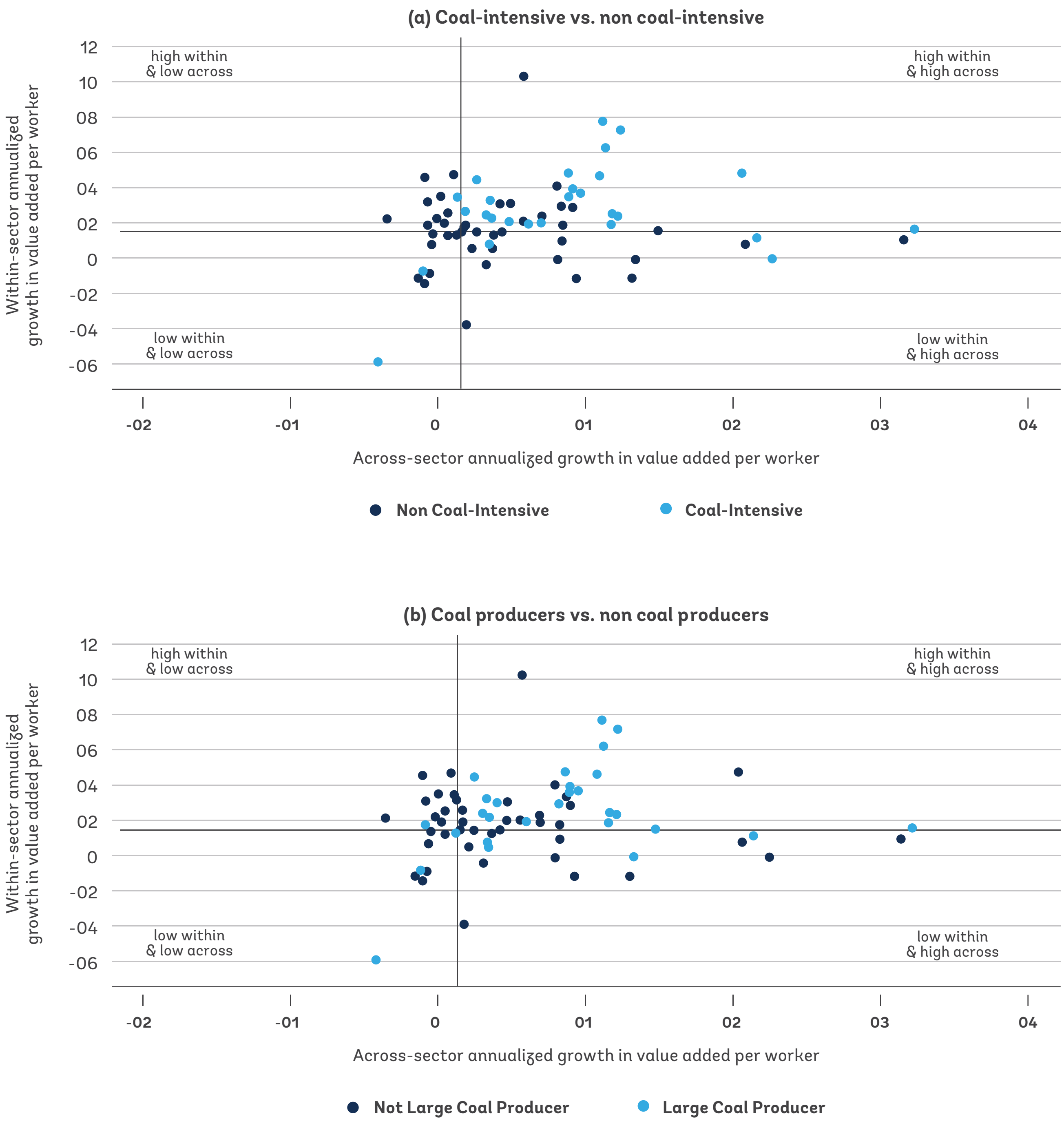
Note: Each dot corresponds to a country growth episode, with episodes defined over the following periods: 1991-2000, 2000-2009, 2009-2018.

Source: Authors' calculations based on WDI data and BP Statistical Review of World Energy.

[14] Those among the top 20 coal producing countries identified in Chapter 2.

Figure 3.6

Decomposing structural transformation patterns in 28 low-income countries, 1991-2018



Note: High/low thresholds defined on the basis of above/below median productivity gains for within- and across- components respectively between 1991 and 2018. Countries defined as 'coal-intensive' when coal contributes more than 20% of total energy needs at start of episode.

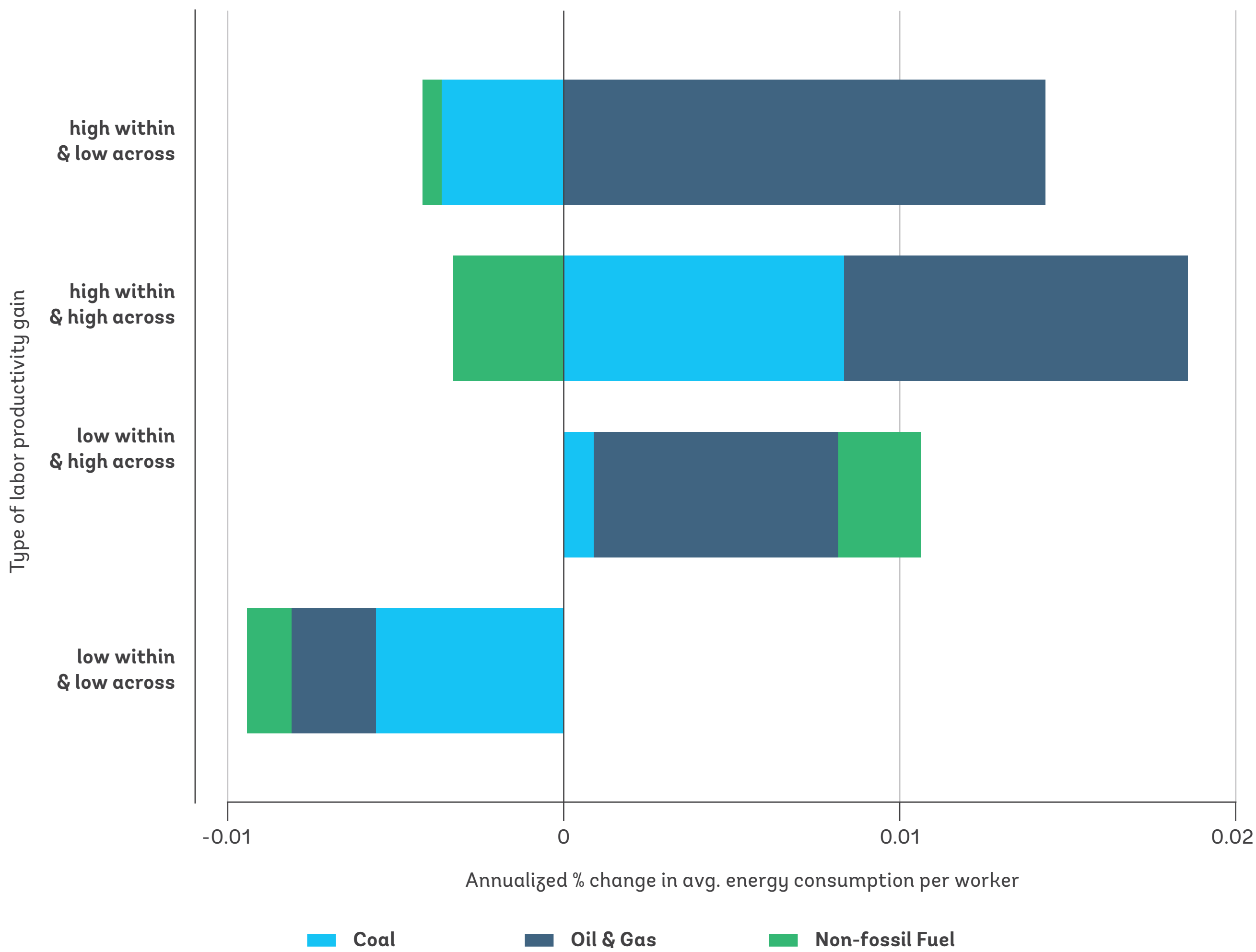
Note: Each dot corresponds to a country growth episode, with episodes defined over the following periods: 1991-2000, 2000-2009, 2009-2018.

Source: Authors' calculations based on WDI data and BP Statistical Review of World Energy.

Countries undergoing more rapid structural change also experienced higher growth in energy consumption per worker. It is interesting to note that the fastest transformers (high within, high across) increased their per-worker coal consumption, while countries with low across-sector productivity gains reduced their coal consumption during the period, especially those with low within and low across productivity growth (bottom of Figure 3.7). We would expect more high-income economies to have low across-sector productivity growth (that is, being in an advanced stage of structural transformation), so this finding is consistent with evidence that advanced economies are transitioning away from coal toward alternative energy sources.

Figure 3.7

Change in energy consumption by fuel source and pattern of structural transformation



Note: High/low thresholds defined on the basis of above/below median productivity gains within- and across- components respectively between 1991 and 2018.

Source: Authors' calculations based on WDI data and BP Statistical Review of World Energy

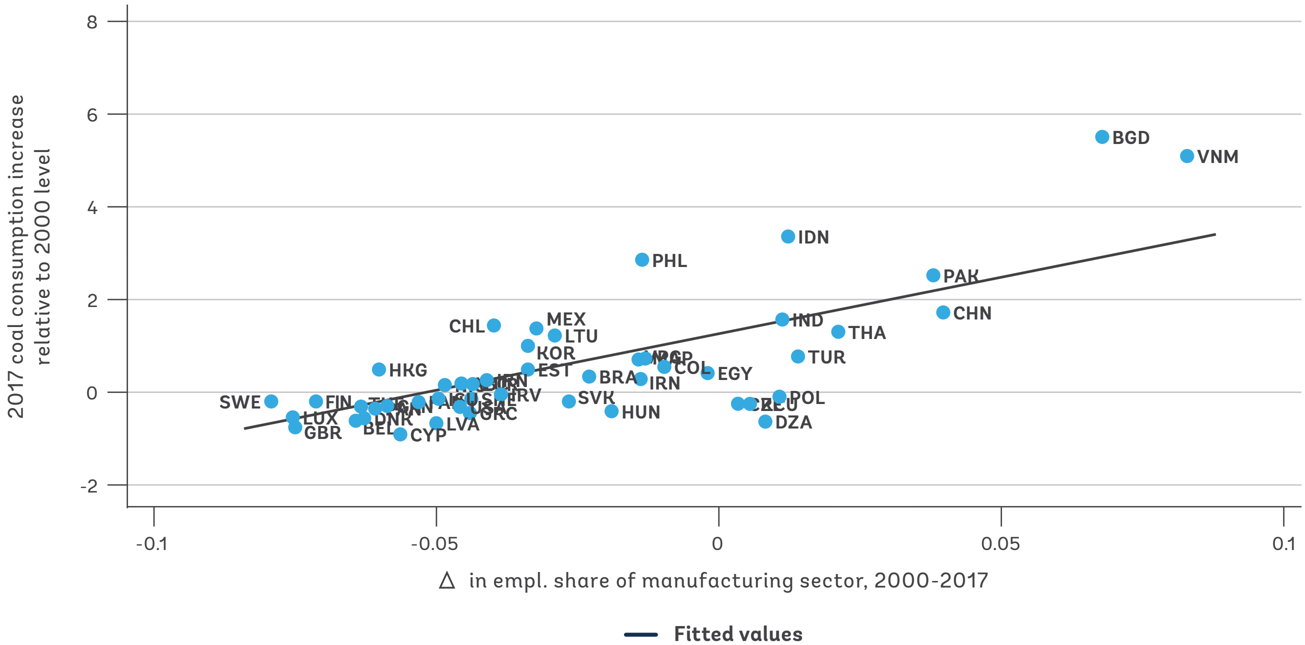
3.2 Coal's Direct and Indirect Use in Manufacturing

The observed linkages between coal and labor productivity are largely driven by growth patterns in the manufacturing sector. All countries that experienced moderate-to-rapid productivity gains on account of labor reallocations into industry and/or within industry improvements intensified their coal-based electricity use or coal-fired combustion, while productivity gains on account of the services sector were less strongly associated with increases in coal-based electricity intensity. Most manufacturing activities require energy inputs. Growth in manufacturing employment and coal consumption move hand in hand[15] (Figure 3.8), and especially growth in labor-intensive low-productivity manufacturing. This suggests that the rapid structural transformation in coal-intensive countries was associated with an influx of labor to the manufacturing sector from less productive agriculture or services activities (such as own account production or informal personal services or retail jobs). This finding is underscored by comparing the manufacturing employment share across countries of different income levels and different resource intensities. We expect to observe a concave relationship, namely rising manufacturing share in the early stages of economic development followed by declining manufacturing share as high-income economies shift increasingly into skilled services. This "graduation" pattern indeed holds for both non coal and coal-intensive countries, albeit with higher manufacturing employment shares in the latter (Figure 3.9).

[15] This positive correlation also holds for other sectors.

Figure 3.8

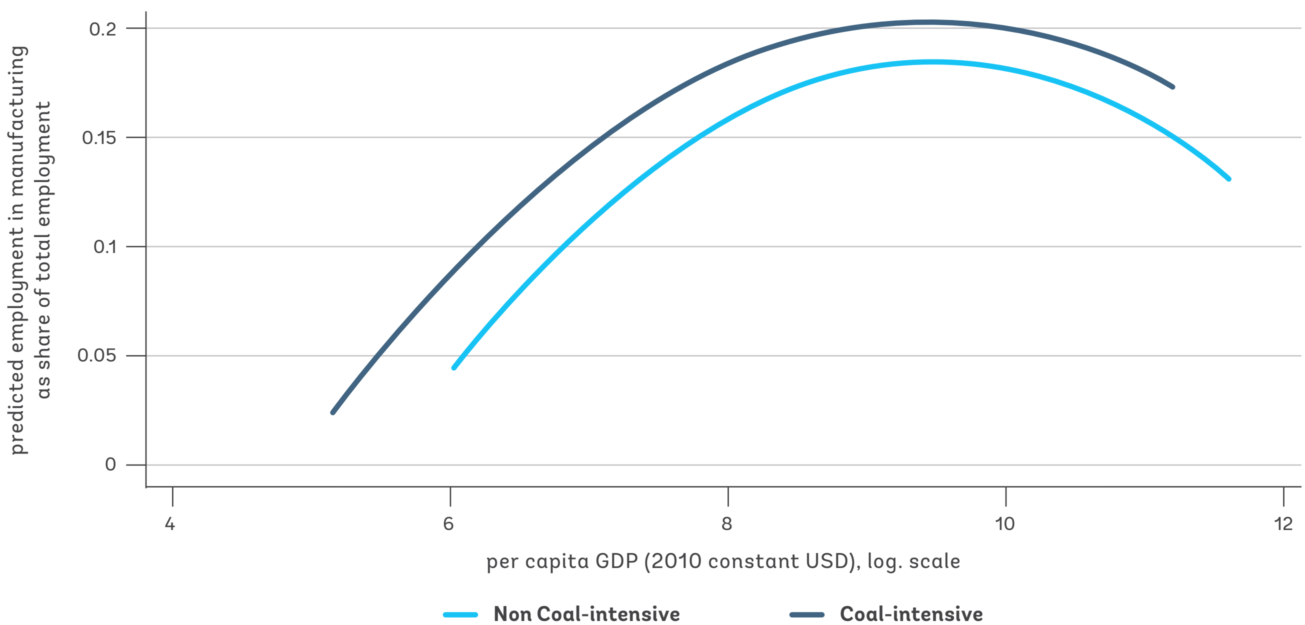
Correlation between coal consumption and manufacturing employment



Source: Authors' calculations based on BP Statistical Review of World Energy and WDI data

Figure 3.9

Both coal-intensive and non coal-intensive countries eventually shift away from manufacturing



Note: Countries defined as 'coal-intensive' when coal contributes more than 20% of total energy needs at start of episode.

Source: Authors' calculations based on WDI data, World Bank Cross-Country Database of Sectoral Labor Productivity (Dieppe and Matsuoka, 2020), and BP Statistical Review of World Energy

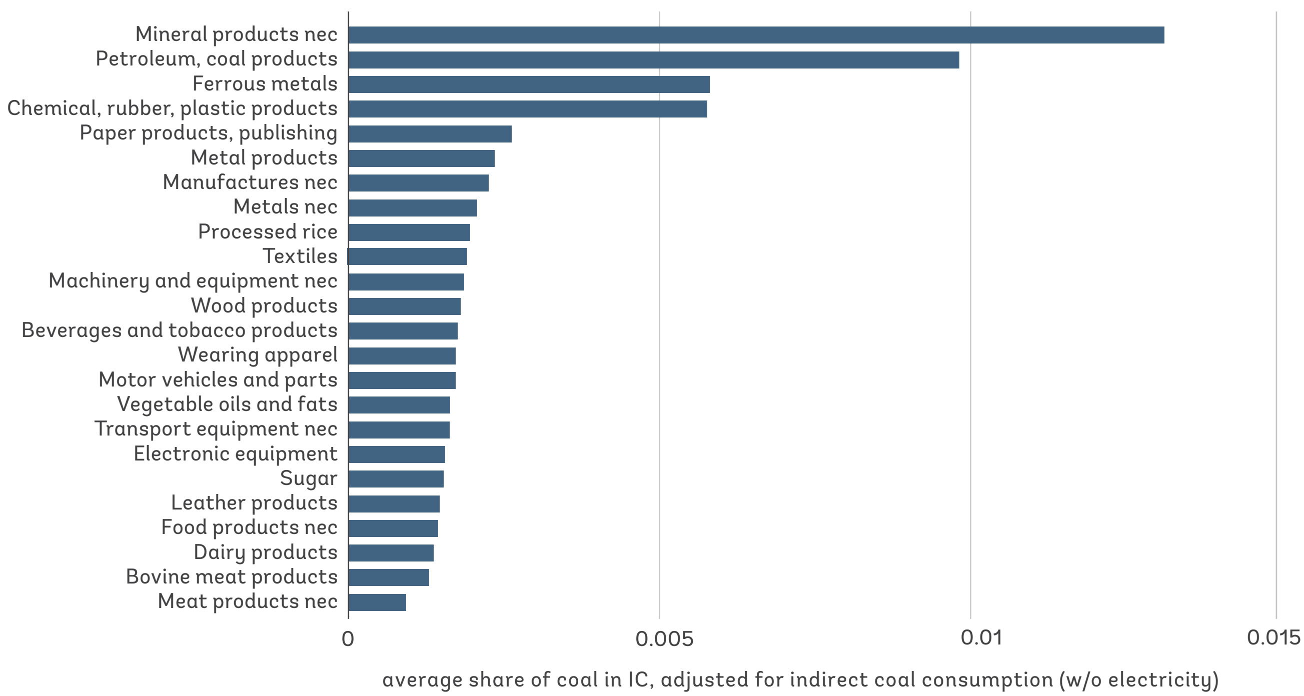
Coal's role in electricity generation is not the only driver of this manufacturing link; coal and its derivatives are also used as inputs to production in many manufacturing sub-sectors, such as steel, chemical and metal products, and even in light manufacturing. Analyzing data from input-output tables for 121 countries in the Global Trade Analysis Project (GTAP) database (methodology described in Annex 1) indicates that as an intermediate good, the utilities sector is by far the largest consumer of coal, namely for power generation. But coal is also a direct input for many manufacturing subsectors, notably in heavy manufacturing dominated by chemicals and metals industries, and an indirect input to many other manufacturing subsectors – e.g., paper products, processed rice, textiles, wood products, motor vehicles and parts, and processed foods (Figure 3.10).

As economies grow and transition to higher-value production activities, coal's importance in manufacturing wanes. Historical patterns of early-stage economic transition from agriculture-based production to labor-intensive light manufacturing, resource-intensive heavy manufacturing and low-productivity services eventually give way to more sophisticated manufacturing and services that are more human capital-intensive, rely less on coal, and add more direct and indirect value to the economy. The pattern of declining coal inputs to manufacturing holds across both coal- and non-coal producers, although the shares of coal-inputs are higher in coal-producing countries (illustrated in Figure 3.11).

Figure 3.10

Sectors' use of coal as a direct or indirect input to production

(% of intermediate consumption; excludes electricity)



Source: Authors' calculations based on GTAP I/O tables

Figure 3.11

Comparison of indirect coal inputs to manufacturing by country income group

Note: X axis represents average share of coal in IC, adjusted for indirect coal consumption (w/o electricity)

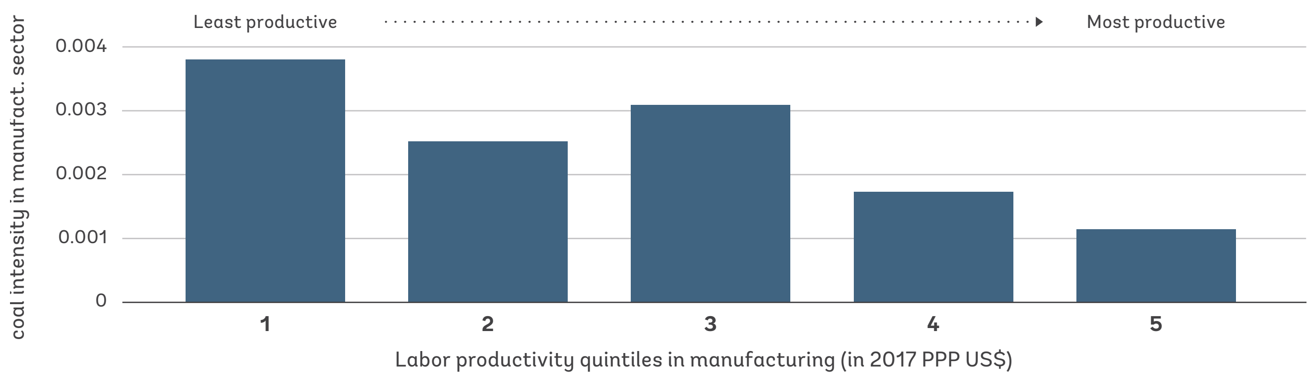
Source: Authors' calculations based on GTAP I/O tables

The link between coal-intensive manufacturing and job quality is complicated. In static terms, average productivity levels in heavy manufacturing sub-sectors within LIC/LMICs tend to exceed those in apparel and food and beverage manufacturing activities and pay higher relative wages. This means better-quality jobs in heavy manufacturing compared to alternatives in light manufacturing or in the low-productivity agriculture and service jobs prevalent in most developing economies. On the other hand, heavy manufacturing is more capital-intensive and therefore creates fewer jobs.[16] In dynamic terms, as economies shift up the value chain and increase their reliance on more sophisticated ICT-intensive manufacturing and high-skilled services and reduce their reliance on coal inputs and less-skilled labor, the manufacturing sector becomes more productive and generates better quality jobs. This pattern is confirmed when comparing manufacturing productivity levels and manufacturing coal-intensity across the global GTAP database; Figure 3.12 indicates that countries with the least productive mix of manufacturing activities (those in the lowest quintile) use more coal in their manufacturing sectors than countries with higher manufacturing productivity. The upward trajectory of productivity and job quality inherent to economic structural transformation aligns with broader objectives of transitioning away from economic dependence on coal and other fossil-fuels.

The degree to which coal-intensive manufacturing patterns in emerging economies matter for advancing up the value chain to more sophisticated, higher-value production is unclear. But when economies have a large number of indirectly coal-linked manufacturing jobs in addition to direct coal jobs associated with coal-fired electricity and coal extraction, a coal-centric structure of economic production may in fact slow the diversification of economies toward higher productivity activities. This theme will be explored in the next chapter.

Figure 3.12

Coal intensity and labor productivity in manufacturing



Note: Coal intensity in manufacturing sector calculated as average intensity across all GTAP manufacturing sub-sectors in each country on the basis of measure (iii) of Annex 1

Source: Authors' calculations based on GTAP I/O tables and World Bank Cross-Country Database of Sectoral Labor Productivity (Dieppe and Matsuoka, 2020)

[16] Note that the net impact on aggregate productivity of creating a small number of highly productive jobs in heavy manufacturing versus a large number of less productive jobs in light manufacturing may be positive or negative.

CHAPTER 4

Labor Market Implications of Coal Production in Five Country Case Studies

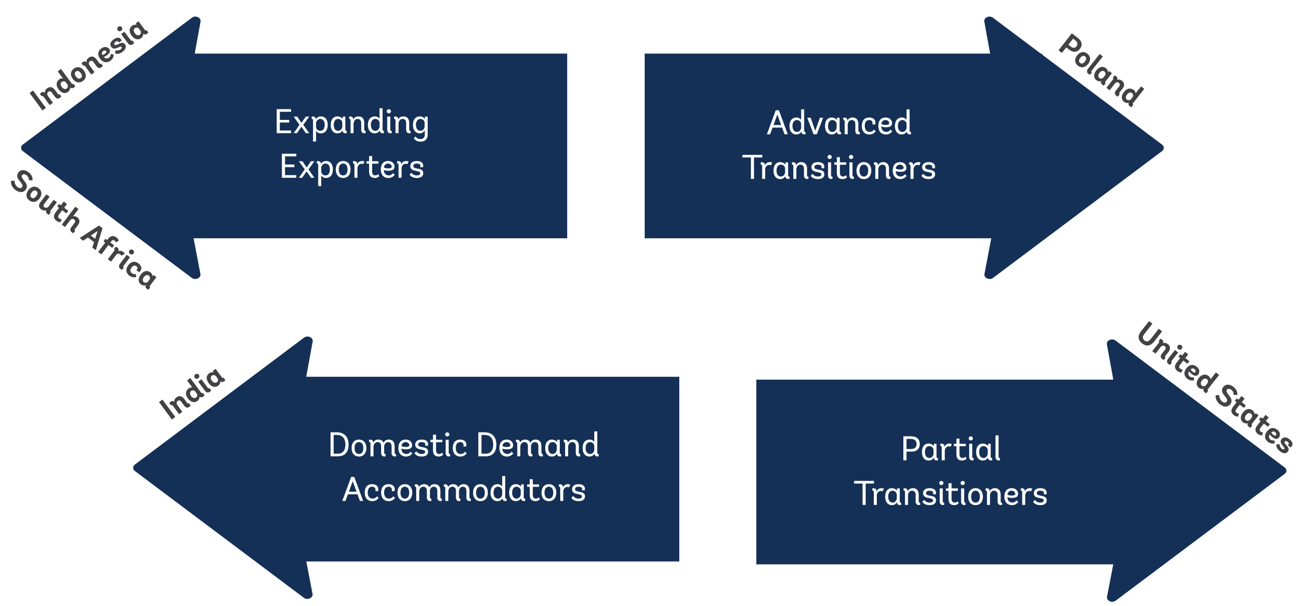
4.1 Direct and Indirect Effects of Coal Demand on Coal and Non-coal Jobs

Global coal mining employment trends belie significant heterogeneity at the country level. Rising coal production may or may not be accompanied by an increase in coal mining employment; the analysis in Chapter 2 presents a rather mixed picture, even when comparing employment trends within the largest and fastest growing coal producers. To what extent are countries' coal production patterns linked to their coal employment patterns? In other words, are there common patterns among the various categories of coal producers defined above, namely the (i) advanced coal transitioners, (ii) partial transitioners, (iii) accommodators of domestic demand, and (iv) expanding exporters?

Five country case studies help to unravel the production-employment link. In this chapter, we explore these questions through the lens of specific country experience, illustrating some of the complex realities behind past and present coal production and employment in five countries. These examples reflect a wide array of experiences and provide the basis for considering the future job implications of changing demand for coal. Countries were selected to represent the different categories of coal producers, noted in Figure 4.1, with two examples to illustrate the expanding exporter category – Indonesia and South Africa – due to their distinct labor market contexts.

Figure 4.1

Four categories of coal producers, five country examples



Job quality is at the core of economic development and well-being. As discussed in the previous chapter, economies undergo structural transformation from largely agricultural or primary production-based activities performed by self-employed or low-wage workers using unsophisticated production technologies (manual rather than mechanized) with low-quality inputs and serving local markets on the one hand, to more industrialized activities centered in firms with many workers, specialized by task, and using more capital inputs to generate more added value and selling to larger (urban, national or external) markets. Wage employees who engage in more productive work earn a higher return (i.e., salary) than workers in low-productivity activities. For individuals, higher earnings facilitate increased consumption and may facilitate household savings, enabling investment in physical assets and/or human capital, as well as access to social insurance (e.g., in a formal wage job) and/or an old-age pension. These investments, in turn, facilitate household human capital and income gains not only within the family but also intergenerationally, enabling even low-endowment families to transition eventually out of poverty to middle-class status.

Are coal mining jobs of high quality? What counts as a good job? Different criteria can be used to rate job quality, such as compensation, working conditions, social externalities, or environmental and economic sustainability considerations. These criteria are likely to vary between a worker's perspective, his/her family's perspective, and society's perspective. Job quality is also a relative rather than absolute concept. Coal mining jobs tend to pay well, significantly more than local alternatives in agriculture or low-skilled services, and typically more than similar occupations in the construction and manufacturing sectors. This high wage premium – and in many settings, early retirement eligibility – reflects compensation for the hazardous nature of mining work. Underground mining jobs can mean difficult, dangerous or unhealthy working conditions, while surface mining can be highly mechanized, involving heavy machinery. Many coal mining jobs are formal and therefore subject to labor code protections and covered by social insurance.[17]

Coal production and its associated employment make a positive short-term contribution to local economic development. Coal mine investments – similar to other extractive activities – bring jobs and economic stimulus and their associated tax revenue to otherwise small, remote and under-funded districts, many of which have above-average poverty rates. The creation of coal mining jobs spurs labor demand within coal supply chains as well as in other local sectors, as coal workers spend their wages on local goods and services, generating taxable transactions that can contribute to government coffers. Estimates of the size of the multiplier effect of added coal mining jobs vary, with evidence from advanced economies ranging from very small local spillovers (0.174 multiplier estimated by Black et al. (2005a) in four US coal states during a boom period) to modest spillovers (0.99 multiplier estimated by Moritz et al. (2017) in northern Sweden), to moderate spillovers (1.74 multiplier estimated by Farren and Partridge (2015) across 3 counties in the US state of Virginia, based on I/O modeling), to highly variable

[17] Formal employment status can be defined in different ways. The most widely used criteria is social insurance coverage. In some settings – often as a result of data limitations – formal work status is defined based on whether or not the worker has a written contract, regardless of the benefits specified in that contract.

spillover effects by sector (not significant in some sectors, but multipliers of 0.4 in real estate services, 1.2 in wholesale trade, and 1.5 in accommodation and food, estimated by Fleming and Measham (2014) in Australia).

Evidence on the longer-term effects of coal mining employment is quite negative, linked to boom and bust cycles that can undermine economic growth. Coal can be characterized as a natural resource curse because it distorts the local economy by driving up wages and potentially crowding out other economic activity. When job seekers are aware that coal mine jobs pay well-above the prevailing alternatives, they may only be induced to accept jobs with similar pay. Wage distortions can have persistent dampening effects on labor demand across multiple sectors in the local economy, ultimately constraining economic growth. There is a wide literature documenting these types of effects. For example, Van der Ploeg's (2011) literature review finds lower long-run growth rates in natural resource-intensive locations when averaged over boom and bust cycles. Black et al. (2005a) find positive job spillovers during booms, but larger negative job impacts during busts. According to Freudenburg (1992), communities "over-adapt" to extractive industries by assuming that booms are the long-term norm, while busts are temporary. Haggerty (2014) concludes that longer periods of natural resource specialization (in this case, oil and gas) result in lower average incomes. Glaeser et al. (2015) and Betz et al. (2015) find evidence that the presence of coal mines and coal employment crowd out business start-ups and entrepreneurship.

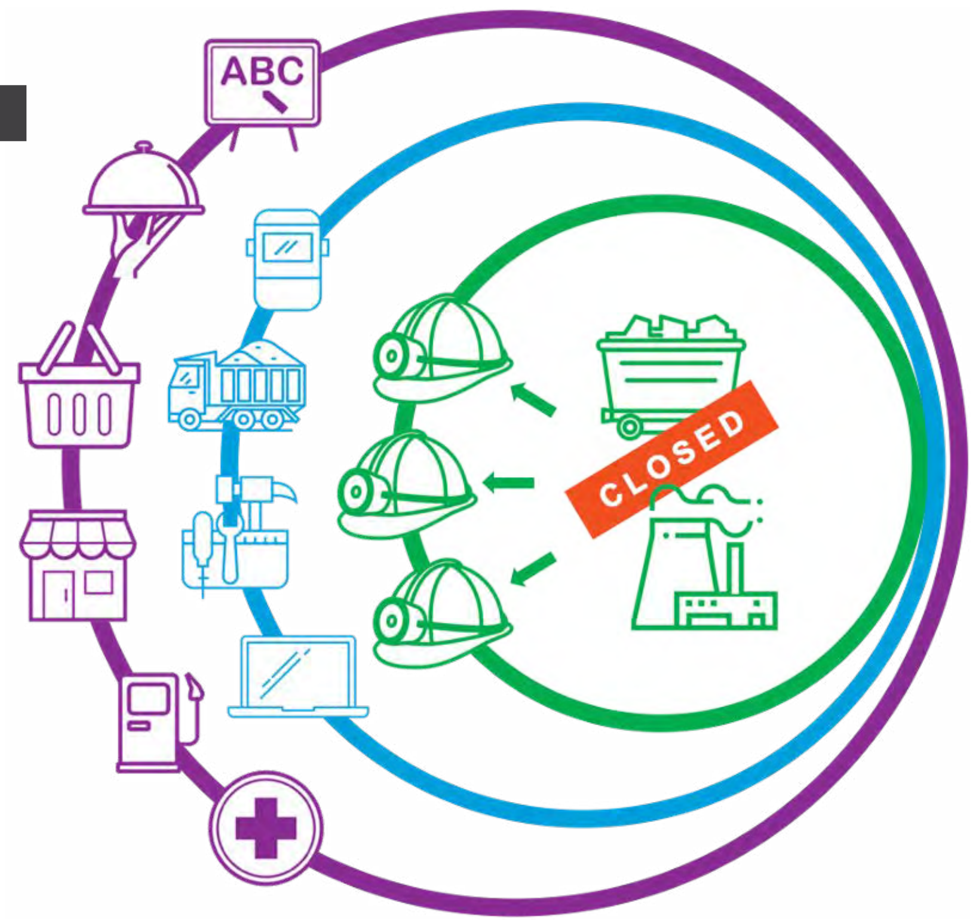
A large demand shock to coal has multiple transmission channels, both direct and indirect. Closing a coal mine means that mine employees lose their jobs. This includes miners engaged in production occupations, as well as the non-production staff performing support functions such as coal sorting, grounds and machinery maintenance, administration and management. Coal is part of a supply chain that includes inputs used to extract the coal, such as machinery and processing chemicals, and the goods and services associated with the downstream use of coal, such as transportation to the end-user, which could be a power plant, or port services and shipping for exported coal. The mine closure reduces demand for these goods and services along the supply chain, which in turn reduces labor demand in these sectors. The lost income associated with coal mine job losses and coal supply chain job losses reduces families' purchasing power, causing them to curtail consumption of local retail, entertainment and restaurant services, and even essentials like health services and food. As a result, these firms lose business and therefore earnings, which curtails their own spending and leads to reductions in operations and layoffs (these effects are often referred to as induced job losses). In this way, a negative shock to coal demand gets transmitted through multiple channels.

When a negative shock is large relative to other economic activity in the communities near the closed mine, local economies can be severely disrupted. As with any sector downsizing, there can be significant collateral damage, for both people and communities. When retrenched workers' incomes plummet and are not quickly replaced through alternative employment or other cash benefits such as severance pay or unemployment insurance, households no longer frequent local businesses and risk losing their savings and often their housing. Some families migrate for better work opportunities, accelerating the shrinking economic base. This in turn puts pressure on the tax base, as governments are unable to collect income or profit taxes from unemployed workers or insolvent businesses, and at the same time are burdened with higher spending on social assistance. The financial stress on families can contribute to negative social behaviors such as substance abusive and within-family violence (Lobao et al. 2021). In coal-dependent regions, mine closure can result in deep and prolonged economic recession as the initial shock ultimately spills over into the housing market and reduced government investment in health and education services, which in turn risk undermining human capital, weakening social capital, and contributing to increased outmigration.

The five country deep-dives that follow examine the impact of changing patterns in coal production and coal mining employment within specific country labor markets. This approach enables a better understanding of the complex short- and longer-term labor market outcomes that new coal jobs can bring, and that destroyed coal jobs can engender. Each country study begins with a description of coal production and consumption trends over recent decades, and then examines in greater detail the effects of coal mining jobs on local labor markets as well as within the broader national labor market context, exploring the extent to which coal mining employment contributes to or works against better job outcomes and stronger economic development.

Figure 4.2

Loss of coal mine jobs creates wide-ranging ripple effects

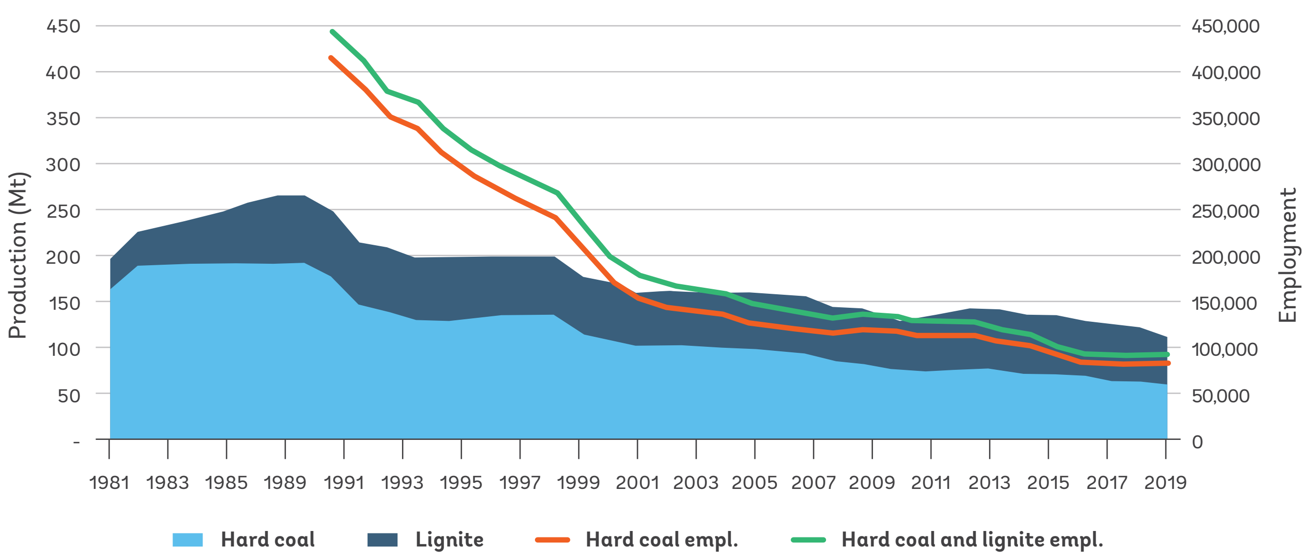


4.2 Poland: Lessons from a Long Transition

Poland's coal sector has been in gradual but steady decline since 1990. Annual production of coal fell by more than half between 1988 and 2019, driven by reductions in hard coal (Figure 4.3). Poland is the EU's second-biggest producer after Germany, when considering both hard coal and lignite together, and currently accounts for 30 percent of total EU production and 95 percent of the EU's hard coal production. Already inefficient and unprofitable before 1989, the coal mining sector subsequently came under increasing financial stress, leading the government to close mines (Baran et al. 2018). The number of operating coal mines declined from 70 in 1990 to 24 today (Kapetaki et al. 2021), and more are scheduled for closure in 2022.[18] The industry continues to suffer from weak market conditions and elevated production costs, partly due to surplus labor, and partly due to the low quality of coal produced. In the past seven years alone, coal production fell by 31 Mt.

Figure 4.3

Poland's coal production and coal mining employment



Note: Data excludes lignite mining employment.

Sources: OECD; energy.instrat.pl

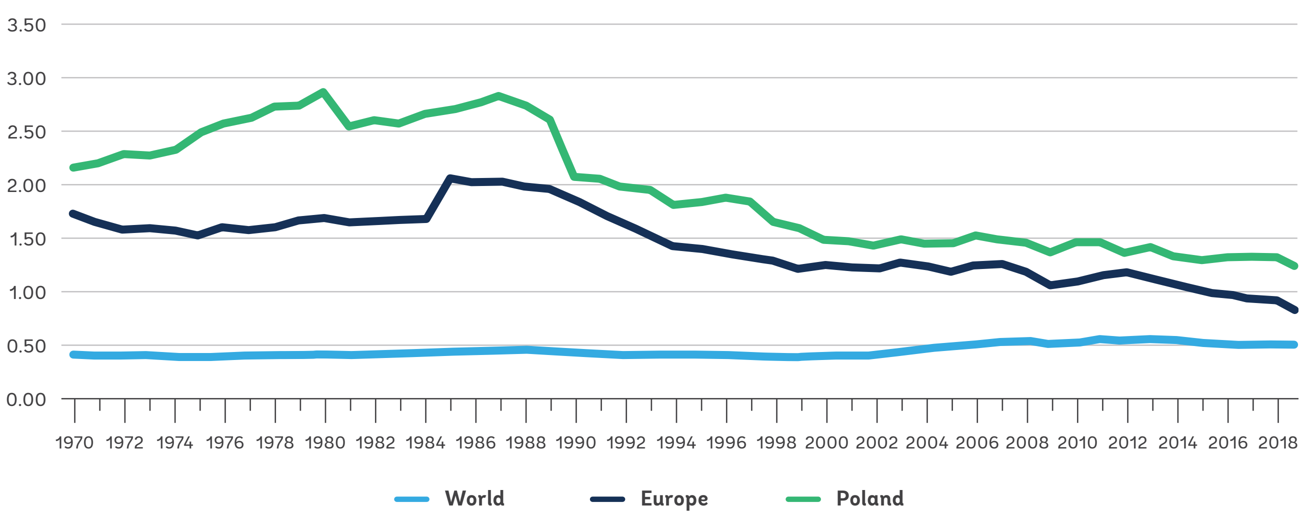
[18] Hard coal mines that remain in operation are located in the Upper Silesian Coal Basin (with the exception of Bogdanka in the Lublin region) and are either owned or controlled by the state (Baran et al. 2018; Polish Geological Institute 2021). Lignite mining is located in Belchatow (Lodzkie) and Turow (Dolnoslaskie) (both owned by the state's power company PGE), Konin-Turek región (Wielkopolska)(privately owned by ZE PAK), and Sieniawa (Lubuskie) (a small family-held mine).

Poland has extremely high per capita coal consumption, even though it has fallen by half over the past three decades. Historically, Poland's per capita consumption of coal-based energy was four to six times the world average, and as much as 70 percent higher than the average for Europe (Figure 4.4). Poland's energy consumption has declined very rapidly since 1990, to 1.2 toe per capita in 2019, although this is still more than double the global per capita level. Most of Poland's hard coal production is consumed domestically. Prior to 2004, the industrial sector was the dominant consumer (final consumption), but its sharp decline in demand was replaced by rising residential demand, which has remained relatively unchanged for over a decade. Final consumption of electricity has however continued to increase, not only in the residential sector but also by industry and by commercial and public services (IEA data).

Despite declining coal production, coal remains the primary source of electricity generation. Power generation in Poland was almost exclusively based on coal until the early 2000s when alternative power generation sources began to emerge (mostly natural gas). Renewable energy sources did not achieve scale until 2018. By 2019, coal still accounted for 74 percent of total power generation (down from 92 percent in 2017), while renewables[19] (excluding hydropower) and natural gas accounted for 14 percent and 9 percent, respectively. This persistence of coal-fired electricity – among the highest in Europe (Figure 4.5) – is partly the result of massive installed capacity, two-thirds of which is older than 30 years (most were built between 1960 and 1980) and need replacement by 2050 (Bogdan et al. 2015) and many even sooner.[20] The efficiency of Poland's power plants is lower than others across Europe, resulting in higher production costs and CO2

Figure 4.4

Energy consumption per capita from coal (toe)



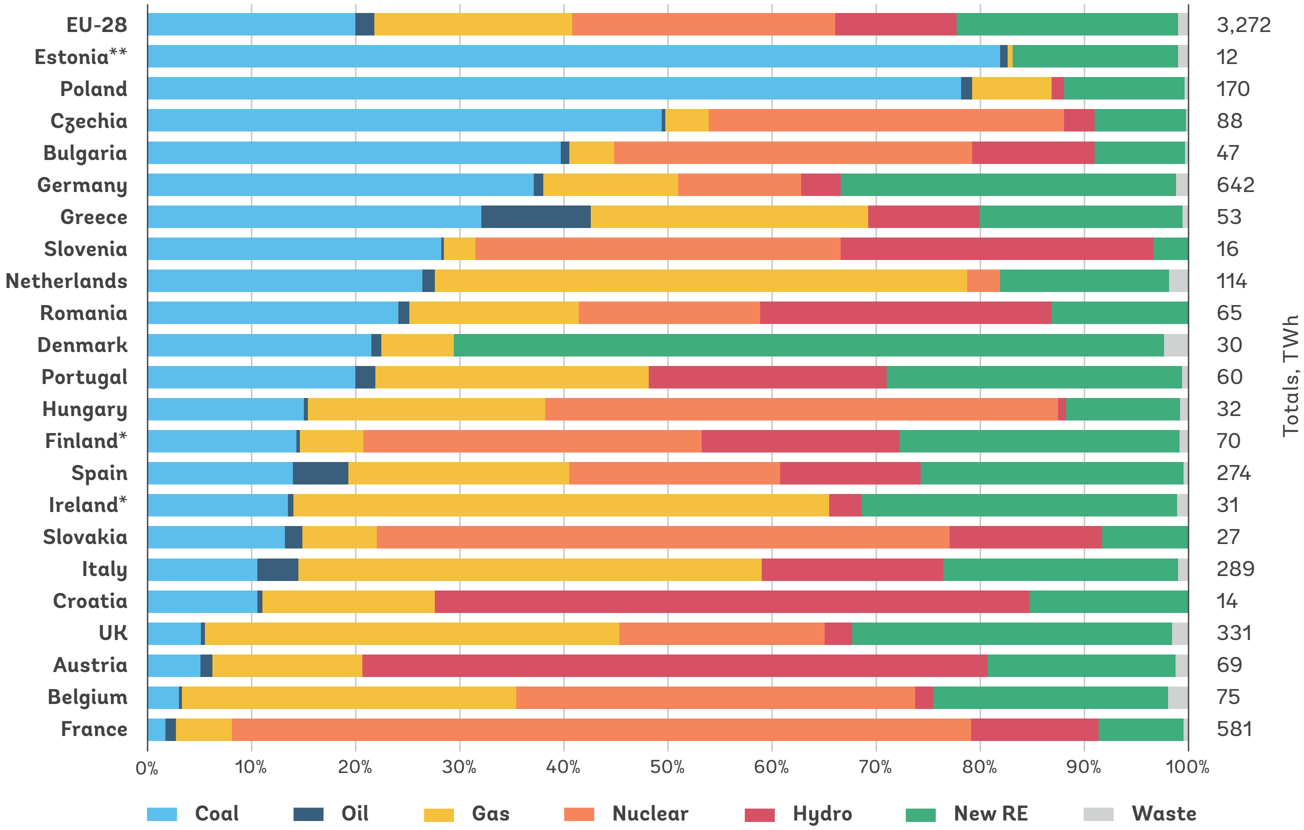
Source: Authors' calculations based on BP Statistical Review of World Energy, WDI data

[19] Note that 25 percent of renewables used in electricity generation is biomass co-fired with coal in power plants.

[20] Rogala (2021) reports the average age of power plants is 47 years.

Figure 4.5

Europe's electricity generation mix in 2018



*Note: * denotes that coal includes peat; ** denotes that coal includes oil shale.*
Source: Eurostat data (graphic by Euracoal 2021)

emissions (Alves Dias et al. 2018).[21] Globally, Poland has the 6th highest number of coal-fired power plant units with over 30 MW capacity, at 156 operating units spread across 50 power stations, and ranks 10th in terms of generating capacity, at 30,200 MW (End Coal 2021). Between 2010 and 2020, 48 generating units were retired (nearly 6,000 MW), another 23 were cancelled, and 2 were mothballed. One thousand MW in new generating capacity that was approved and under construction was recently converted to a gas-fired power plant (Carpenter 2020). About four-fifths of total generation capacity is either state-owned or controlled, and the transmission grid is owned and operated by state-owned Polskie Sieci Elektroenergetyczne (PSE).[22]

[21] Most power generation companies struggle financially, given that the generation cost of one megawatt-hour of electricity is higher than the revenue from its sale (Czyżak and Wrona 2021).

[22] Note that the electricity generation market is controlled by four state-owned companies: Polska Grupa Energetyczna (PGE), Tauron Polska Energia, Energa, and Enea. These companies also have some control and/or ownership over coal mining companies. Both Polish coal mining and electricity generation are dominated by state presence.

A major driver of high residential demand for coal is its use for heating. Two-thirds of Poland's residential heating comes from coal, double the share in European neighbors Czech Republic and Bulgaria; most of Europe uses other sources for 80-90 percent of heating needs (Bertelsen et al. 2020; Figure 4.6). Poland is the only country in Europe to use more coal-derived energy for heating today than it did in 1990 (The Economist 2021). Much of this is associated with coal-fired district heating systems, but direct burning of hard coal by small consumers also contributes (Badiani-Magnusson et al. 2019). About one-half of households have a coal-fired furnace, reflecting installed capital that would be extremely costly to replace at national scale.

The negative environmental effects stemming from coal production as well as consumption are considerable. Poland's CO2 emissions originate mostly from coal, although CO2 emissions have been declining since the early 1990s (Figure 4.7). In addition to the legacy of environmental damage to land and water resources, methane leakage from coal operations – 659 kilotonnes in 2018, most from underground mines – is a major source of GHG emissions (Kasprzak 2020).[23] Several of Poland's hard coal mines are deep underground

Figure 4.6

Fuel sources of residential heating across Europe (2015, TWh)

Note: 2015 level of coal consumption for residential heating was 135 TWh in Poland, 62 TWh in Germany and 23 TWh in the UK.

Source: Bertelsen et al. (2020).

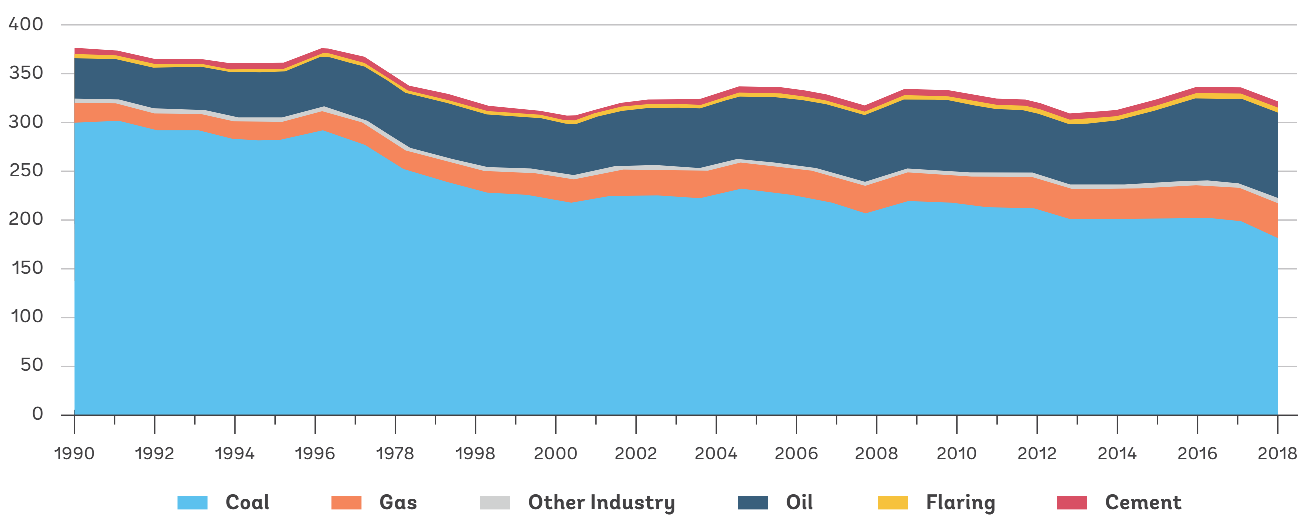
[23] The impact of one tonne of methane emissions is equivalent to 86 tonnes of CO2 emissions, when considered for a 20-year time horizon (Kasprzak 2020).

and have high methane content. Coal, especially hard coal, is by far the largest source of greenhouse gas emissions and air pollution, posing serious threats to public health and the physical environment within Poland and beyond national borders by exacerbating climate change (Alves Dias et al. 2018).

Poland's air quality is among the worst in Europe. Coal-only emissions are measured by levels of PM10, SOx, NOx, and more general ambient air quality is measured by levels of PM2.5; all are estimated to have high concentrations in Poland. Upper Silesia and Malopolska regions are home to Poland's highest mining-related polluting cities. In fact, two-thirds of Europe's most polluted cities are located in Poland, according to the World Health Organization (Mortkowitz and Martewicz 2016). Coal-based residential heating is also a major pollutant. In summer, Poland's PM2.5 level is only slightly above the EU average, but in winter, it us up to three times greater (The Economist 2021). About 44,000 annual premature deaths are attributable to smog in Poland (European Environment Agency 2016)[24], half of which are due residential coal stoves (Ministry of Development 2018). Most countries have banned this fuel for individual heating. In recognition of the adverse health effects, the Government of Poland offered subsidies to replace coal-powered heaters under the Clean Air Priority Program (CAPP); this proved effective in eliminating coal-burners in large public, commercial, and residential buildings. The city of Krakow was the first to ban residential burning of coal and wood (The Economist 2021). Eleven out of 16 Polish regions have imposed emissions standards for heating appliances in single-family homes, with implementation dates ranging from January 2022 to January 2027, after which it will become illegal to use heating appliances that are not compliant with the standards.

Figure 4.7

Poland's CO2 emissions by fuel source (Mt of CO2)



Note: Includes emissions from combustion as well as methane leakages from coal mines.

Source: Our World in Data (Ritchie et al. 2021)

[24] In 2018, the numbers of premature deaths rose to 46,300, according to European Environment Agency (2020).

Emissions from coal-fired power plants are blamed for serious health risks that translate into significant economic costs. In the period 2010-2019, CO2 emissions from coal-fired plants were 130 Mt annually (data from Europe Beyond Coal 2021). In 2016, an estimated 2,500 premature deaths and over two thousand hospitalizations were attributed to emissions from Poland's coal-fired power plants, according to civil society alliance Europe Beyond Coal based on data from 35 power plants (Table 4.1). Additional health impacts include chronic bronchitis among adults and asthma symptoms in children, giving rise to additional health costs. An estimated 776,000 days of work were lost in 2016 as a result of coal plant pollution (albeit less than in Germany). The estimated economic costs associated with these pollutants were €7,5 billion in 2016 (Europe Beyond Coal 2021).[25]

Coal sector subsidies and bailouts represent enormous direct cost to taxpayers. Indirect subsidies of coal-related activities come in the form of environmental, health and labor productivity losses (described above), as well as the cost of wages to mine workers employed in the state's unprofitable mines and power plants. Stoczkiewicz et al. (2020) estimate that between 2013 and 2018, the state spent €6.8 billion propping up the power sector. Some subsidies have been touted as promoting the transition to renewables or supporting the transition of workers and communities. In 2017, coal mining subsidies were allocated to mine decommissioning, rehabilitation and the support of former miners through reemployment in other sectors, compensatory pensions and social security benefits (Whitley et al. 2017). Devoting substantial public resources to sustain the coal sector displaces

Table 4.1

Health impacts from coal power plants in 2016

	Modelled health impacts (caused by power plants in country/region)						
	Premature deaths	Chronic bronchitis (adults only)	Hospital admissions	Lost working days	Asthma symptom days in children	Health costs (Million Euro 2016) (median)	Health costs (Million Euro 2016) (high)
EU (not including the UK)	12,243	5,627	9,396	3,707,296	238,388	18,613	35,583
Germany	4,238	1,700	3,124	1,308,036	69,761	6,338	12,205
Poland	2,596	1,106	2,093	776,559	42,402	3,934	7,536

Note: Based on methodology in Jones (2018)

Source: Europe Beyond Coal (2021)

[25] Estimation methodologies vary by source. A similar analysis by Jones et al. (2016) found that in 2013, Poland's coal power plants were to blame for 1,100 premature deaths in Poland and another 4,700 premature deaths (combined) in nearby Slovakia, the Czech Republic and Hungary, as well as Italy, Greece and France. Poland itself also suffered an additional 700 premature deaths due to coal plant emissions from outside its borders. The study also estimates total annual health costs at €8 - €16 billion.

climate-friendly financing and potentially undermines the transition process.

Recent impetus to reduce Poland's coal dependence is coming from many quarters, both internal and external. In spite of the high direct cost of continued subsidy as well as government's acknowledgment of serious environmental threats and their high associated costs to health and labor productivity (not to mention the costs related to climate change), the pace of transition is slow. The country's high degree of coal dependence explains some of this inertia; the scale of infrastructure replacement or re-configuring to shift electricity and heating to renewable sources is massive and costly. The government has allocated resources to energy efficiency initiatives and renewable energy investments, reflected in the rising foothold of renewables in electricity generation. Over the years, however, Poland has been reluctant to reach consensus on the EU's commitment to achieve climate neutrality in all EU member states by 2050.[26]

The government continues to provide mixed signals on how – and how fast – to complete the coal transition. At COP 24 in Katowice, Poland (December 2018), the coal industry was proudly showcased, and President Andrzej Duda confirmed that "there is no plan today to fully give up on coal" (Brauers and Oei 2020). Poland's current commitments to energy transition by 2030 are inconsistent with EU targets (Czyżak and Wrona 2021). The provisions of the Poland Energy Policy for 2040 (PEP 2040) assume a decrease in coal's share of energy generation from 75 percent to 56 percent by 2030, far above the EU target of 2 percent.[27] In addition, the PEP 2040 projects a 32 percent share of renewable energy sources in electricity generation in 2030, while the EU average is expected to be 68 percent. Together, these projected reductions will be insufficient to reach the EU's 55 percent GHG emissions reduction target by 2030 (Kasprzak 2021; Czyżak and Wrona 2021). Recent discussions of coal phase-out between the government, mine operators (such as PGG), generation companies (such as PGE) and unions appear to be taking place without any consideration of PEP 2040.[28] Moreover, the PEP 2040 projections themselves seem highly unlikely, because they require a massive uptake of nuclear (where little has happened so far) and hydrogen energy sources, increases in biomass use in co-combustion,[29] as well as significant generation by offshore wind energy (from its current capacity of zero; Van Renssen 2021).[30] More recently, the government has proposed post-COVID-19 recovery investments that are not moving away from business-as-usual (Van Renssen 2021).

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[26] At the time of writing, Poland is the only EU member state that has not signed up.

[27] Even in Poland's ambitious scenario, coal is expected to account for 30 percent of net electricity generation in 2030 (Czyżak and Wrona 2021).

[28] In September 2020, the Polish government and trade unions reached an agreement to halt operations of two thermal coal mines of state-owned Polska Grupa Gornicza (PGG) and to close all of PGG's coal mines (8 mines) by 2049 (IEA 2020). The last mines to be closed in 2049 will be Chwalowice and Jankowice in the town of Rybnik, considered PGG's most efficient. The agreement is the first time Poland has put a timeline on ending coal, and is in line with EU's climate targets of net-zero carbon emissions by 2050. However, the agreement is conditional on the European Commission's consent for new state aid to ensure the stability of the hard coal mining companies.

[29] Based on this plan, a recent analysis indicates that Poland would need to import waste biomass in the future (Mankowska et al. 2021).

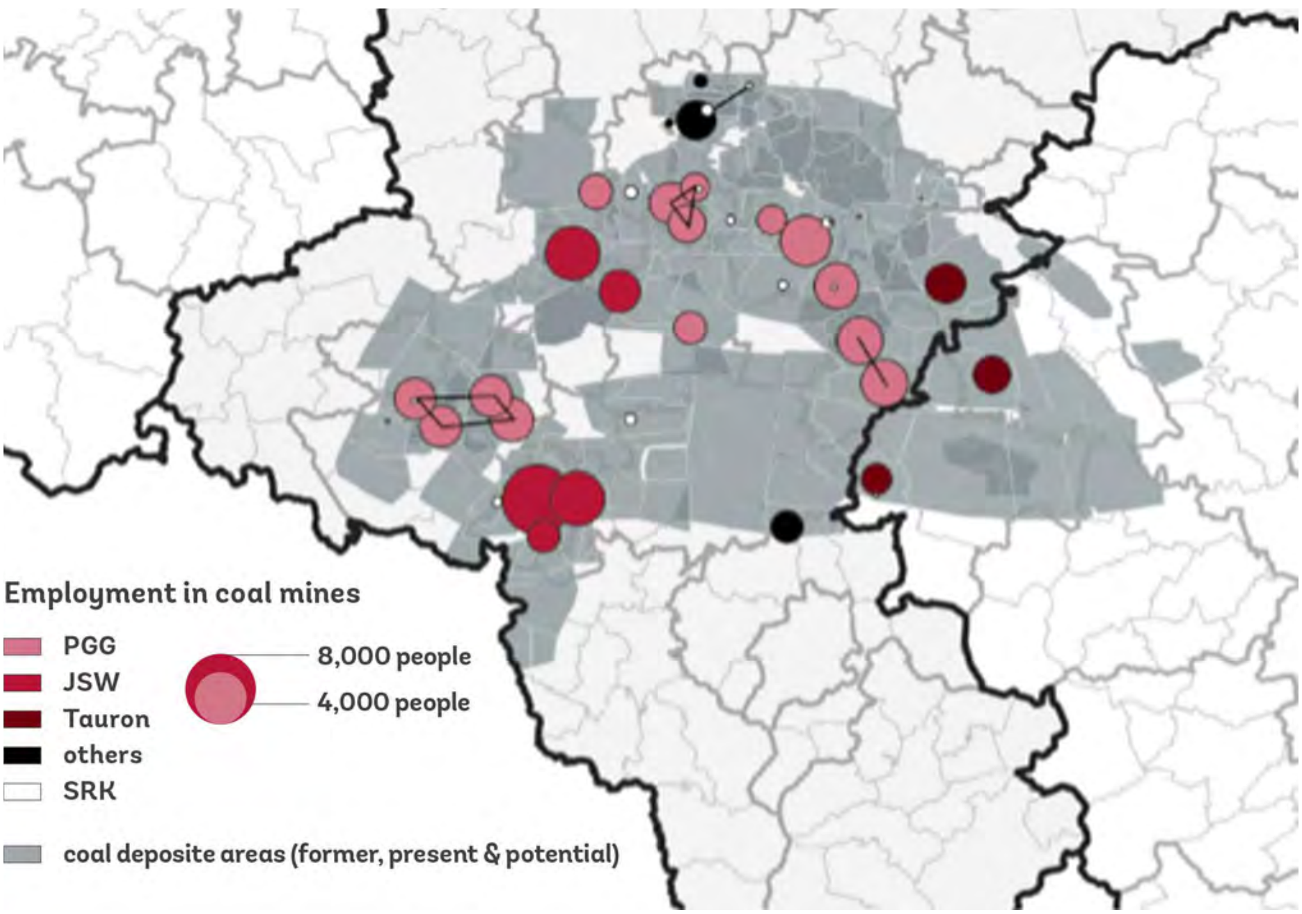
[30] In January 2021, Poland passed a historic Offshore Wind Act which paves the way to 4GW in 2030 and 28GW capacity in 2050. Czyżak and Wrona (2021) argue that unblocking investments in onshore wind farms is crucial for accelerating Poland's coal phase-out and aligning with EU targets.

To achieve the challenging coal transition targets, Poland will need to consolidate and accelerate its approach. Poland's coal regions have prepared or are updating their regional development plans that incorporate green objectives, but a national coal phase-out plan that meets the EU's climate net zero target by 2050 or complies with Paris Agreement commitments of an EU-wide coal phase-out by 2030 is still lacking (Czyżak and Hetmański 2020). The European Commission is offering a range of incentives for transition, including through regulation, financial support, advisory support and capacity building. Ongoing European Commission technical assistance and financing is being provided to Poland's various coal regions to prepare Territorial Just Transition Plans, which will include project proposals to accelerate coal communities' transition to alternative economic activities. Under the European Green Deal's Just Transition Fund, Poland is slated to receive EUR 3,5 billion to support economic diversification and labor transition (World Bank 2021a).

The number of coal mining jobs has fallen sharply since the beginning of the transition period. From a height of 444,000 coal mining

Figure 4.8

Scale of employment in Silesia's hard coal mines



Source: Lewandowski et al., 2020. Based on data from Industrial Development Agency, Branch Office in Katowice (2018) jobs[31] in 1989, the aggressive mine closures initiated in 1990 triggered massive layoffs (Czerwińska 2002); by 2002, coal mine jobs had fallen by nearly two-thirds to 164,000. This was followed by a slower pace of contraction, largely due to attrition rather than layoff (Baran et al. 2020). By 2019, coal mining employment had fallen to 92,600, equivalent to 0.5 percent of total employment in the Polish economy. Ninety percent of hard coal mining is located in Upper Silesia, and 80 percent is in underground mines (Figure 4.8; Lewandowski et al. 2020). Employment in the lignite sector is much smaller than in hard coal; as of 2019, there were 9,300 people working in lignite mines (energy.instrat.pl 2021).

Although only a small share of the labor force, coal mining jobs play a disproportionate role, especially in Upper Silesia. The coal mining industry has a large presence in Silesia, where it directly accounts for 4 percent of total employment and over 7 percent of male employment (2019 data from Energy.instrat.pl and Statistical Office in Katowice 2020). In addition to direct coal mining jobs, many jobs in the region are indirectly related to the sector. It is estimated that one job in the mining industries gives rise to between 1.16 and 1.35 jobs in other economic sectors (IBS 2020). About one-fifth of all mining and quarrying jobs within the EU-27 are located in Silesia (2017 data).

Hard coal mining operations are labor intensive, dominated by semi-skilled production occupations, and employ mostly men. The vast majority of employees in the sector work in mines (94 percent), while 4 percent work in associated processing plants and 2 percent in mining administration (Lewandowski et al. 2020). Four-fifths work in production occupations (Lewandowski et al. 2020). Coal mining workers are relatively low-skilled compared to many other sectors and tend to have lower than average educational attainment. In 2014, 6 percent of coal mining workers had primary education and 37 percent had basic vocational education, which is 16 pp. higher than the national rate. Only 16 percent of coal mining workers had tertiary education, about half the average for all workers (Baran et al. 2018). Men account for 80 percent of the coal mining workforce.

Coal mining jobs pay high wages with generous benefits, which distorts local labor markets and impedes labor reallocation to other sectors. The hard coal and lignite sector's average monthly wage is about twice the prevailing wage in manufacturing (Baran et al. 2018). Part of this higher wage can be explained as a hazard premium, due to the health[32] and other risks associated with mine work, especially in underground mining activities. Mine workers are also eligible for early retirement. The high sectoral returns are especially large for less educated workers, whose non-coal employment alternatives pay significantly lower wages. Black et al. (2005b) provide evidence from U.S. coal regions that educational attainment declined in periods when demand for coal workers was strong. The impact of high mining wages on the local labor market is three-fold: (i) it drives up the reservation wage of mine workers, reducing their willingness to take other jobs; (ii) it squeezes labor demand in competing sectors;

[31] Includes hard coal and lignite.

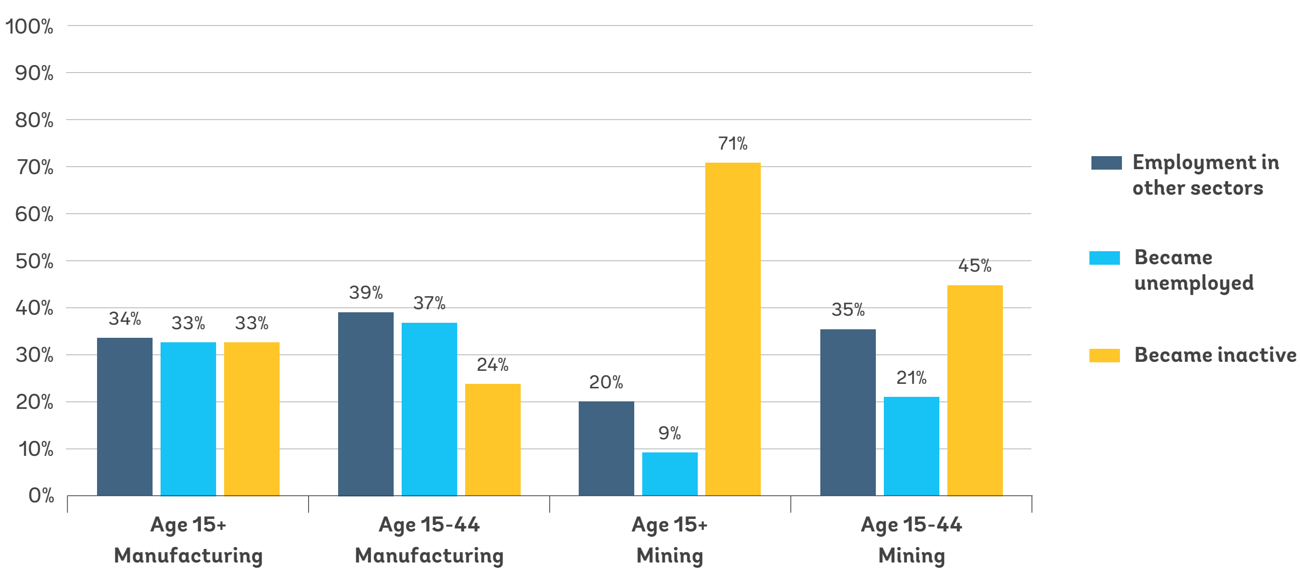
[32] Every year, an average of 400 new cases of pneumoconiosis – caused by coal dust inhalation – are diagnosed among current and former mine workers (WUG 2017).

and (iii) it pushes education choices toward mining-oriented technical training that has little relevance outside of the increasingly obsolete mining sector.

The large magnitude of coal mining jobs lost during the first stage of transition generated persistent economic challenges in mining communities. The post-separation employment outcomes for displaced mine workers depend on the profile of workers, the incentives to transition, and the availability of alternative work. Older mine workers may be less inclined to take a new job if available work is low paid or if their degraded health limits their work options. Baran et al. (2020) find evidence of very high rates of inactivity among workers who left mining jobs during 2002–2015, much higher than those who exited manufacturing jobs during the same period (Figure 4.9). The effect is especially large for workers over age 45, which can be explained by the generous early retirement policy in the Polish mining sector.[31] These early retirement provisions create a strong incentive to remain in the sector until pension eligibility. Winkler (2021) finds evidence of persistent negative employment effects in municipalities that experienced at least one mine closure, including lower long-run employment rates for men (8 percentage points lower, considering employment in non-micro-sized firms only).

Figure 4.9

Destination of workers exiting mining and manufacturing jobs (2002-2015 average)



Note: "Age 15+" category reflects all employed workers in the sector, whereas "Age 15-44" restricts the sample to younger workers. Mining defined broadly but using data only from regions with active hard coal mines. The figure shows probabilities of transition in the year following job exit.

Source: Baran et al. (2020).

[33] The regular retirement age for men is 65, whereas underground miners can retire up to 15 years earlier. Specifically, they can retire at age of 50 (55) if they have worked at least 25 years, including at least 15 (10) years working underground.

Until around 1996, the unions successfully resisted proposals to reduce wages or cut employment, but in 1998, government introduced the Mining Social Package to accelerate voluntary layoffs while protecting against a significant deterioration in miners' standard of living. Despite its success in facilitating mine closures, the generous terms incentivized labor force exit rather than transition to new sectors of work. Between 1998 and 2002, a total of 67,000 mining workers benefited from the package. Nearly 37,000 received miners' leave assistance, paid at a level equal to 75 percent of their monthly mining wage. Workers within five years of retirement were made eligible. Individuals on the miners' leave were not permitted to receive other forms of assistance, but they were allowed to take employment outside of mining, in which case their benefit was reduced by a half. The 29,700 workers ineligible for miners' leave assistance instead received conditional redundancy payments offered to miners who voluntarily left the mining sector and found a job within 24 months. It was paid at the moment the individual started his or her new employment. If the worker started the new job by the end of 1999, the payment was equivalent to 14.4 months of the average wage in the mining sector. Payment was gradually reduced to about 7.2-monthly average wages for those workers starting a new job by the end of 2002. An unconditional redundancy payment was also available, equivalent to 24-monthly average mining sector wages, but recipients were required to give up other forms of assistance. The last program offered – which was taken up by just 419 individuals – was a monthly welfare allowance equal to 65 percent of the pre-layoff wage, paid for a maximum of 24 months and intended to assist those taking retraining courses.

Given the high cost of the Mining Social Package, the impacts on post-separation outcomes were rather mixed. The total funds spent on assistance under the Mining Social Package during 1998-2002 amounted to 5.38 billion PLN, equivalent to 0.75 percent of Poland's GDP over that period (Turek and Karbownik 2005, Baran et al. 2018). An impact assessment of miners who took redundancy payment found that 54-65 percent found a job within several months of leaving the mining sector (Turek and Karbownik 2005), while the rest exited the labor force. Apart from one optional retraining course, there was no comprehensive job-search support under the program. There is evidence that the average economic status of beneficiary households worsened systematically after job separation; Karbownik (2005) found that in 2001, 6 percent of beneficiaries declared they could not afford to cover expenditures for basic needs (food, electricity, clothes), and by 2004, this share had risen to 13 percent.

Government ownership of mines can in theory simplify transition planning, but it also complicates the landscape, with the effect of slowing progress. Because most of Poland's mines are under government control, they fall victim to competing objectives of commercial viability on the one hand, and job creation and economic stability in lagging regions on the other hand. A recent IMF study asserts that although Poland has successfully transitioned out of its communist-era legacy, the footprint of SOEs remains significant; SOEs account for one-eighth of total employment (Richmond et al. 2019). Whereas the initial phase of mine closures was part of a broader economic restructuring effort, the current environment for announcing the next phase of closures is more fraught, partly due to the negative and in some places lingering effects of high unemployment and economic losses. The state must therefore balance a number of political objectives; and these are complicated by the presence of unions, which exert tremendous influence in the sector.[34]

Progressing to a complete phase-out of coal-fired power generation and the attendant reductions in coal production are essential for meeting emissions reduction targets, but this will necessitate labor adjustment in communities where coal has been a dominant economic player. Shifting to renewable energy, green technologies in other sectors and other greening services will create alternative work opportunities, but not necessarily in the same numbers, or with the same skills profiles, or in the same communities as current coal sector workers. Finding the right policies and programs to facilitate the transition of both local economies and workers towards sustainable alternatives will not be easy. It will be critical to avoid exacerbating labor market distortions via too-generous separation packages to mine workers who already benefit from higher (publicly-financed) wages compared to workers in other sectors; widening existing labor market distortions risks slowing the pace of adjustment and local economic recovery. Significant political will is needed to accommodate the competing interests of various stakeholders in a way that balances the broader objectives of the state with the needs of local communities.

[34] According to Szpor et al. (2018), coal mining trade unions are among the strongest in Poland, their strength having originated in the 1970s and 1980s when Solidarność—both a trade union and a social movement—became the driving force of the country's democratic transformation.

4.3 United States: Slow Convert to Post-Coal Transition[35]

From the early 19th century, Appalachia was the primary U.S. coal producing region, but over the course of the last century, coal jobs declined and Appalachia's coal industry ultimately faded from market dominance. Recall from Figure 2.9 that US coal production experienced a steady rise from the 1950s until the 2000s, whereas coal mining employment has been declining for a century, from a height around 800,000 in 1919 to less than 50,000 today. The displacement of Appalachian-sourced coal by less labor-intensive surface mining of less polluting coal in the Powder River Basin of Wyoming and southeastern Montana in the western U.S. exerted downward pressure on coal sector labor demand in Appalachia, especially from 1980 onward (Figure 4.10).

Appalachia's transition from sector dominance to dwindling relevance took a very long time, and spanned periods of localized boom and bust, with new mine openings and mine closures across the many counties of Appalachia. Decline in north Appalachia began immediately after World War I, while the central Appalachian coal industry experienced more volatile ebbs and flows. The northern Appalachian states of Pennsylvania and Ohio had no periods of sustained coal employment increase from 1919 to 2017, whereas the coal sector in central Appalachian states experienced mini-booms, with employment increasing in many counties during 1963-1982 and 2000-2010. But the alternating bust-periods vastly overwhelmed positive employment effects during coal booms. The central Appalachia coal industry ultimately followed northern Appalachia, but with a lag of 20-30 years. The "bust" years of the 1980s triggered more mine closures, which intensified in subsequent years with the tightening of environmental regulations and competition from the rapid emergence of fracking beginning around 2005.[36] By the 2012-2017 period, central and northern Appalachian coal mining employment each tracked downward. All five Appalachian states experienced a long-term collapse of coal employment: over the last century, West Virginia lost 85 percent of coal mining jobs, compared to 78 percent for Virginia, 85 percent for Kentucky, and 98 percent in both Ohio and Pennsylvania (Figure 4.11).[37]

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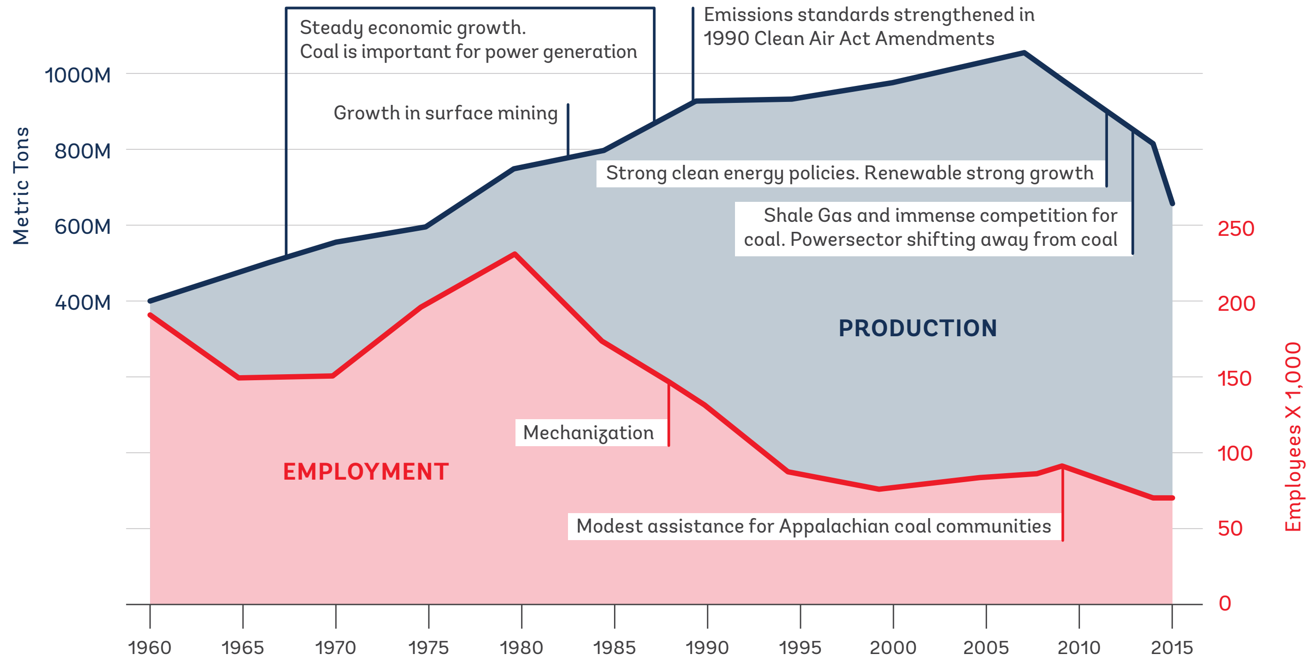
[35] This case study draws from the more detailed 2021 study entitled "Socioeconomic Transition in the Appalachia Coal Region: Some Factors of Success" by L. Lobao, M. Partridge, O. Hean, P. Kelly, S. Chung and E. Ruppert Bulmer, produced for the World Bank under the Global Support to Coal Regions in Transition project.

[36] Scores of U.S. coal companies have filed for bankruptcy in recent years, including giants Peabody Energy, Cloud Peak Energy, Arch Coal, Murray Energy, and Alpha Natural Resources (see https://en.wikipedia.org/wiki/Coal_mining_in_the_United_States (downloaded April 30, 2020)).

[37] Beginning in the 1920s through the early 1960s, key reasons for declining coal demand were the growing use of electricity, oil, natural gas and other fuels; substitution of diesel locomotives for steam locomotives; and the general rise of trucking over rail. See http://explorepahistory.com/story.php?storyId=1-9-B&chapter=0 and http://explorepahistory.com/story.php?storyId=1-9-18&chapter=0 (downloaded May 1, 2020).

Figure 4.10

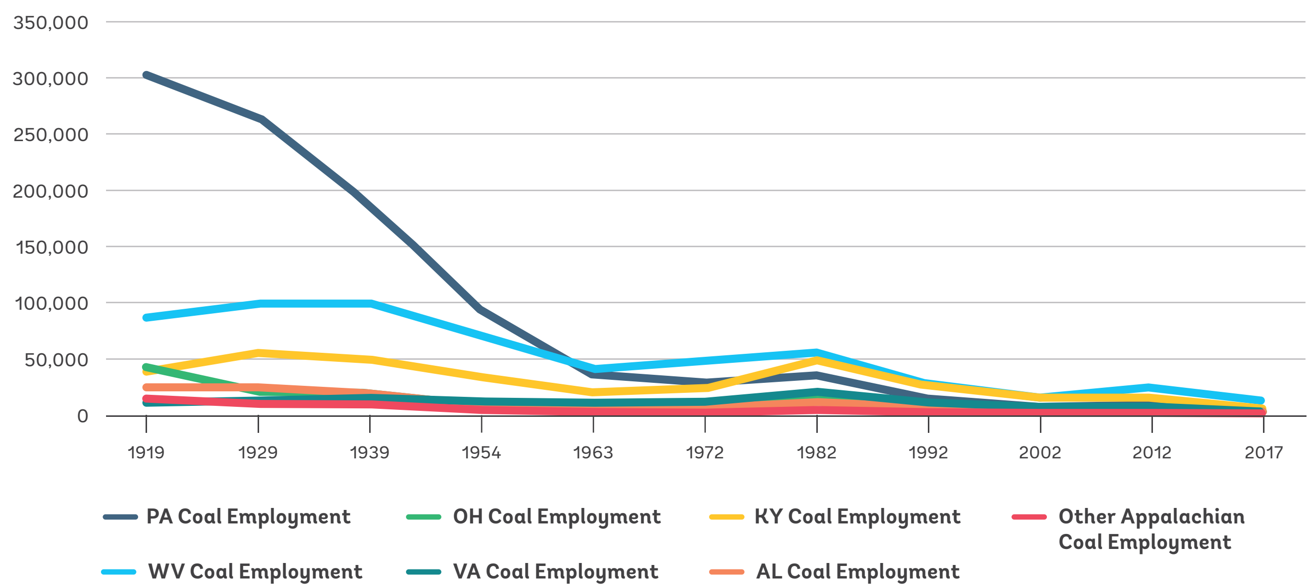
Drivers of US coal production and employment 1960-2015



Source: World Bank (2018a), based on US Energy Information Agency sources and from Coal Transition in the United States, Irem Kok (IDDRI and Climate Strategies, 2017)

Figure 4.11

Coal mining employment by state (selected states)

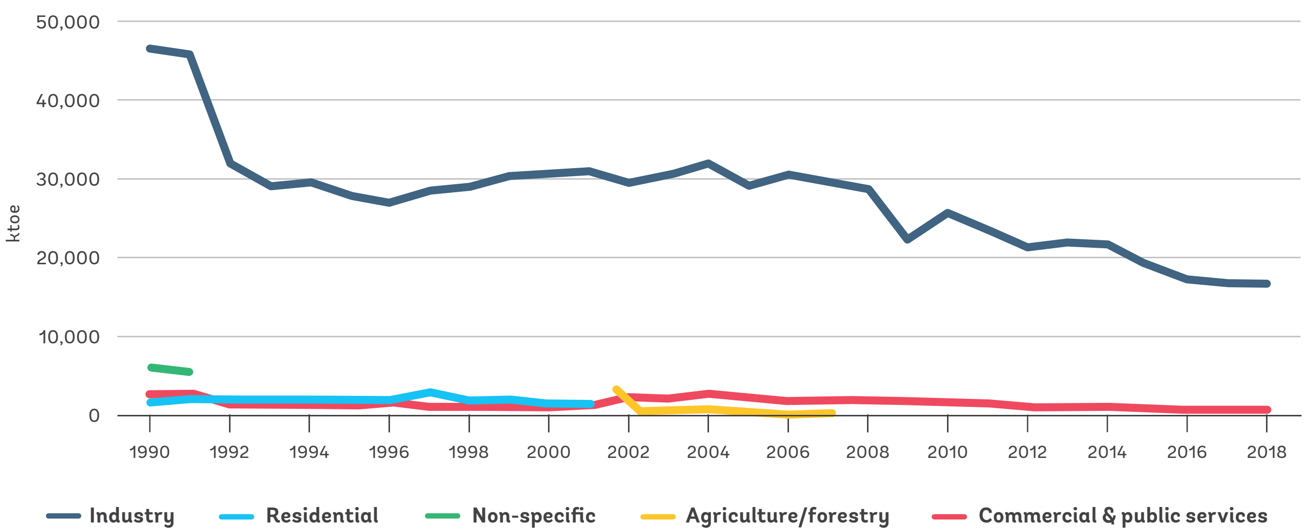


Source: Lobao et al. (2021)

Domestic U.S. coal consumption has diminished in recent decades. Industry demand for coal inputs (excluding coal-based electricity) has significantly declined since 1990 (Figure 4.12), while ever-rising electricity demand is increasingly met by non-coal sources such as natural gas and renewables, which have accelerated over the past decade. Coal-fired power generation capacity has waned in recent years, due to a combination of plant retirements and cancelled construction (Figure 4.13).

Figure 4.12

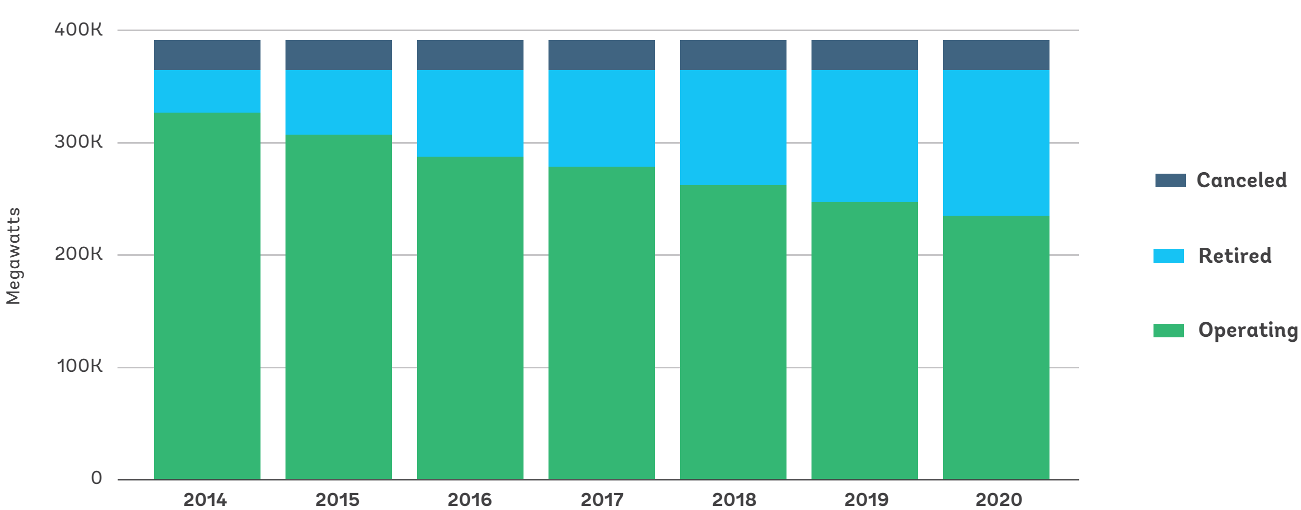
U.S. coal final consumption by sector (ktoe)



Source: IEA data for the US

Figure 4.13

Coal-based power generation capacity in the U.S.



Source: globalenergymonitor.org

The declining fortunes of Appalachia's coal industry exposed many communities to severe negative economic shocks. The coal economy-based Appalachian region has historically been poorer than much of the U.S. For decades, it had some of the lowest per-capita income levels and highest poverty rates in the country (Lobao et al. 2016). During the coal industry's rise, communities across Appalachia became dependent on the coal economy and coal employment, whether in coal mining or in associated coal supply chains. But as coal production began to shift west, the ensuing decline of the coal sector in Appalachia was severe, requiring communities to adjust to new market realities.

The extent and timing of the adjustment varied from one county to the next, but in most regions, the resulting economic outcomes were similar: deep and sustained economic dislocation, high unemployment, sharp declines in household income, and deteriorating measures of community well-being. The negative impact of mine closures was likely exacerbated by the fact that the U.S. coal industry consists of a large number of privately-owned mines; as private operators responded to market conditions, the result was sharper upswings and downswings, with limited coordination with local governments on the labor impacts.

A literature review of 37 U.S.-focused studies addressing transition in coal communities or in communities that share similar characteristics to Appalachian coal communities was carried out by Lobao et al. (2021) to identify factors that facilitate or hinder transition and recovery in Appalachia.[38] The principal lessons are as follows.

- **Mining and coal-dominated communities fair worse on welfare outcomes** such as poverty, incomes, employment, population growth, and other measures of well-being (Betz et al. 2015; Black et al. 2005a; Cook 1995; Douglas and Walker 2017; Freudenburg and Wilson 2002; Lobao et al. 2016). This finding might seem obvious, but these impacts do not necessarily hold for employment shocks in other industries such as service sectors.

- **Coal mining effects on community wellbeing tend to be positive in times of price upswings and negative when prices are low** (Betz et al. 2015; Black et al. 2005a; Lobao et al. 2016). The uncertainty makes it difficult for communities to adjust for the "natural resource curse." Communities over-adapt to extractive industries (Freudenburg 1992). Local receptivity to diversification or alternative industries is cyclical, and depends on commodity price movements.

- **Three key sets of barriers across coal and mining communities exist, related to: (a) geography** and degree of remoteness from cities (Douglas and Walkers 2017; Haggerty 2019; Haggerty et al. 2018; Snyder 2018); **(b) availability of alternative economic opportunities** (Carley 2018; Deaton and Niman 2012; Haggerty 2014; Haggerty et al. 2018); **and (c) population vulnerability,** reflected by low educational attainment (Douglas and Walker 2017; Haggerty et al. 2018) or an aging workforce (Haggerty 2019). These structural barriers limit workforce upgrading and occupational mobility.

[38] See Lobao et al. (2021) appendix A for a detailed description of the publications reviewed and their main conclusions.

- **Local environmental degradation hampers future development and the ability to attract tourism and other non-extractive industries** (Appalachian Citizens' Law Center et al. 2019; Haggerty et al. 2018; Kelsey et al. 2016). Places with higher quality of life – including natural amenities as reflected in climate, topography, and water area – are more likely to attract migrants, especially retirees (Isserman et al. 2009; Partridge and Olfert 2011).

- **Transition-affected populations are aware of the challenges their communities face.** In Appalachia, residents' concerns about their community shifting to non-coal employment include fear of potential job loss and business closures, detrimental effects on schools and retail as families leave, lack of affordable housing elsewhere, and high attachment to the community (mobility barriers) (Carley et al. 2018).

- **The prevalence of a "coal culture" impedes transition in Appalachia.** Carley et al. (2018) note that coal mining generational employment has fostered a community bond and identity with the industry. Haggerty et al. (2018) point out that residents' resistance to change can arise when populations blame restrictive environmental regulations, while they ignore the larger role of markets and price competition from, for example, natural gas. Carley et al. (2018) note that promising return of coal jobs discourages community and individual efforts to adapt to change. Long-term dependence on coal delays acceptance of transition, but in any case, populations find it difficult to move elsewhere (Haggerty 2019).

- **Rural communities are not homogeneous, and the benefits/costs of transition vary by population group.** Appalachian communities with a greater share of coal employment tend to have a lower share of sole proprietors, higher disability rates, and a higher share of poor people (Betz et al. 2015). Much has been written about the uneven impacts of natural gas expansion, with communities divided among those who benefit and those who do not. Extractive industries employ a higher proportion of men, and women tend to have fewer local employment opportunities. Declines in extractive employment affect family structure, and may increase the share of female-headed households (Cook 1995).

- **Communities with higher levels of social capital – that is, strong inter-group relationships within the community – tend to be more resilient.** In the case of plant closures, Besser et al. (2008) find that residents report less negative overall quality of life where social capital is higher.

- **Low capacity of local governments is a barrier to transition.** Lack of local government capacity in rural and small U.S. communities has long been noted (Johnson et al. 1995; Lobao and Kelly 2020).[39] The overriding problem is replacing and stabilizing income streams (Haggerty et al. 2018). Haggerty (2019) summarizes the barriers small or rural governments face when coal plants close, including limited administrative leadership capacity (for example, little or no planning staff); limited staff and ties to state or regional actors, which limits ability to apply for federal and state assistance; and low fiscal autonomy,

[39] This has been documented in studies of transition planning, but there are few empirical analyses of actual transitions.

which limits local budgeting authority. Haggerty et al. (2018) and Haggerty (2019) stress that small communities often lack access to a dedicated transition fund, requiring them to substitute other funds or secure external funding.

- **Conventional policies to attract business investment, retain local businesses, and develop the workforce have variable effects.** Benefits from economic development policies typically appear to be modest (Daniels et al. 2000), and strategies tend to be overly focused on retaining or attracting a single large employer (Haggerty et al. 2018). No policies or programs work everywhere, and successful models appear difficult to replicate.

Whereas Appalachian coal communities are well-studied, knowledge gaps remain. For example, the existing literature tends to focus at the regional multi-state level rather than the community level, missing important heterogeneity. Much analysis is case-study based, although some key quantitative studies estimate employment spillovers during boom and bust (for example, Black et al. 2005) and long-run natural resources curse (Deaton and Niman 2012). Factors that contribute to positive local outcomes in the wake of coal decline are not well-studied. Betz et al. (2015) find that Appalachian communities with a larger share of coal employment had lower entrepreneurship rates, which limits the degree to which communities can transition to other economic activities. Historical studies and case studies of the region (Billings and Blee 2000, Duncan 2014, and others) explain how coal mining weakened local government and institutional capacity to address residents' needs. A majority of studies examining community-level impacts (positive or negative) of coal or other mining employment focused on a single or specified point(s) in time, rarely addressing the long-term consequences of transitioning from coal (with the exception of case studies).

The study by Lobao et al. (2021) addresses these knowledge gaps to deepen our understanding of the factors that contribute to communities' ability to transition successfully from reliance on coal. The study draws on the wider social sciences literature regarding the factors that contribute to community well-being and successful transition, and then empirically tests the relevance of these factors for Appalachia. Their regression methodology exploits county-level differences in socioeconomic outcomes across 99 coal-dependent communities (within a broader sample of 420 Appalachian Regional Commission (ARC) counties plus 650 counties within 100-mile buffer zone) to identify the counties that have successfully transitioned away from coal at some point during the period from 1950 to the present. "Successful transition" is defined as a county that was dependent on coal mining sometime in the past, is no longer dependent on coal mining today, and sustained above the sample-average population growth during 1980-2018.[40]

[40] Population growth is the most common metric for assessing regional success in U.S. studies. Betz et al. (2015) found that population growth highly negatively correlates with intensity of local coal mining employment, and they found a statistically significant causal link between coal mining employment and population decline. Other variables associated with economic prosperity —per-capita income, poverty rates, and growth in median household income— positively correlate with population growth. Moreover, population growth directly captures the movement of people in and out of these regions based on economic as well as socioeconomic factors. Population data is also readily available at the necessary disaggregated levels.

Based on these selection filters, only four "successful" transition counties emerge out of 222 mining-intensive counties: Sequatchie County, Tennessee; Laurel County, Kentucky; Athens County and Noble County, both in Ohio (shown in Figure 4.14, among the 420 counties within ARC boundaries). It is notable that these successful counties transitioned at different times, and for different reasons. Robustness checks and qualitative analysis confirm the results and yield six key conclusions.

The first and perhaps most striking conclusion from this quantitative analysis is that very few Appalachian counties have managed a positive transition from coal dependence, and the level of success is modest. Only four counties managed to transition and remain economically viable communities with sustained population growth. And traditional measures of economic well-being are not particularly strong. While the four counties have grown in population and diversified their production, and most have experienced significant poverty reduction, average household incomes remain low and poverty rates exceed national and ARC averages.

Secondly, severe economic structural impediments across Appalachia constrain growth. Being small and remote, most ARC counties have limited access to labor markets with more and diverse job opportunities. ARC counties have low levels of physical capital, especially infrastructure, and high transportation costs. Human capital is also low, with lower educational attainment and lower quality education and health services.

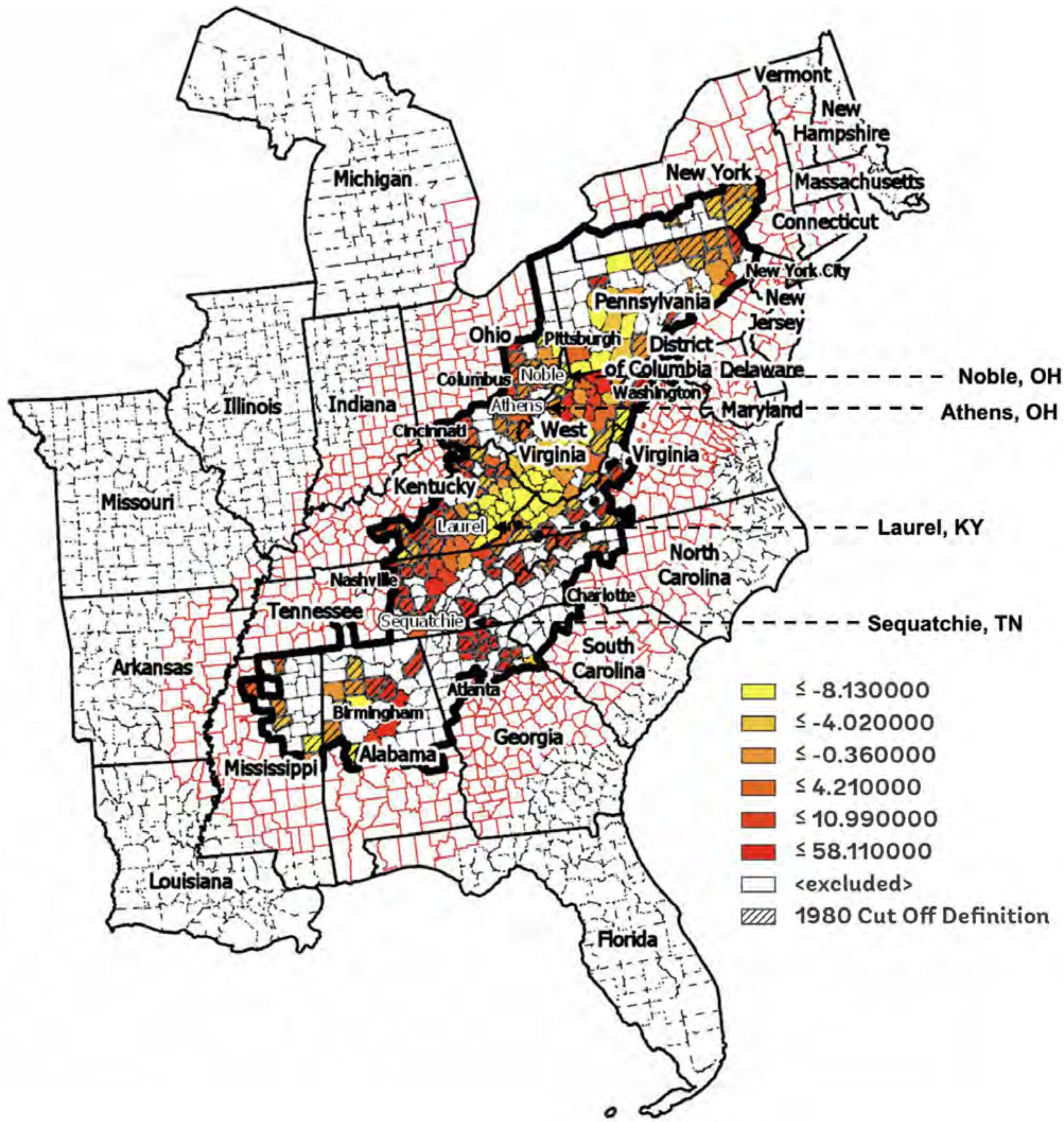
Thirdly, the prevalence of non-structural impediments reinforces poor economic outcomes and reduces local economic resilience. Whether or not structural impediments are present, historically coal-dependent communities exhibit less economic diversification, modest manufacturing activity, problematic patterns of "boom and bust" cycles, and low levels of entrepreneurship.

The fourth main finding is that institutional capacity and social capital have helped some counties transition more successfully. Local government institutional capacity and social capital are generally low across the ARC region compared to national averages. In the four counties, local government capacity to design, finance, and implement economic development initiatives in collaboration with local civil society and regional planning authorities appears to have helped sustain transition impetus.

In fifth place, infrastructure investment is a common theme in the successful counties, but is not sufficient to guarantee successful transition from coal. Much of Appalachia has received significant investment, at least with respect to road infrastructure, and yet most counties failed to remain viable or thrive. That said, improved roads helped our four successful counties by increasing connectivity to larger metropolitan areas and manufacturing chains, and increasing access by larger urban centers to tourism, recreational opportunities and affordable housing.

Figure 4.14

County-level population growth rates within the ARC region 2000-2018



Note: Dark red denotes counties with the fastest population growth between 2000 and 2018. Black line denotes the Appalachian Regional Commission (ARC) boundary, which encompasses 420 counties.

Source: Lobao et al. (2021)

Finally, the transition paths of each of the four counties have unique features and success factors distinct from one another, making it difficult to generalize approaches. But each has some kind of economic anchor that stimulated both direct and indirect job creation.

- ***Athens County's*** economic development has centered around its large public Ohio University which supports direct and indirect jobs and generates local social capital.

- ***Noble County*** was able to attract a large public investment to build a state prison, which has served as an economic driver.

- ***Laurel County*** became a regional hub following investment to construct two major highways – including Interstate-75, which linked the area to northern manufacturing centers – as well as a regional airport, a hydroelectric power dam, piped water supply, and industrial parks.

- ***Sequatchie County*** benefited from investments in highways to access nearby Chattanooga, a large metropolitan market offering diverse job opportunities. The county became a main "bedroom" community for daily commuters into Chattanooga.

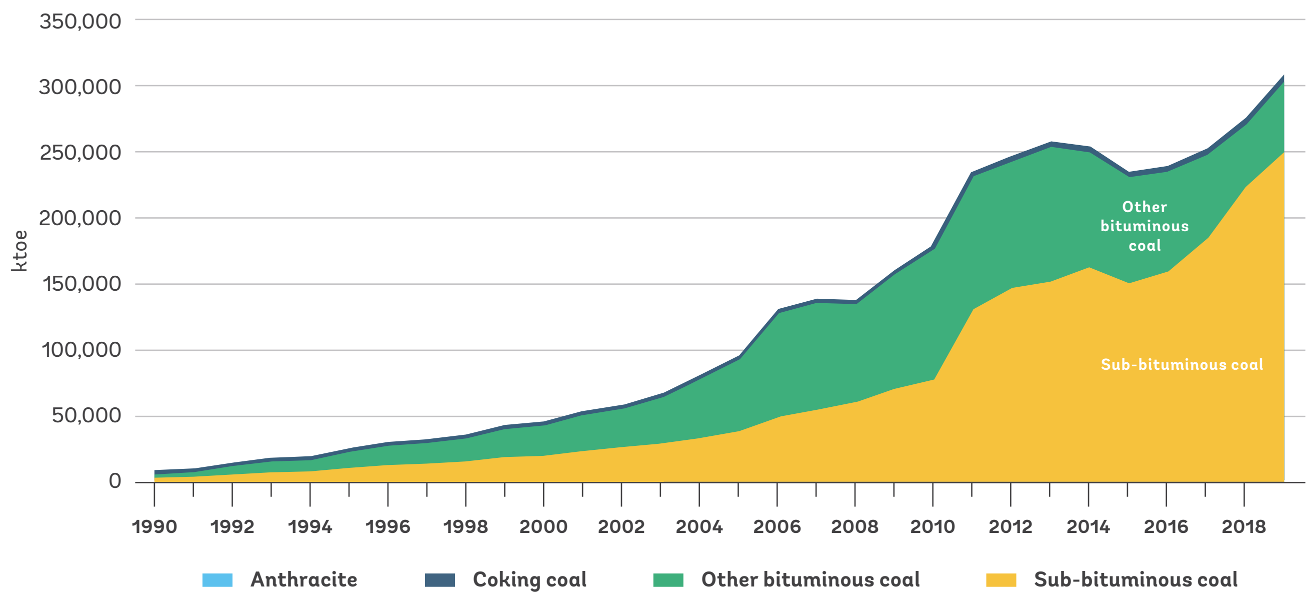
The checkered transition experience of Appalachia's coal-dependent communities provides some broad policy takeaways for governing authorities and other stakeholders seeking better transition outcomes in their own coal regions. The very long nature of the transition meant that it spanned multiple changes in local, regional and national governments and their associated policies. And because the period of study was long enough to coincide with countless human and physical capital investment initiatives at the local, regional and national levels, it is impossible to isolate which policies were effective in supporting or facilitating transition, and whether these worked in isolation or jointly. There are some broad lessons that emerge, however, including the importance of enhancing connectivity of remote coal regions with larger economic centers, investing in human capital to improve labor mobility, diversifying business activities to foster resilience to boom and bust cycles, building local institutional capacity, especially regarding economic planning, and coordinating across multiple levels of government and other stakeholders for strategic longer-term economic development.

4.4 Indonesia: Crowding into the Export Market

Coal production has grown rapidly in Indonesia, directly contributing to the economy through increased output and exports. Expanding steadily since the early 1990s, Indonesia's coal sector took off in the mid-2000s, subsequently averaging 10 percent annual growth in production (Figure 4.15). Between 2000 and 2010, coal exports nearly tripled to 6.2 Exajoules, and reached 9.2 Exajoules in 2019 (BP Statistical Review of World Energy 2020). In terms of export share, coal grew from a modest 2 percent of Indonesia's total export basket in 2000 to nearly 10 percent by 2018 (Harvard Atlas of Economic Complexity). Half of Indonesia's coal exports are destined to China and India, each having vastly increased their import demand compared to other markets (Figure 4.16). During this period, Indonesia's petroleum products lost market share: domestic oil production fell by nearly half, and oil exports declined from 20 percent of total exports in 2000 to 8 percent in 2018.

Figure 4.15

Indonesia's rising coal production (ktoe)



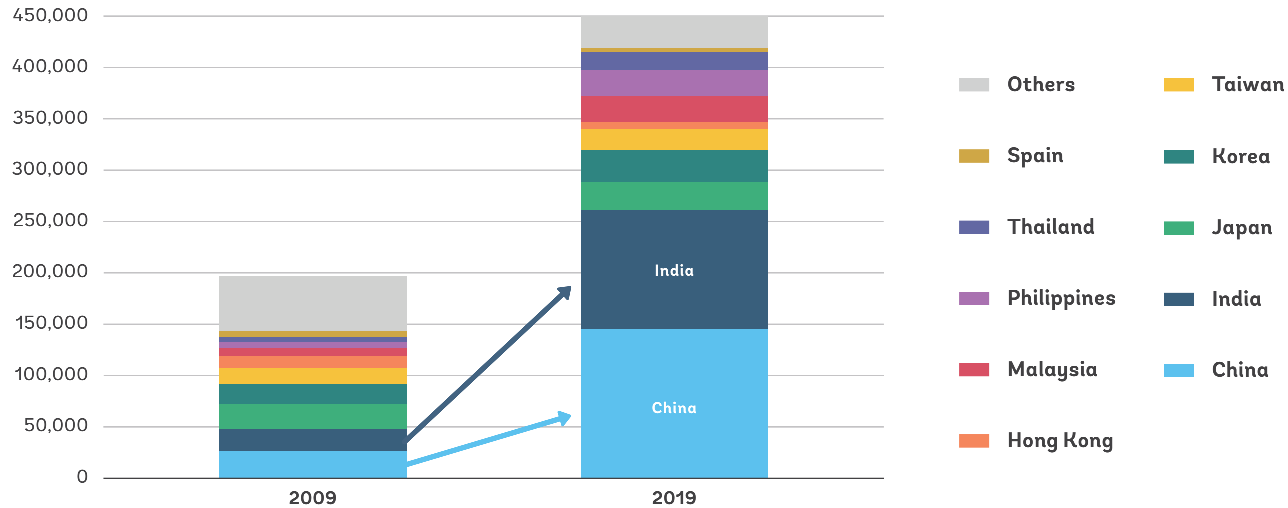
Source: IEA data for Indonesia

[41] IEA data reports Indonesia coal exports of 154,511 ktoe in 2010 and 235,987 ktoe in 2018.

[42] Philippines, Malaysia and Thailand are significant exceptions.

Figure 4.16

Shift in Indonesia's coal export destination markets (thousands of tons)



Source: 2019 Handbook of Energy and Economic Statistics of Indonesia, Ministry of Energy and Mineral Resources

In addition to rising external demand for coal, domestic demand for energy has surged, driving the coal sector's expansion. Three-quarters of domestic coal is consumed by power plants.[43] Low production costs for extracting Indonesia's abundant coal deposits translated into relatively cheap energy inputs, especially when combined with Government-imposed price controls[44], spurring demand by households and by industry. Indonesia's strong GDP growth over the last two decades – averaging 5 percent per year – was accompanied by significantly higher per capita incomes and declining poverty (Figure 4.17). As domestic incomes grew and living standards rose, more Indonesian households gained access to electricity, and households consumed more electricity, disproportionately sourced from coal-fired power plants. Between 2009 and 2019, the share of households with access to electricity increased from 94 to 99 percent (World Bank 2021b), and the total amount of electricity sold to households by Indonesia's state electricity company[45] nearly doubled.[46] Electricity consumption by industry increased at a similar pace, followed by commercial and public services (Figure 4.18). Indonesia's electricity consumption per capita rose by 67 percent over the last decade, outpacing the regional average for Asia Pacific, although lagging the lightening pace observed in China (98 percent).[47]

[43] The 2020 Ministry of Energy and Mineral Resources (MEMR) data indicate that iron, steel and metallurgy activities accounted for nearly 11 percent of domestical coal demand, while the cement industry accounted for another 9 percent.

[44] MEMR sets the price of domestic coal used for coal-fired power generation and sets a quota for domestic coal consumption – the Domestic Market Obligation (DMO).

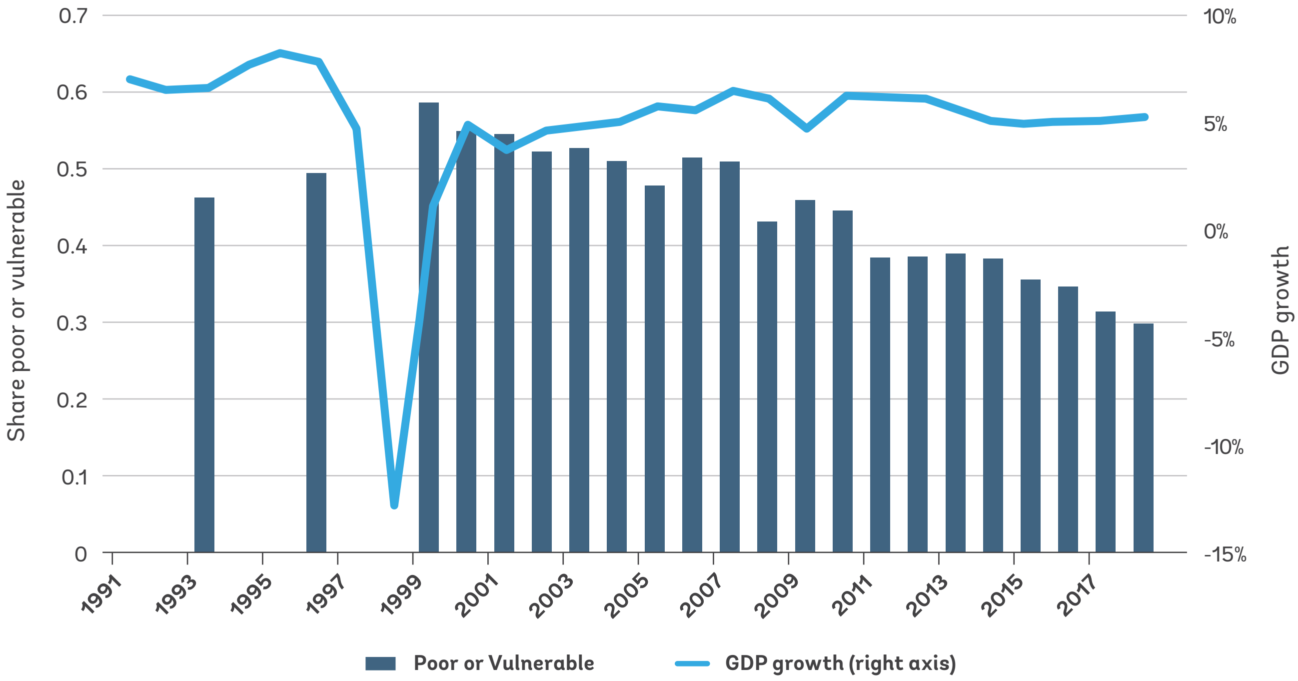
[45] PLN - Perusahaan Listrik Negara.

[46] Based on data from the Directorate General of Electricity and PLN (Perusahaan Listrik Negara) Statistics, reported in the 2019 Handbook of Energy and Economic Statistics of Indonesia.

[47] IEA data.

Figure 4.17

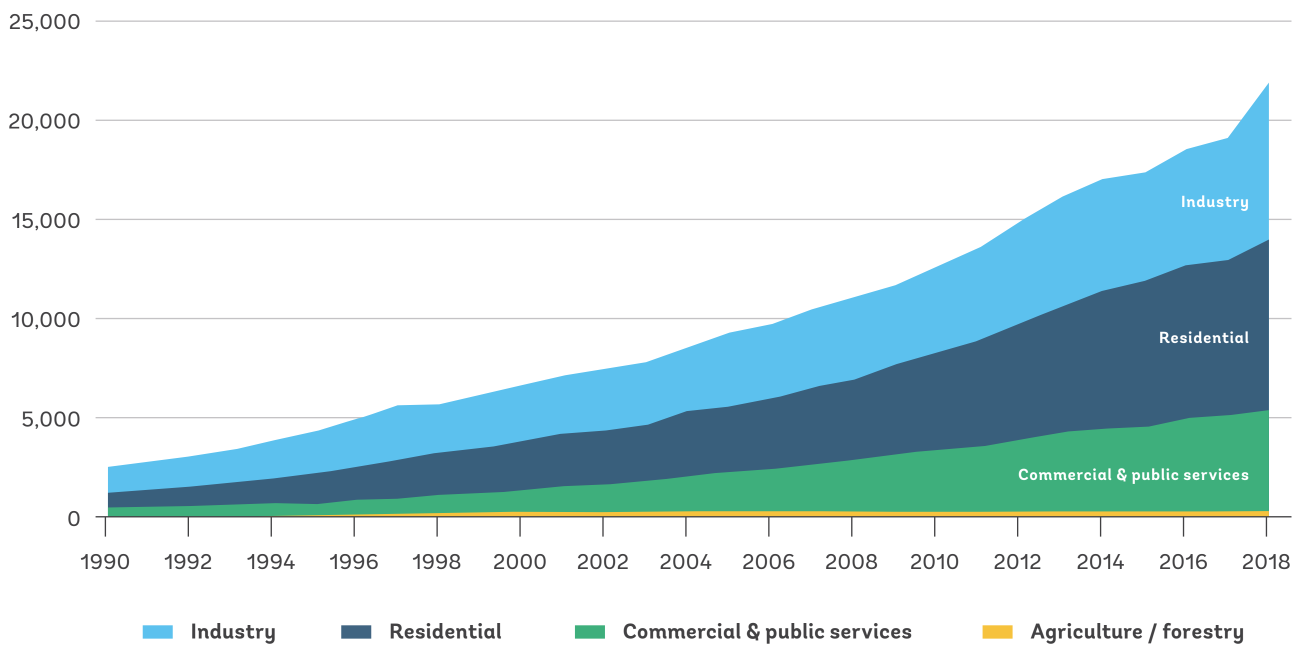
Robust GDP growth and declining poverty and vulnerability



Source: World Bank "Pathways to Middle-Class Jobs in Indonesia" (2020a), using the Susenas national poverty line.

Figure 4.18

Upward trajectory of electricity consumption across sectors (ktoe)

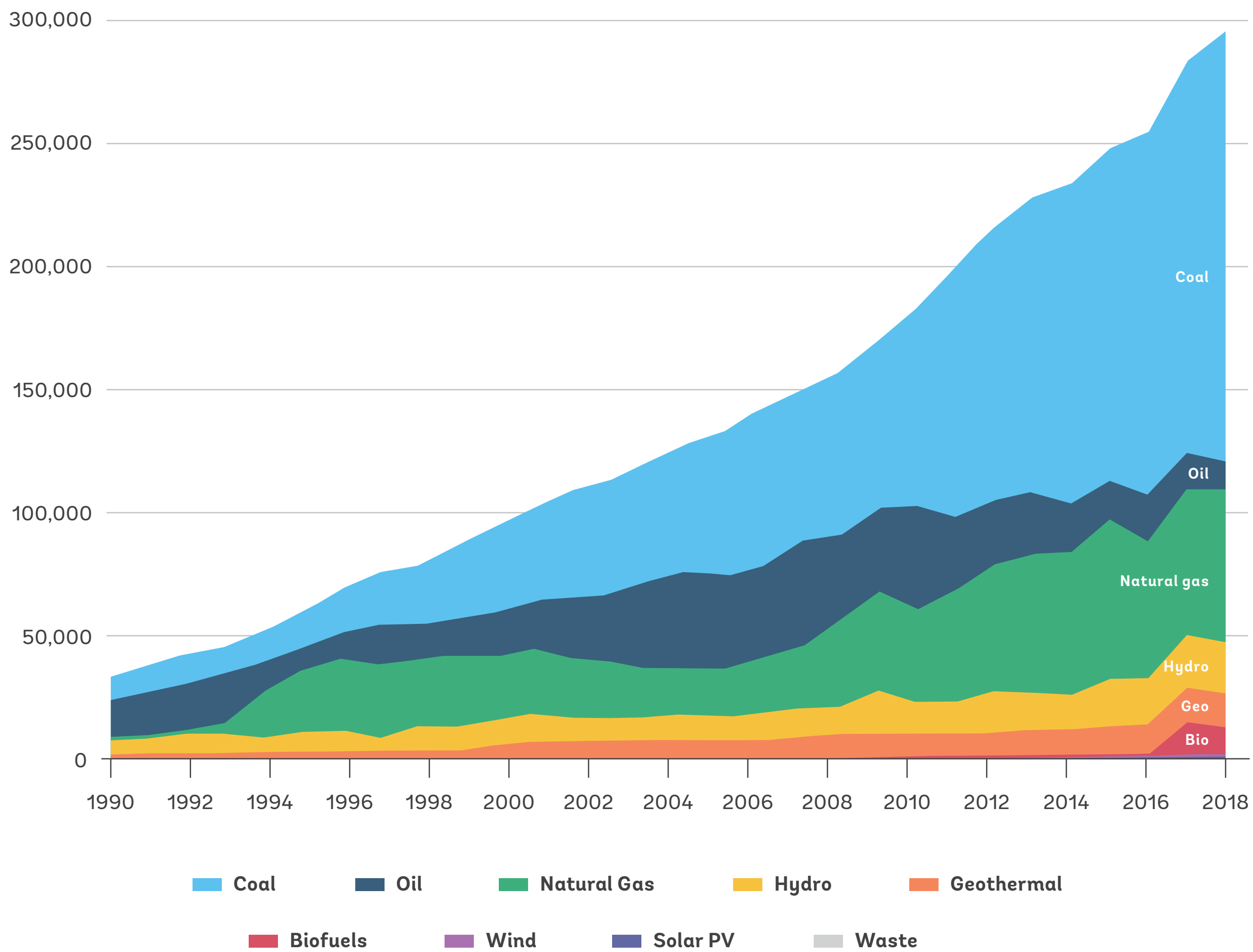


Source: IEA data for Indonesia

Coal increasingly dominates the electricity mix in Indonesia, even as other countries are shifting to greener alternatives. Electricity generation grew by 9 times between 1990 and 2019, and coal-fired electricity expanded even faster, as coal's share of electricity grew from 30 percent in 1990 to nearly 60 percent in 2019 (IEA data). Figure 4.19 shows that oil-based electricity has been squeezed out by natural gas over the last decade, and renewables are just starting to pick up.

Figure 4.19

Indonesia's electricity generation by source (GWh)

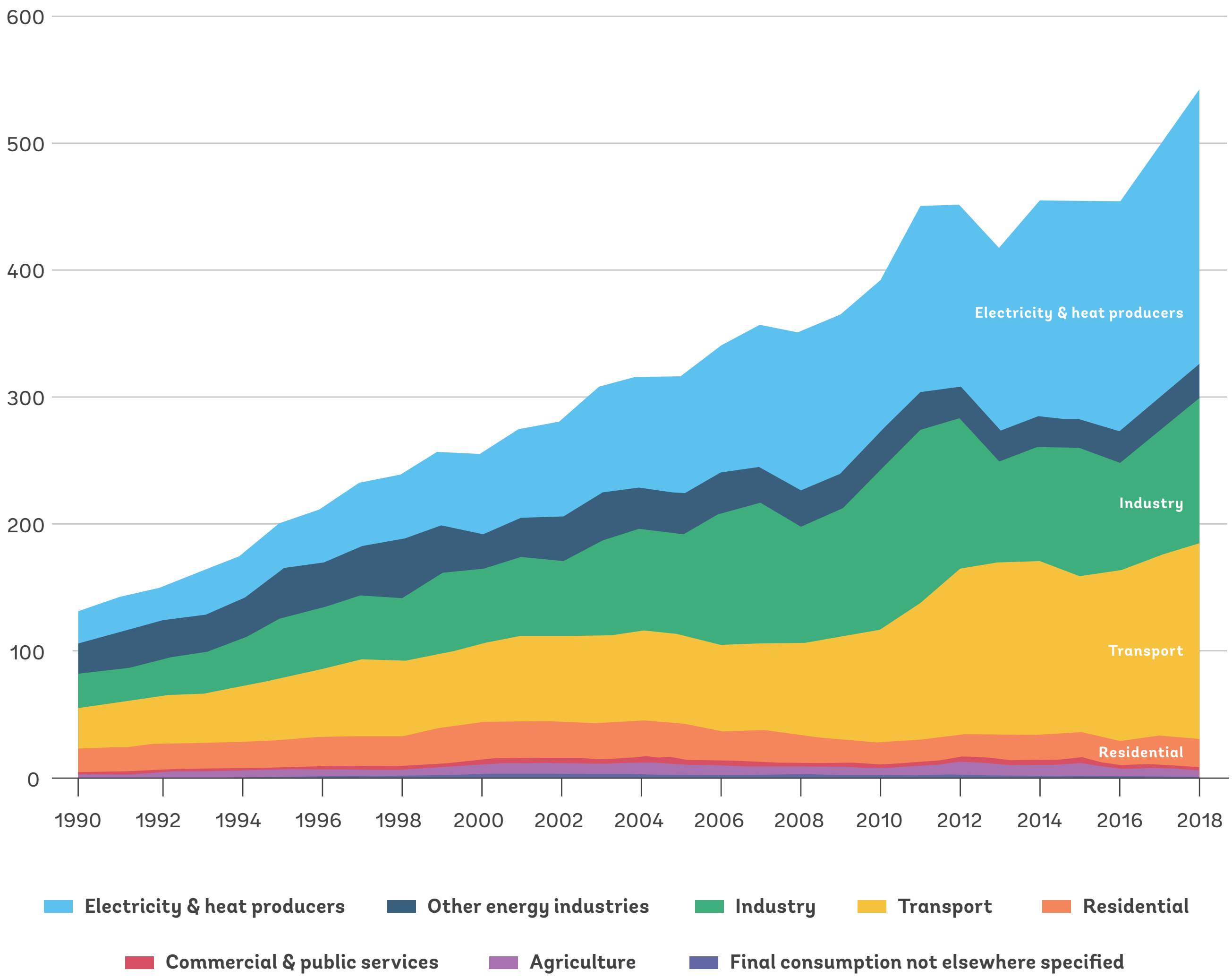


Source: IEA data for Indonesia

Indonesia's total carbon dioxide emissions quadrupled over the same period, the greatest share of which is attributed to electricity and heat producers, followed by transport and then industry (Figure 4.20). Guan et al. (2021) examine the many factors that drive emissions increases in Indonesia and around the world. Their decomposition exercise for the period 2010 to 2018 finds that most of Indonesia's increase in CO2 emissions was due to its rising per capita incomes and growing population, followed by the expanded share of coal in energy production (Figure 4.21). None of these factors bodes well for reversing the upward emissions trajectory in the near term or achieving Indonesia's NDC target.[48]

Figure 4.20

Indonesia's CO2 emissions by sector (Mt CO2)

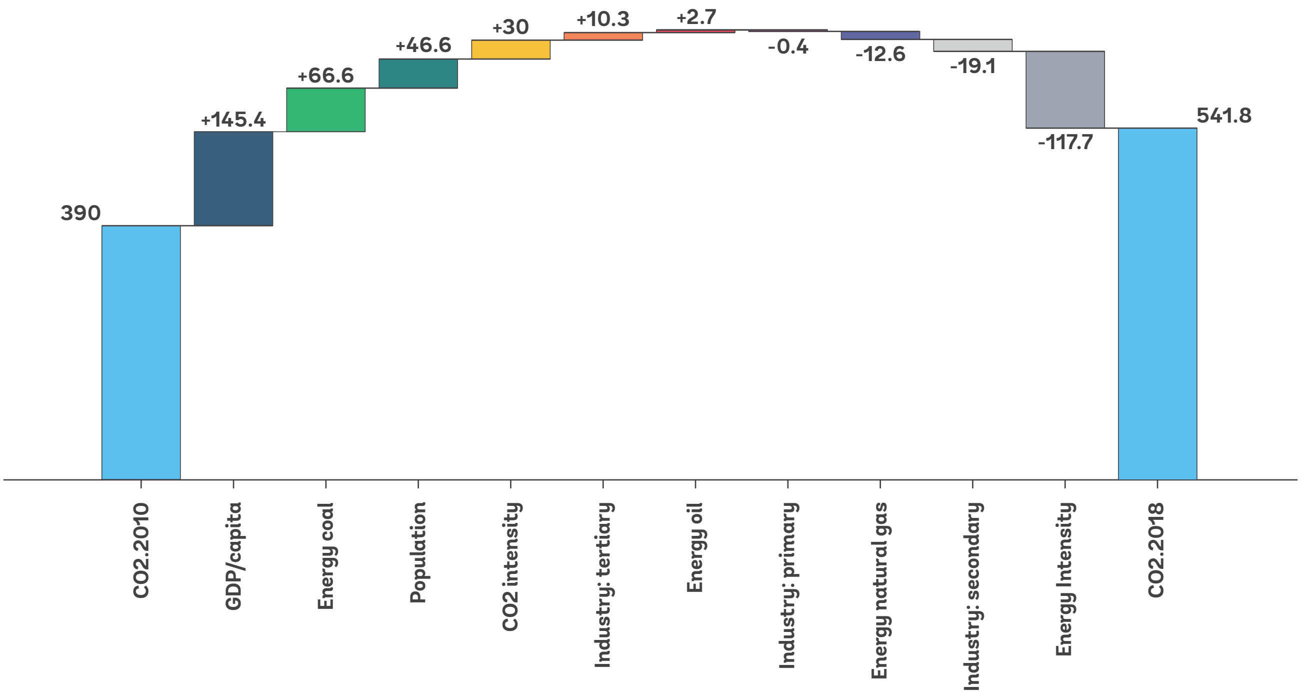


Source: IEA data for Indonesia

[48] Indonesia's energy intensity, defined as energy consumption per unit of GDP, did at least decline between 2010 and 2018, which helped to constrain the upward pressure on CO2 emissions (Cui at al. 2020).

Figure 4.21

Factors driving Indonesia's rise in CO2 emissions (2010-2018)



Source: Guan et al. (2021)

The slow adoption of alternative energy sources is largely explained by coal's low production cost and the monopoly power of Indonesia's state electricity company PLN (Perusahaan Listrik Negara), which plays an influential role with respect to Indonesia's energy strategy. PLN's mandate to return a profit was a main reason why it resisted renewable energy alternatives that are more expensive than coal; this disconnect was addressed in a 2017 regulation requiring the state electricity company to purchase any surplus renewable-source electricity generated by Independent Power Producers, and effectively subsidizing any cost differences (Atteridge et al. 2018, Susanto 2017). PLN's grid-based energy purchases from IPPs and PPUs are still highly concentrated in coal-fired generation (accounting for about two-thirds), but the portion from renewable resources is finally increasing (albeit from a very low base).[49]

In addition to rising consumer demand, other factors contributed to the explosive rate of coal mining growth since 2000. According to a report by Stockholm Environment Institute (2018)[50], a confluence

[49] Indonesia's state electricity company PLN has purchased hydro and geothermal power from IPPs and PPUs for at least a decade, but solar and wind generation represents a new source (based on data from PLN (Perusahaan Listrik Negara) Statistics and Electricity Statistics, Directorate General of Electricity, reported in 2019 Handbook of Energy and Economic Statistics of Indonesia).

[50] A. Atteridge, M. Thazin Aung and A. Nugroho, "Contemporary Coal Dynamics in Indonesia", SEI working paper 2018-04, Stockholm Environment Institute.

of institutional and governance factors fueled the proliferation of new mining permits, which surged from a modest number of mining firms that were directly contracted by the national government to a much higher number following the decentralization of licensing decisions to the district government level. This shift in permitting authority was part of the broader decentralization reform in 1999. Between 2001 and 2008, the number of mining permits grew more than eight-fold, reaching 8,000 by 2008, and increasing further to 11,000 by 2014, two-fifths of which were for coal mining, mostly small and medium-sized mines (Hayati 2015 and HFW 2014, cited in Atteridge et al. 2018). The fee structure for coal permits, under which coal producers pay a royalty on production as well as a land rent on the area covered by the permit, incentivizes district governments to issue more permits. Atteridge et al. (2018) also point to weak governance and oversight, illustrated by examples where local politicians profit directly or indirectly from mining activity. Government has introduced a series of measures to increase oversight and exert more control over what it deems a national resource, albeit with mixed effect.[51] It is notable that, despite the relative ease of acquiring a permit, significant illegal mining takes place – whether in non-permitted areas or in protected forest reserves where permits should not have been issued – and illegal exports are also a problem (Atteridge et al. 2018). The recently issued Omnibus Law on Job Creation (Undang-Undang Cipta Kerja, 2020) includes provisions to revoke local government authority over mining permits (unless stipulated in specific implementing regulations) but the Ministry's limited capacity for local oversight and monitoring may impede the law's effectiveness.

The coal sector in Indonesia has generated significant employment over the past decade. According to national labor force survey data, coal mining employment more than doubled from around 90,000 jobs in 2007 (the first year for which sufficiently representative data are available) to a peak of almost 264,000 in 2014, before receding to 215,000 jobs by 2015 (Figure 4.22).[52] Coal mining employment expanded thereafter, reaching nearly 240,000 jobs in 2018. Indonesia's coal mining workers account for only 0.2 percent of Indonesia's 120 million employed workers but represent 5 percent of the global coal workforce (recall from Chapter 2).

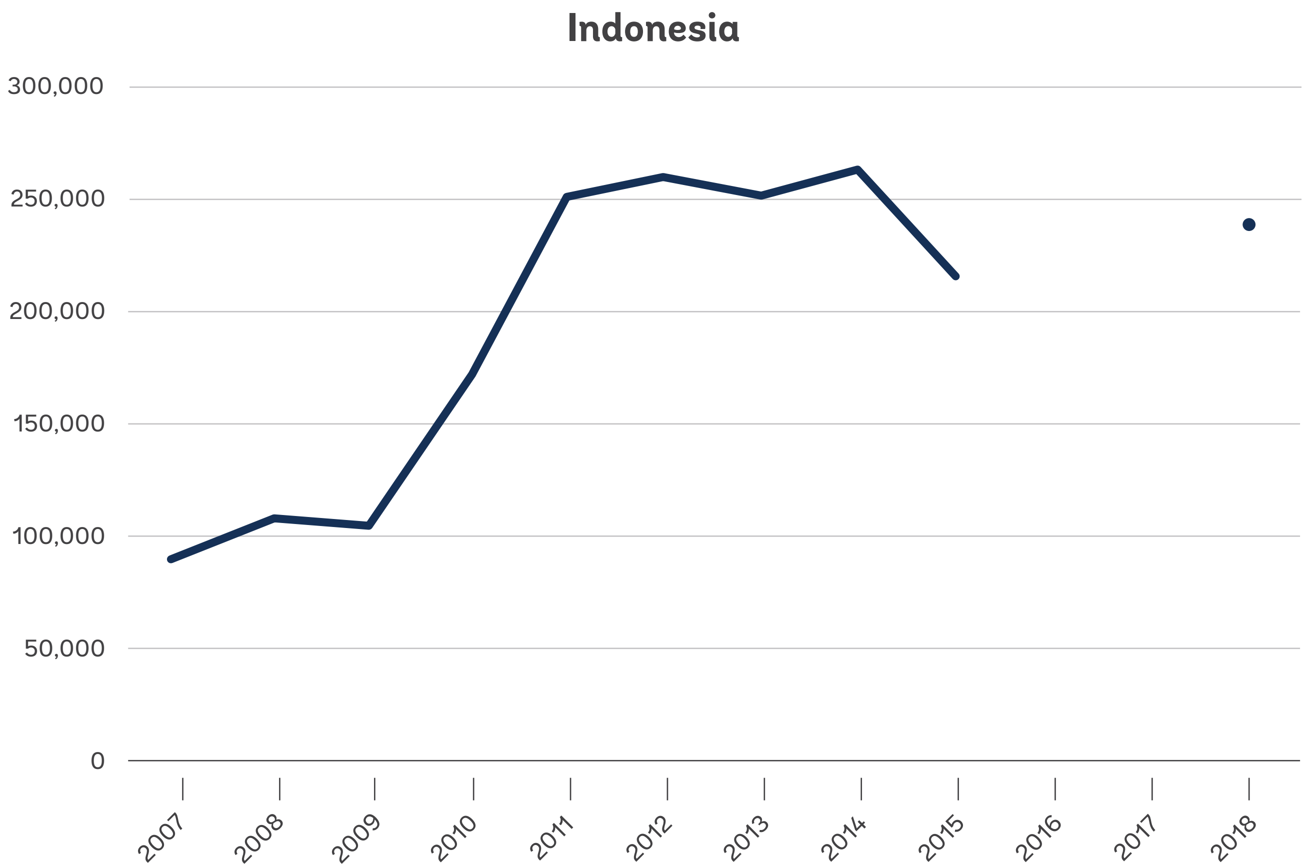
Indonesia's labor market is steadily modernizing. Although still a largely rural labor force, over the past decade employment has increasingly shifted away from agriculture-based work toward services and, to a lesser degree, manufacturing (Figure 4.23). The share of agriculture jobs fell from 40 percent in 2007 to 27 percent a decade later, as workers increasingly moved into alternative employment in the services,

[51] In 2009, limits on the share of coal available for export were introduced via the Domestic Market Obligation established as part of the 2009 Mining Law and MEMR Regulation No. 34/2009. Regulations were added in 2010 requiring mine owners to prepare a post-closure mine reclamation plan and deposit an upfront reclamation guarantee, but these rules are often ignored. Since its 2015 inception, the Clean and Clear program is a certification process that reviews mining firms' compliance with a range of obligations.

[52] The data used for this analysis comes from Indonesia's National Labor Force Survey, Sakernas, conducted by BPS-Statistics Indonesia. Since its inception in 1976, Sakernas has undergone a series of improvements in geographical coverage and type of labor market information collected. It is the largest source of employment data in Indonesia, representative at the district level beginning in 2007. We utilize the August wave of Sakernas because it provides the necessary level of industrial sector disaggregation to differentiate coal mining activities from non-coal mining and quarrying. Note that this level of disaggregation is not available for 2016, 2017 or 2019. As in the rest of this report, using industry classifications to measure coal mining employment captures direct coal mining jobs but not indirect employment in supporting activities.

Figure 4.22

Coal mining employment 2007-2018



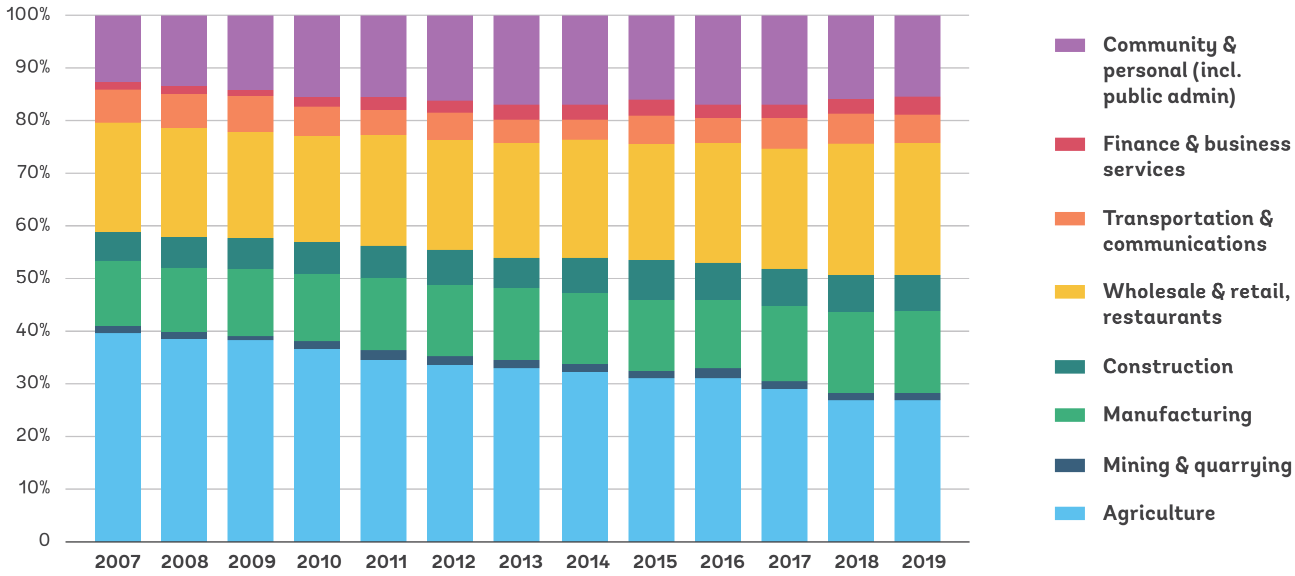
Source: Sakernas data 2007-2018

manufacturing and construction sectors. This pattern reflects continued structural transformation of the economy, but with a shift in focus to natural resource-based export activities in the aftermath of the Asian financial crisis, compared to earlier periods of dynamic industrialization focused on labor-intensive manufacturing exports. The World Bank's (2020a) jobs assessment asserts that Indonesia's declining competitiveness in the 2000s led to a contraction in the manufacturing employment share to around 13 percent while low-value added services absorbed the greatest share of jobseekers.

As high commodity prices started to ease in the early 2010s, manufacturing employment picked up again, but labor productivity growth in most sectors of the economy has been slower this decade compared to last, and most jobs are in low-productivity sectors and/or in relatively unskilled occupations (World Bank 2020a). Note the concentration of current employment (bubble size denotes employment share) and decadal job creation in low-paid low-productivity sectors in the left half of Figure 4.24, especially in commerce, manufacturing and construction.

Figure 4.23

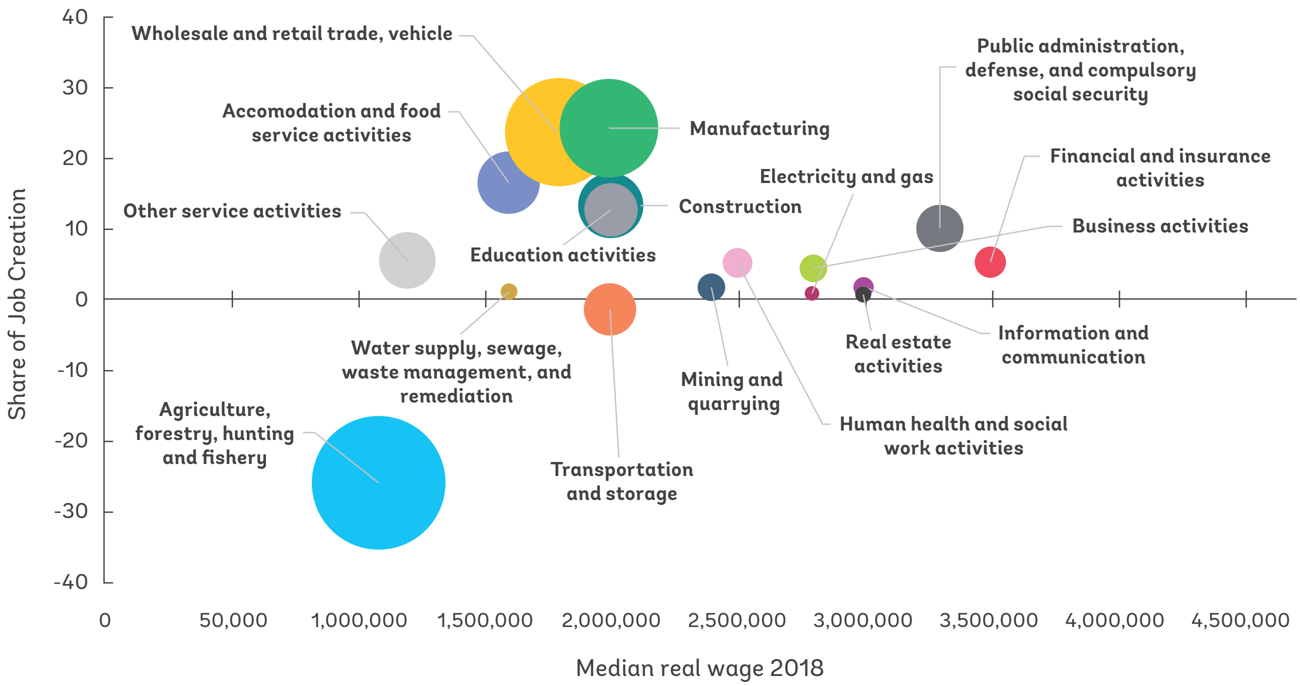
Shifting sectoral employment shares (% of total employment)



Source: Sakernas data 2007–2019

Figure 4.24

Job creation during 2000-2018 concentrated in relatively low-productivity sectors



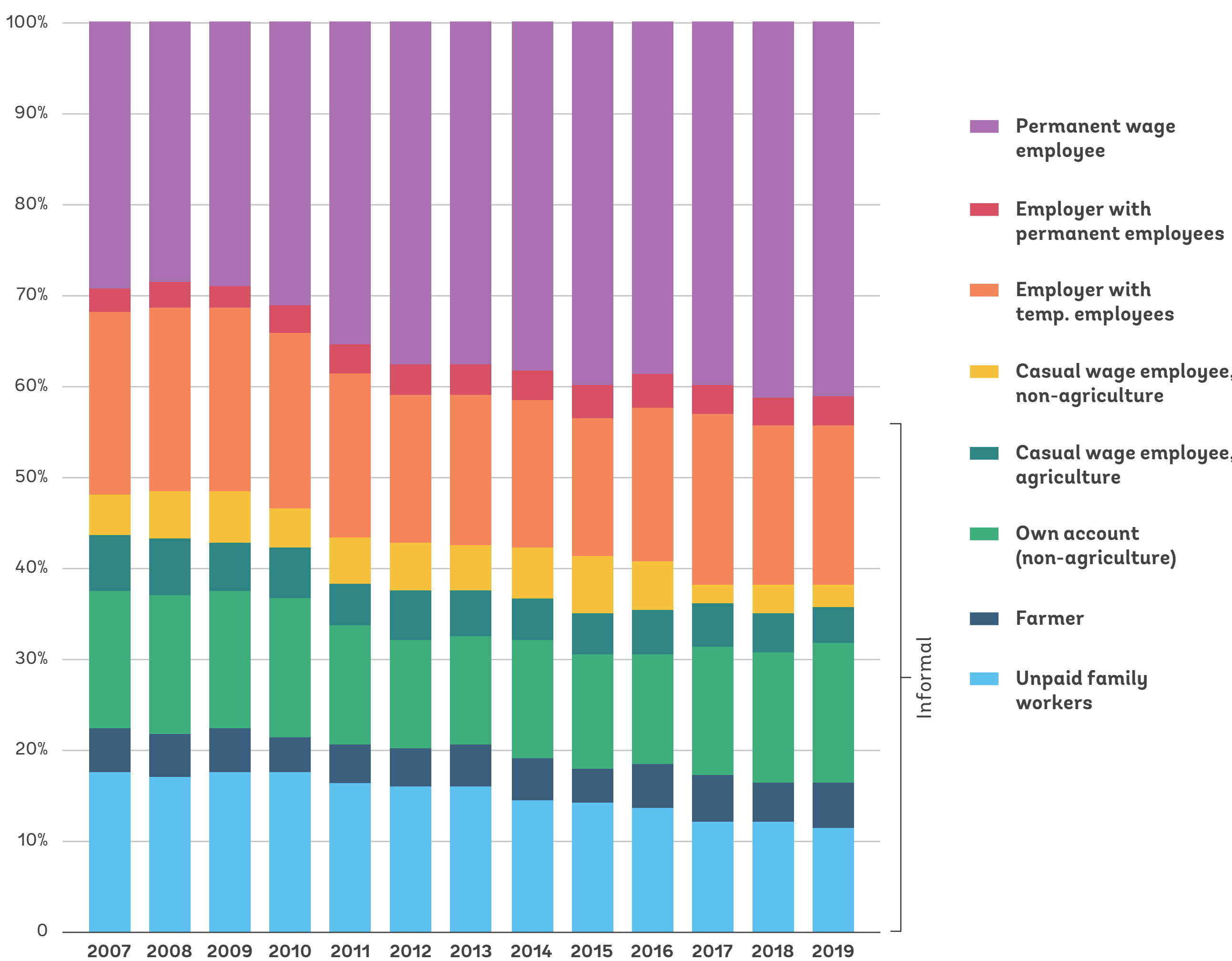
Note: Bubble size denotes share of employment in 2018

Source: from World Bank (2020b) using Sakernas data 2000–2018

Formal employment – defined here as permanent wage work – is becoming more prevalent, although informal work status remains widespread. Nearly every sector increased its share of permanent wage jobs, an indication of the labor market's shift to more formal structures of production and more formal employment contracts. The rise in permanent wage jobs from 29 percent in 2007 to 41 percent in 2019 was a key contributor to the increasing share of middle-class jobs observed over the past decade (World Bank 2020a). Nevertheless, informal[53] work status is still predominant, with 56 percent of workers engaged in self-employment, casual work, or unpaid family work in 2019 (Figure 4.25).

Figure 4.25

Breakdown of work status (% of total employment)



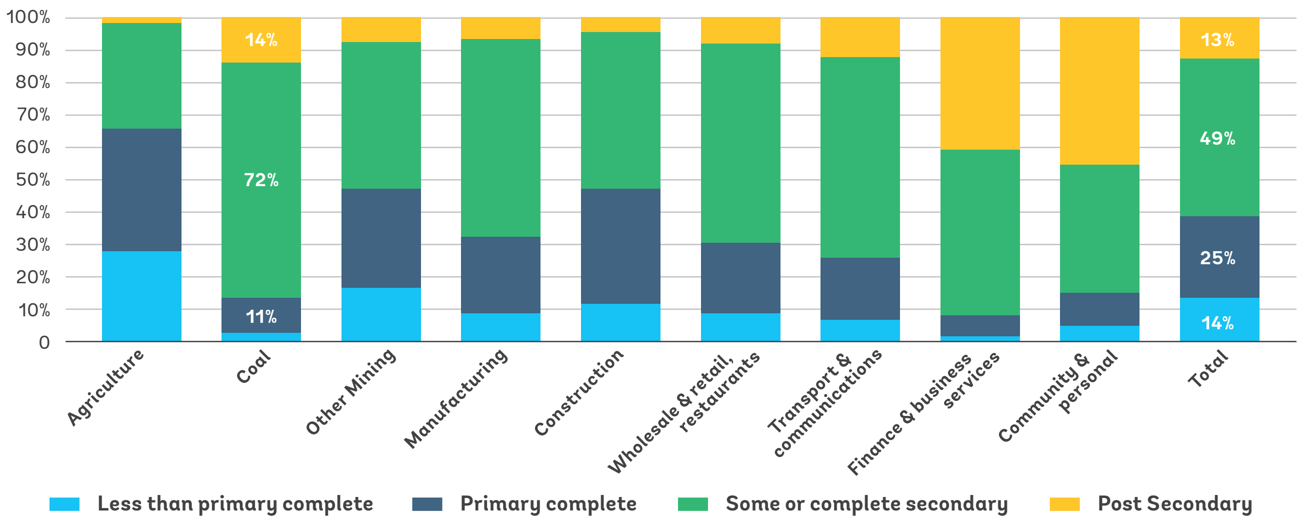
Source: Sakernas data 2007-2019

[53] Various criteria can be used to define informality. In this analysis, we define informal as those in casual wage employment, own account work including farmers, unpaid work, and employers of temporary employees.

Coal mining jobs are of higher average quality and pay more than most other sectors in Indonesia's economy. Over 95 percent of coal mining jobs are formal, on par with the government sector, and employ workers with above-average education, mostly with secondary school qualifications (Figure 4.26). Coal mining workers are relatively young, nearly all male, and predominantly engage in production occupations or as machine operators, at rates similar to those observed in manufacturing, construction, and transport and communications. Coal mining jobs pay higher wages than most sectors, more than double the average agriculture wage, 86 percent higher than the average construction job, and 59 percent more than the average manufacturing wage (2018 data; Figure 4.27).

Figure 4.26

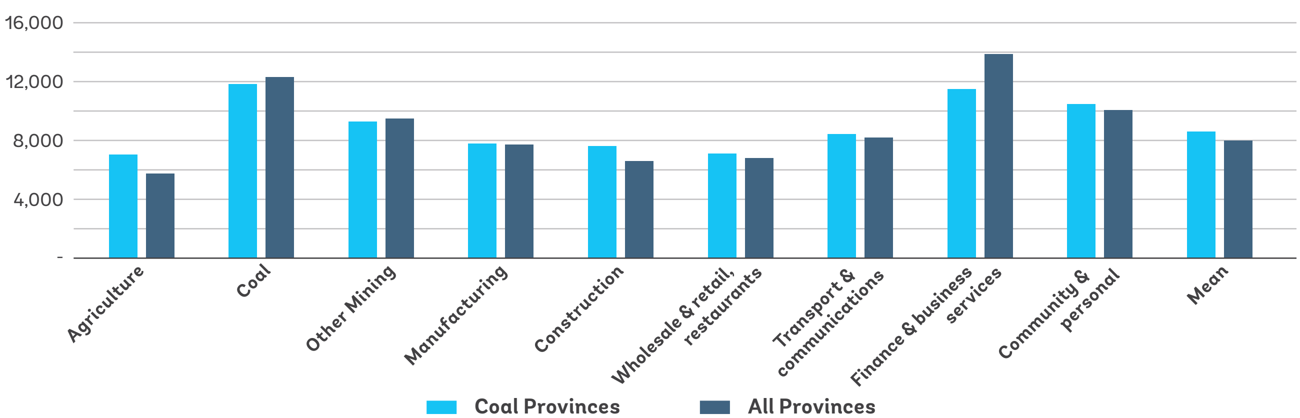
Educational attainment levels by sector



Source: Sakernas data 2018

Figure 4.27

Comparison of average sectoral wages (2018, constant 2007 rupiahs)



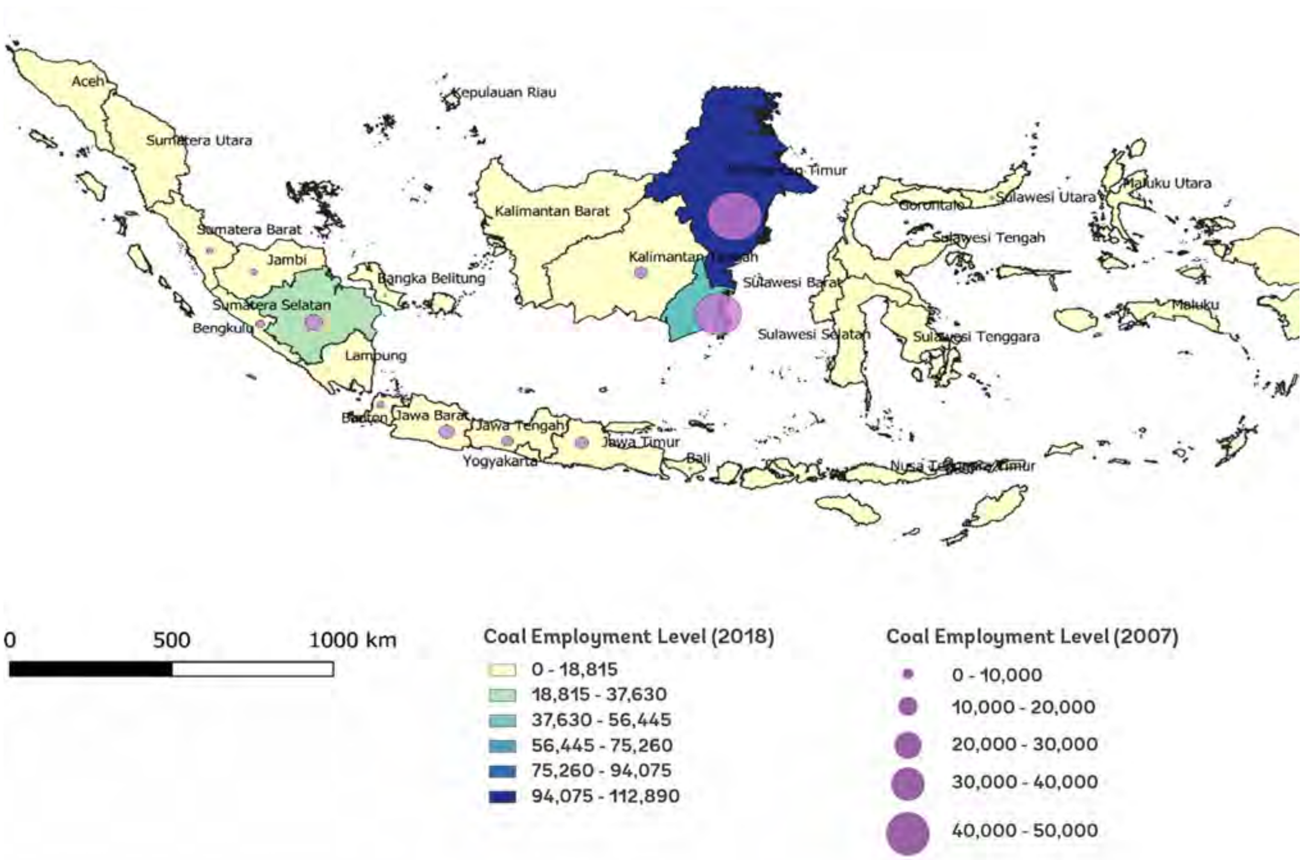
Source: Sakernas data 2018

Indonesia's coal activities are geographically concentrated in Kalimantan, and to a lesser extent Sumatera. South Kalimantan, East Kalimantan and North Kalimantan provinces[54] account for the bulk of coal employment, followed by South Sumatera (Figure 4.28). Within these "coal provinces", coal intensity varies by district. Figure 4.29 shows the district-level variation in coal employment shares across Indonesia, which are clearly concentrated in the three provinces, but to different degrees from one district to the next, ranging from negligible or zero coal jobs up to 15 percent.

Figure 4.28

Coal employment high and rising in South Kalimantan and East and North Kalimantan

(coal employment levels in 2007, 2018)



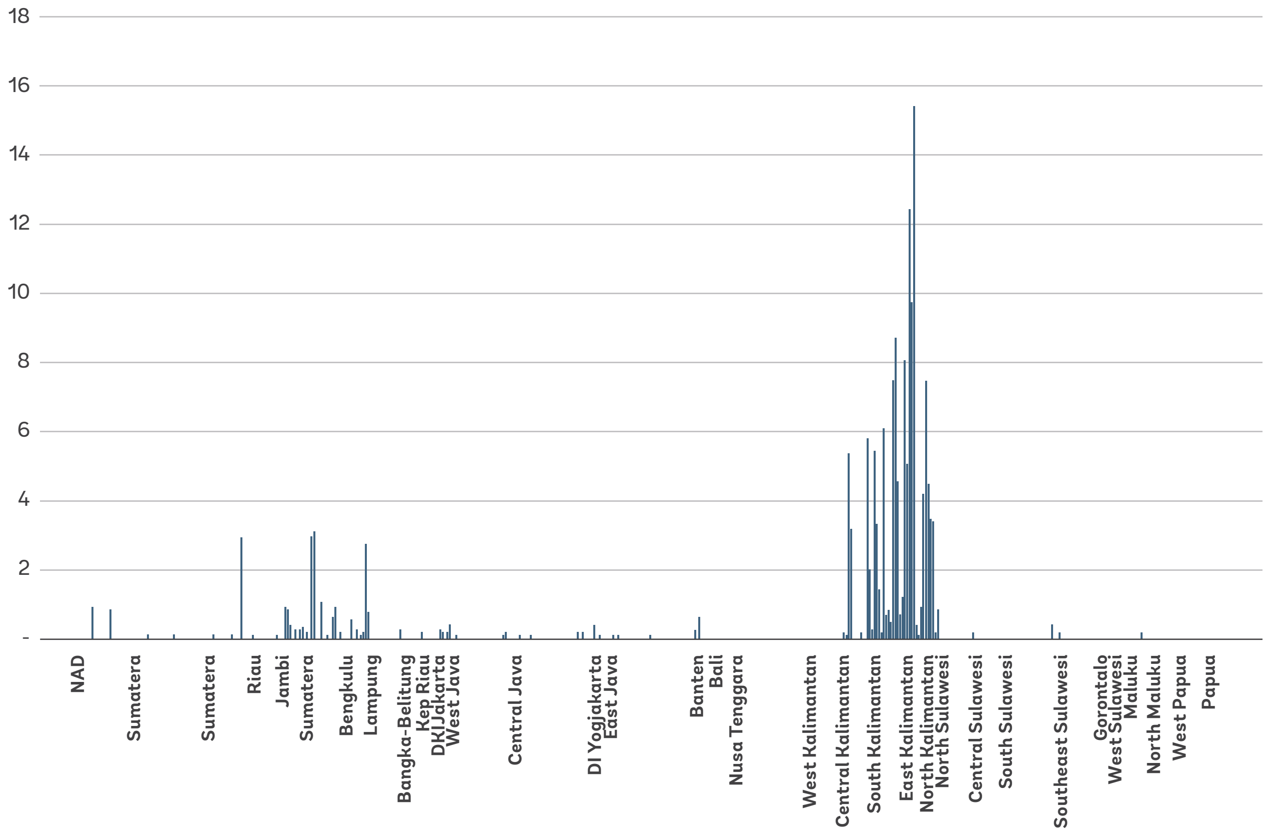
Source: Sakernas data 2007, 2018

[54] Note that although East Kalimantan and North Kalimantan became two separate provinces in 2012, the analysis below considers them together to ensure consistent treatment across the entire period of analysis, namely 2007-2019.

Figure 4.29

Coal employment intensity by district

(% of total employment, 2018)

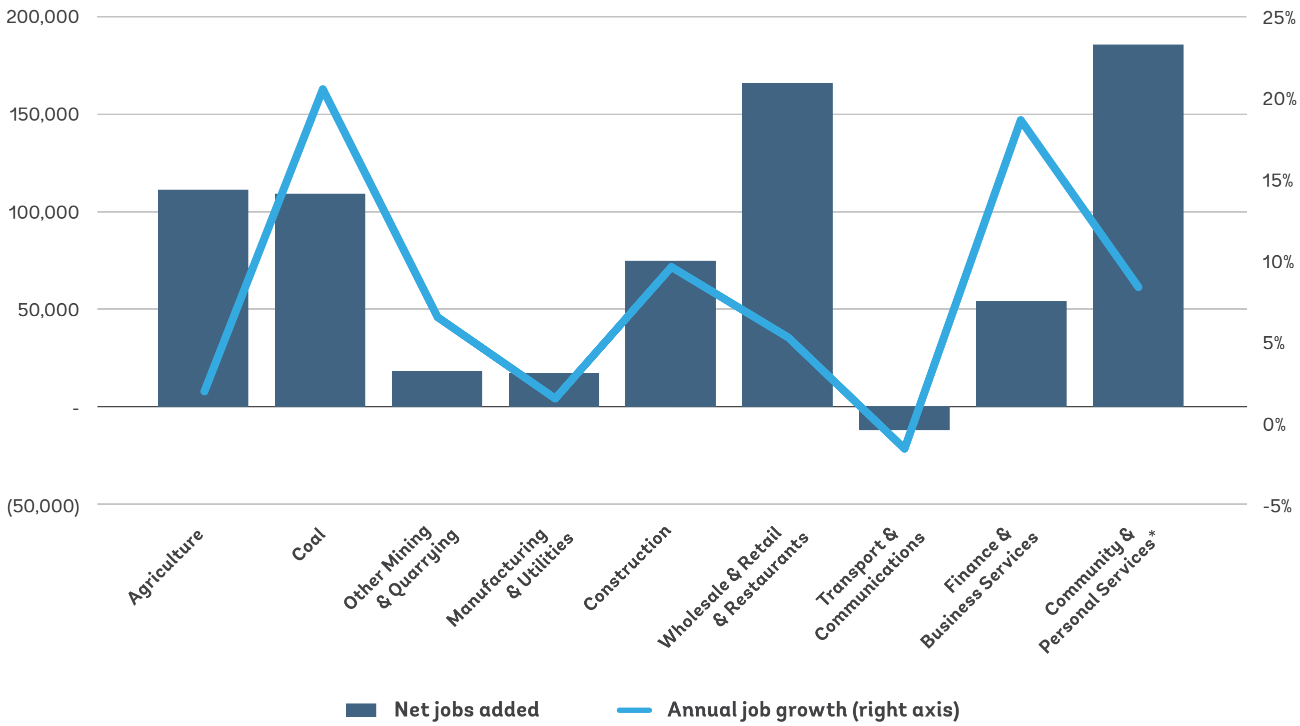


Source: Sakernas data 2018

Despite its small share in total employment, coal plays an outsized role, especially in coal-intensive districts. During the period of rapidly expanding coal production – notably between 2007 and 2012 – the economies of South Kalimantan and East and North Kalimantan added 726,000 net jobs in total, nearly 110,000 of which were coal mining jobs, reflecting a 21 percent annual average growth rate in coal mining employment (Figure 4.30; details in Annex 2 Table 1). Whereas the scale of total job creation in non-coal sectors dwarfs the number of coal jobs created, coal mining jobs – like other extractive activities that are vulnerable to boom and bust cycles – can have large spillover effects for the local economy. As coal production expands and new coal jobs are created, labor demand increases through two main channels: (i) within coal supply chains (e.g., linked to mining, mining operation inputs, coal transport, and coal-fired power generation), and (ii) in non-coal sectors within local economies. Regarding the latter, as more coal workers spend their higher earnings on local goods and services and local tax revenues rise, increased aggregate demand and government spending induce additional job creation in other sectors.

Figure 4.30

Sectoral job growth in South Kalimantan and East and North Kalimantan from 2007 to 2012



** Includes public administration.*

Source: Sakernas data 2007, 2012

The Indonesia data shows that the presence of coal mining jobs significantly affects local labor market outcomes related to both wage levels (positive) and wage growth (negative). Regression analysis on the correlates of wages indicates that coal wages are higher than all other sectors even when accounting for education level and other characteristics (Figure 4.31 shows the wage regression coefficient values; details in Annex 2 Table 2). This positive and strongly significant correlation also holds when we restrict the estimate to the two main coal provinces, South Kalimantan and North and East Kalimantan (Annex 2 Table 3). Looking at the local impact of higher coal wages over time paints a mixed picture. Applying the methodology in Black et al. (2005)[55], we find evidence that the increase in well-paid coal jobs pulled up wages in other sectors, but it

[55] Similar to Black et al. (2005), we restrict our sample to include only the wages of men aged 25-45 to reduce bias from any changes in the composition of the labor force. We estimate the following equation:

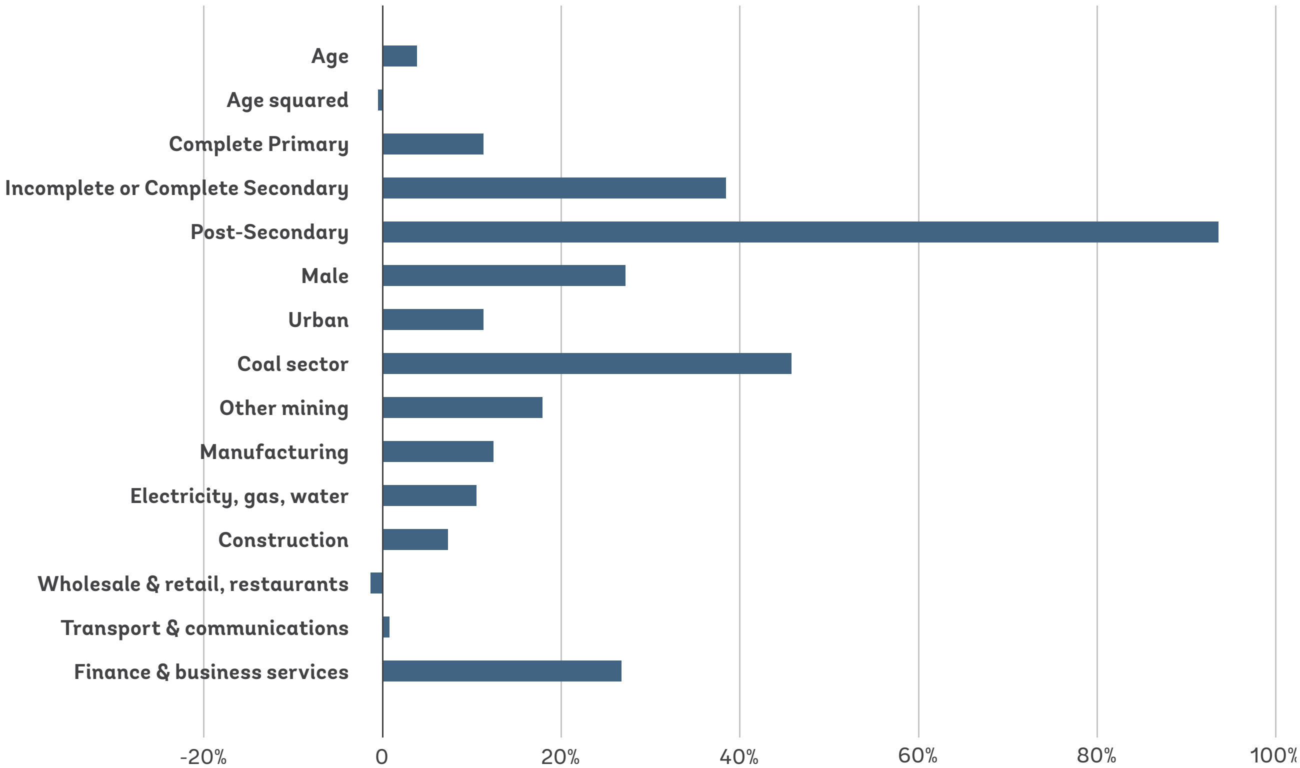
$$Ln(Wage_i) = \beta_0 + \beta_1\, Coal_i + \beta_2 T + \beta_3\, (Coal_i * T) + X\beta_4 + U_i$$

where $Coal$ is a binary variable that equals one if an individual is in our treatment coal-intensive district group; T is a time variable representing year 2007, 2012 or 2018; and X controls for age, age-squared, urban location, province and educational attainment level. β_1 is interpreted as the differential wage between the treatment and comparison district groups and β_3 is interpreted as the differential wage growth in a particular time period (2007-2012 or 2012-2018) between the treatment and comparison districts.

may have squeezed labor demand and wage growth in other sectors where firms had to compete for workers to fill local vacancies. For the 2007-2012 period, non-coal wage growth within coal-intensive districts was 23 percent slower than in districts with lower coal intensity (although it should be noted that wage growth is measured relative to a higher initial wage; Annex 2 Table 4). This result holds across all sectors considered. The strongest negative wage effects are observed in manufacturing and to a lesser extent construction, suggesting a degree of crowding out in these sectors, which employ similar types of workers.[56] There is no significant effect observed in these sectors in the subsequent 2012 to 2018 period when the number of coal jobs declined, although there is some evidence of modest upward pressure on agriculture wages (results reported in Annex 2 Table 5).

Figure 4.31

Correlates of real hourly wage (2018 data)



Note: Coefficient values from OLS regressions on the correlates of real hourly wages reported by wage employees in 2018 (converted to 2007 rupiahs). Independent variables include age, age squared, and dummy variables for education level, male gender, and urban location, and with sector and province fixed effects. Full regression results are reported in Annex 2 Table 2, column 2.

Source: Authors' estimates using 2018 Sakernas data.

[56] This result contrasts with findings by Black et al. (2005) for the US showing separate impacts on tradable sectors (i.e., manufacturing) and non-tradable sectors (i.e., construction and services).

Coal sector growth stimulates job creation in other sectors, but too many coal jobs risks crowding out employment in non-coal sectors; our analysis finds both positive employment spillovers as well as evidence of crowding out in Indonesia's coal-intensive districts. Recall that analysis on the US Appalachia region shows severe natural resource curse effects in isolated regions and/or when compounded over time (Lobao et al. 2021). We test for employment spillover effects in districts within Indonesia's two main coal provinces, South Kalimantan and East and North Kalimantan, using the methodology articulated in Black et al (2005) and summarized in Annex 2. Our regressions indicate a strongly positive correlation[57] between the level of coal employment and employment in other sectors (highest in manufacturing (0.56) and lowest in construction (0.36)), but in districts that are especially coal-intensive , we find evidence of crowding out, namely that the spillovers are not as big compared to less intensive coal[58] districts (results reported in Annex 2 Table 6). The effects appear strongest vis-à-vis the manufacturing sector.

The disproportionate influence of coal mining jobs in local labor markets may stem from their relatively high wages which create distortions in the local economy. The presence of high-paying coal jobs distorts both the labor supply decisions of job seekers and the hiring decisions of employers, generating persistent dampening effects on labor demand across multiple sectors in the local economy and ultimately constraining economic growth. Other channels of persistence include lower public investment and sub-par public services due to the lower tax revenues generated by a struggling economy. This interpretation accords with findings by Edwards (2015)[59] of inferior health and education outcomes in Indonesia's mining-intensive communities compared to neighboring districts.

Past episodes of global demand fluctuations have impacted coal mining jobs in Indonesia. For example, the negative price shocks in 2015 and 2016 affected local mine production and jobs, especially in South Sumatera and Banten, where smaller mines have higher production costs; many of these mines were forced to cease production, at least temporarily (Atteridge et al. 2018). The Sakernas data indicates that coal mining employment in South Sumatera fell from 15,500 in 2012 to 10,000–11,000 in 2014 and 2015, before rebounding to over 21,000 by 2018. Banten province suffered even greater production shocks during this period, leading to permanent job losses; coal employment exceeded 15,000 in 2012, fell to 1,400 in 2015, and only slightly recovered to 3,200 by 2018.

The boom and bust cycles associated with resource extraction are a challenge for sustained economic development. Lobao et al. (2021) and Black et al (2005) provide significant evidence on the challenges facing coal communities vulnerable to price fluctuations that exacerbate local boom and bust effects. The decline in coal consumption in most advanced economies and the associated transition out of coal-fired energy in favor of cheaper and/or cleaner alternatives has inflicted sometimes catastrophic damage on coal-dependent economies. Recall that

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[57] Note that OLS regressions do not indicate causality, only correlation, although there is little reason to think that fast-growing agriculture, manufacturing, construction or services employment would be driving an increase in coal jobs.

[58] Districts are designated as coal-intensive if the coal share of employment is at least 4 percent.

[59] R. Edwards (2015). "Mining Away the Preston Curve", World Development Vol. 78, pp. 22–36.

in the US Appalachian region, districts that were heavily dependent on coal suffered job losses and severe economic dislocation that had persistent effects; very few affected counties have successfully transitioned away from coal and still maintained a viable local economy (Lobao et al. 2021). With respect to Indonesia's mining sector, Bhattacharyya and Resosudarmo (2015) find evidence that increasing coal mining employment has no significant effect on poverty, but when mining activity accelerates, poverty increases, implying a serious negative dynamic effect of coal mining booms. Edwards (2017) cites case study evidence that coal mining in Indonesia crowds out agriculture activity, which is the main sector of employment in rural areas, especially among the low-skilled.

Future prospects for the coal sector and coal mining jobs in Indonesia are uncertain, at least in the medium term. If we see continued growth in coal production and local economic specialization centered around coal mining, there is a risk of coal dependence that increases districts' vulnerability to demand shocks. When the energy transition away from coal finally gets on track, what will it mean for Indonesia's 240,000 coal mining workers and the many others employed in coal-dependent activities? Winding down mining operations and cutting coal sector jobs may take on the characteristics of a "bust" cycle in which employment and wages in other sectors are pulled down faster in the coal-intensive district than in non-coal intensive districts, consistent with Black et al. (2005). If displaced miners delay taking up alternative jobs due to lower wage offers, the size of the local economic shock may be more intense and the subsequent recovery prolonged. In a national survey of Indonesian employers conducted in 2015, respondents reported that the main obstacle to hiring unskilled production workers was applicants' excessive and untenable wage expectations (Gomez-Mera and Hollweg 2018).

The current energy landscape – both in terms of energy supply and projected demand – suggests that Indonesia's transition away from coal may be gradual. Even if change is not imminent because of the rising trajectory of Indonesia's electricity demand, global export markets will ultimately dry up and Indonesia will shift its priorities away from the coal industry. The 2017 National General Plan on Energy (RUEN) caps annual coal production at 400 MT from 2019 to 1950, and targets a rise in the renewable energy share from its 2017 level of 6.2 percent to an ambitious 23 percent by 2025 and 31 percent by 2050. But this target depends partly on biomass for co-firing, which is highly polluting. Moreover, promoting the use of biomass in energy generation is highly problematic because expanding palm-oil plantations can be devastating for forests and biodiversity. Government currently mandates a biodiesel blend of at least 30 percent (B30), but insufficient refinery infrastructure impedes the even higher target of 40 percent minimum (B40) for 2021. Meeting the Government's ambitious targets will be difficult given the current pace of transition as well as institutional weaknesses. The Institute for Essential Services Reform (IESR) projects that the country will likely fall well short of its renewable energy target, forecasting a 15 percent share by 2025.[60] Recent

[60] The National Energy Board (DEN) estimated the 2019 renewable energy share at 9.2 percent. Source: "RI to break long-term green energy promises at current pace: IESR", *The Jakarta Post*, October 1, 2020. https://www.thejakartapost.com/news/2020/09/30/ri-to-break-long-term-green-energy-promises-at-current-pace-iesr.html

recommendations in a 2020 IEA report focus on regulatory reforms to attract private investment into renewable energy production to meet domestic market needs.[61]

Policies that can facilitate transition away from coal need to consider the interests and incentives of the various agents engaged in or affected by coal production – coal sector workers, local governments, small private investors, large energy suppliers and IPPs, state electricity company PLN, and the Government of Indonesia's CO2 emissions reduction commitments. Indonesia's strategic focus on palm-oil mixed biodiesel may generate jobs in the palm oil value chain, but at an excessive environmental cost. With respect to mitigating the negative local effects of coal-related job losses, transitional support mechanisms could be implemented to help workers adjust to the new market context. Chapter 5 lays out a policy framework for facilitating the transition to a post-coal world.

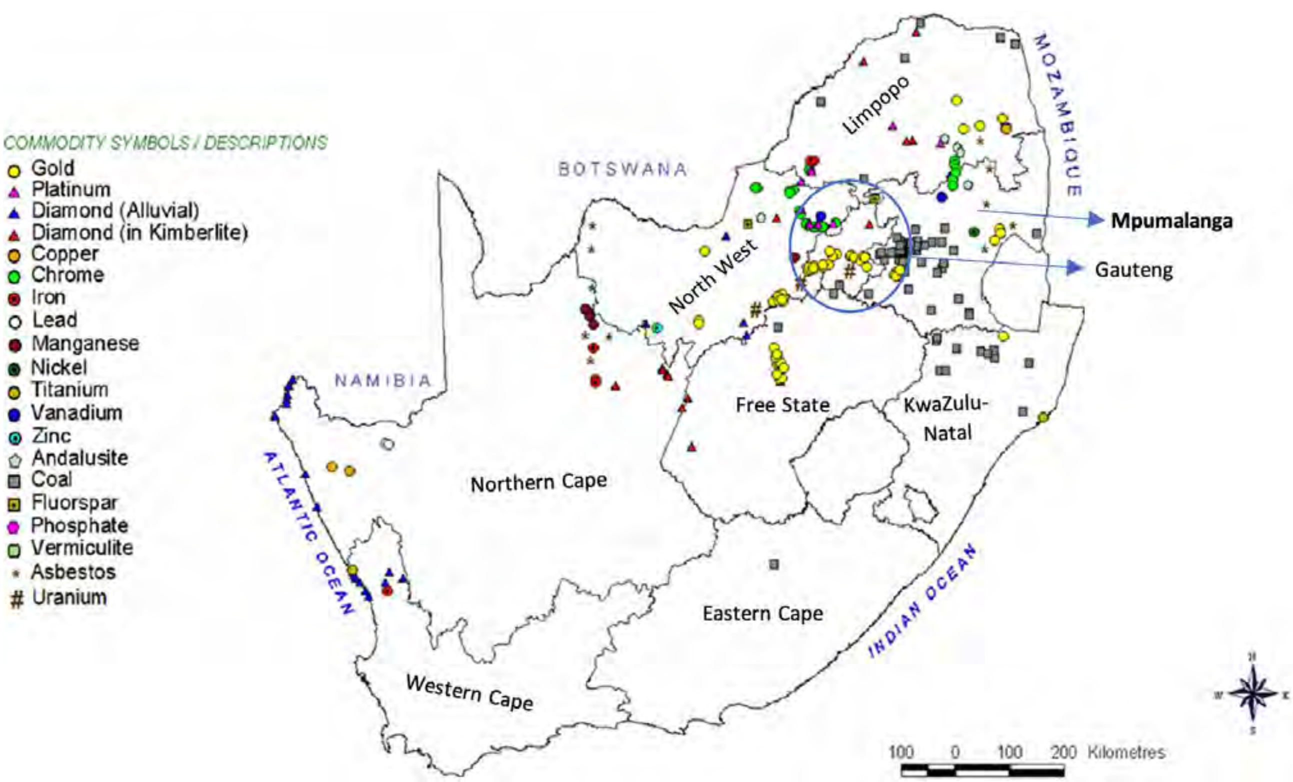
[61] Source: "Attracting private investment to fund sustainable recoveries: The case for Indonesia's power sector", World Energy Investment – Country Focus, Country report July 2020, Energy Supply and Investment Outlook (ESIO) Division of the Directorate of Sustainability, Technology and Outlooks, International Energy Agency.

4.5 South Africa: Holding its Ground

Mineral discoveries in the late 19th century set South Africa on its path to becoming the most industrialized economy in Africa today. Discoveries of diamond, gold and platinum deposits in the late 19th century stimulated large-scale national and international migration, especially to the main mining areas around Kimberley (in Free State province) and Witwatersrand (in Gauteng province; Figure 4.32). The mining boom during the early part of the 20th century required an extremely large workforce, especially in diamond and gold mining (Yudelman 1984). The strong and persistent demand for mine workers and supporting activities contributed to South Africa's economic transition away from a patchwork agrarian economy to a more industrial economy (Turok 2012). This long structural transition was accompanied by significant changes in the labor market. As the economy gradually diversified into manufacturing activities, labor became increasingly specialized and wage employment became the norm.

Figure 4.32

Mining areas in South Africa by product



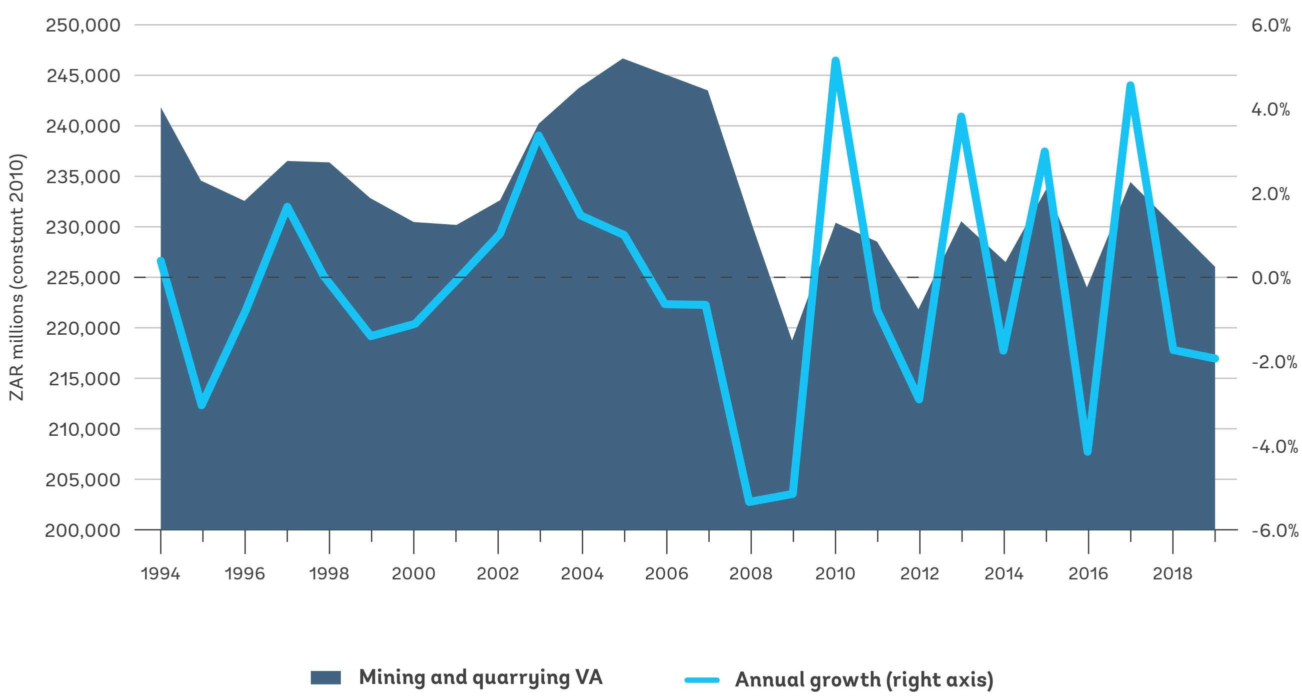
Source: Council for Geoscience South Africa

South Africa's rich natural resource base and the exploitation of these resources spurred the development of many other economic sectors. The scale and variety of mineral resources enabled the establishment of multiple supporting sectors. For example, coal, manganese, and iron ore resources gave rise to a robust steel industry, and manufacturing activities including the production of metals such as electrolytic manganese, chemicals for explosives, and mineral fuels (Harris 1977; Majozi 2015). Machinery linked to extractive industries (e.g. hydraulic technology, underground locomotives and mining fans) not only served the domestic market but became a robust part of the country's export base (IGF 2018). The transformation of minerals and precious metals into higher-value products brought higher profits and earnings. Railway infrastructure - itself mineral intensive – was developed for the transportation and export of minerals. Geographic clusters that formed around mining activities generated spillovers in construction, forestry, and financial services. In addition to industrial diversification, South Africa's high-value agriculture and tradable services – notably citrus and wine products, tourism, transport, and ICT – made important and growing contributions to the economy and job creation.

The mining sector's role in the South African economy has steadily diminished in recent decades. Mining and quarrying as a percentage of GDP fell from 20 percent in 1970 to 8 percent in 2018 (Dessus and Hanusch 2018). Mining and quarrying value added experienced volatile swings, including steep declines in 2008-2009, 2012 and 2016

Figure 4.33

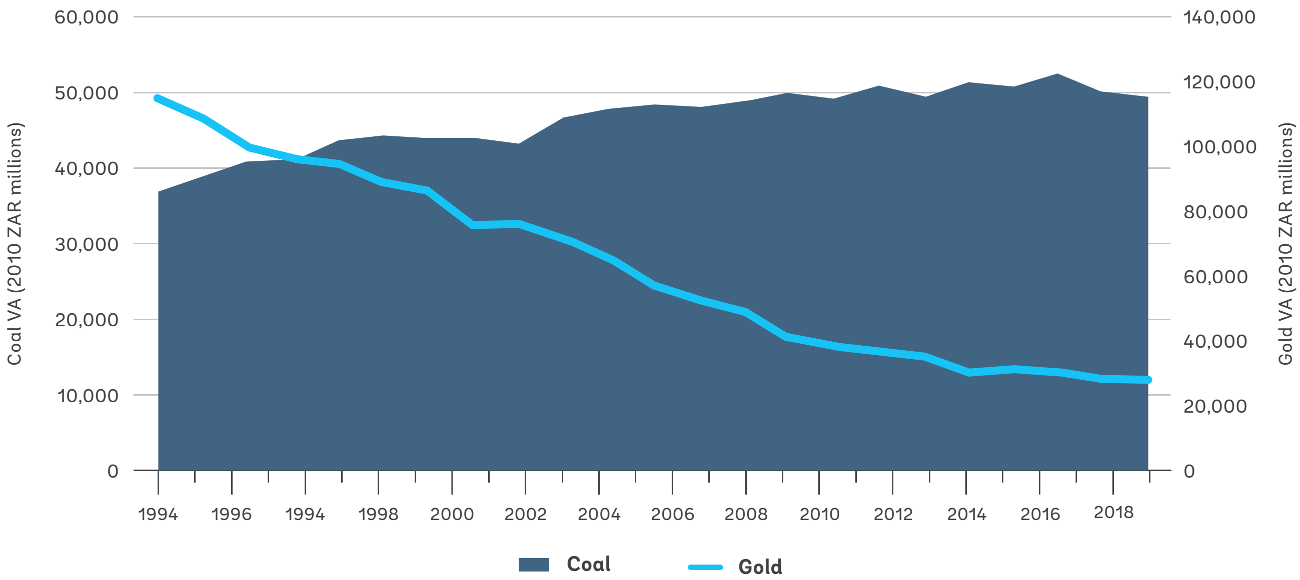
Mining and quarrying value-added (constant 2010 ZAR, millions)



Source: Stats SA, GDP P0441 Annual, quarterly and regional fourth quarter 1994-2019

Figure 4.34

Coal and gold production trends (constant 2010 ZAR, millions)



Source: Stats SA, GDP P0441 Annual, quarterly and regional fourth quarter 1994-2019

with intermittent recovery (Figure 4.33). The sector's contribution to government revenue declined from as high as 29 percent in 1981 to 2.5 percent in 2014 (Haddad et al. 2019), driven by especially sharp contractions in gold mining (Figure 4.34). Gold production fell by more than half between 2004 and 2016; by 2019, South Africa's once significant share of global gold production had fallen to 4 percent (Chamber of Mines 2016; Minerals Council 2019). Mining nevertheless continues to be important for South Africa's balance of payments. In 2018, the sector accounted for 15 percent of private-sector fixed investment, 10 percent of total fixed investment, and 27 percent of total exports (Minerals Council 2019; South Africa Chambers of Mines 2017).

Coal has played a relatively minor but growing role compared to other mining and quarrying activities. During the 1980s and 1990s, coal production increased by 3 percent per year on average, subsequently slowing to 1.3 percent annual growth in the 2000s, and stagnating since 2015 (BP Statistics). Coal's contribution to the economy has hovered in the range of R48 – R49 billion (constant 2010 prices) since 2006, equivalent to about 0.5 percent of GDP (compared to over 2 percent for other mining and quarrying). In terms of mineral sales, coal is the biggest earner, accounting for 27 percent of 2015 total sales, followed by precious gold and metals (21 percent), iron ore (16 percent) and gold (13 percent) (SA Stats 2015).

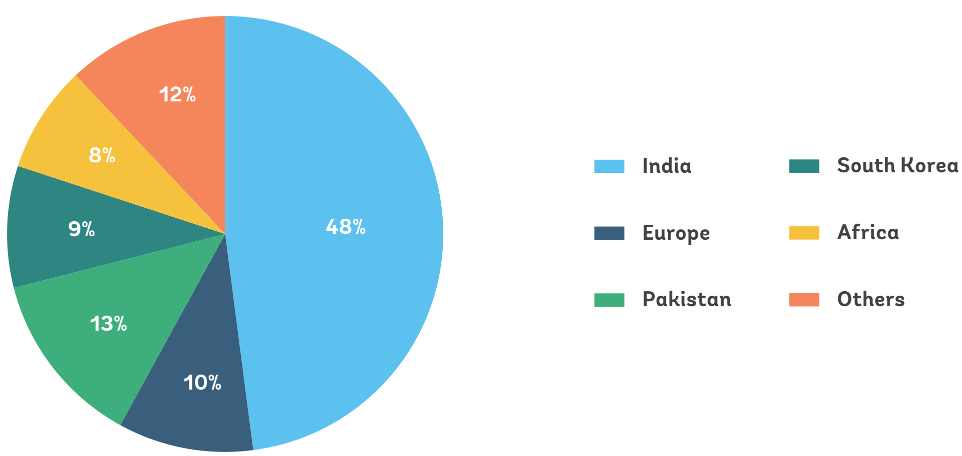
The rise in coal production was driven partly by increasing domestic demand, especially rising demand for electricity. Nearly nine-tenths of South Africa's electricity generation comes from coal (IEA data). Currently, about 70 – 75 percent of coal production by volume (and about 65 percent by value) is consumed domestically, as South Africa exports relatively higher grade coal (Burton et al. 2018a). State-owned Eskom, South Africa's largest electricity company, relies on coal-fired generation, and most of its electricity is sourced from coal-fired power stations located in Mpumalanga province. In terms of electricity distribution, 42 percent goes to the different municipalities, 52 percent is sold directly to industrial, mining, transport, commercial and residential clients, and 6 percent is exported (Winkler et al. 2020). Sasol Ltd., a coal-to-liquids energy company, is also a main consumer of coal (Burton et al. 2018a).

External demand for coal has also been a persistent motivation behind expanding coal production. Since the mid-1980s, South Africa has steadily expanded its coal exports, which accounted for nearly three-tenths of total coal production in recent years. South Africa's share of the coal export market averaged 8-9 percent for much of the 1990s and 2000s, before moderating to around 6 percent in the last decade as Australia, Russia and Indonesia become more competitive.[62] In 2018, more than half of South Africa's exports was destined to India. Other key export destinations are Pakistan, South Korea, Europe, and Africa (Figure 4.35).

Ageing and inefficient rail infrastructure is making access to external markets more difficult. Nearly all South Africa's export coal is transported via rail from the central coal basin to Richards Bay on the East Coast. While port capacity at Richards Bay has increased, coal exports are constrained by rail capacity (as of 2010, rail capacity was below 68 Mtpa; Eberhard 2011). Transnet, South Africa's railway operator, has invested significantly in recent years to expand railway infrastructure, in part to facilitate coal transport. However, a 2017 EIA report flags the risk that weaker global demand for coal, lower international coal prices, and regulatory uncertainties together undermine the rationale for these rail infrastructure investments (EIA 2017).

Figure 4.35

South Africa's coal export destination markets in 2018



Source: Richards Bay Coal Terminal in Nicholas and Buckley (2019)

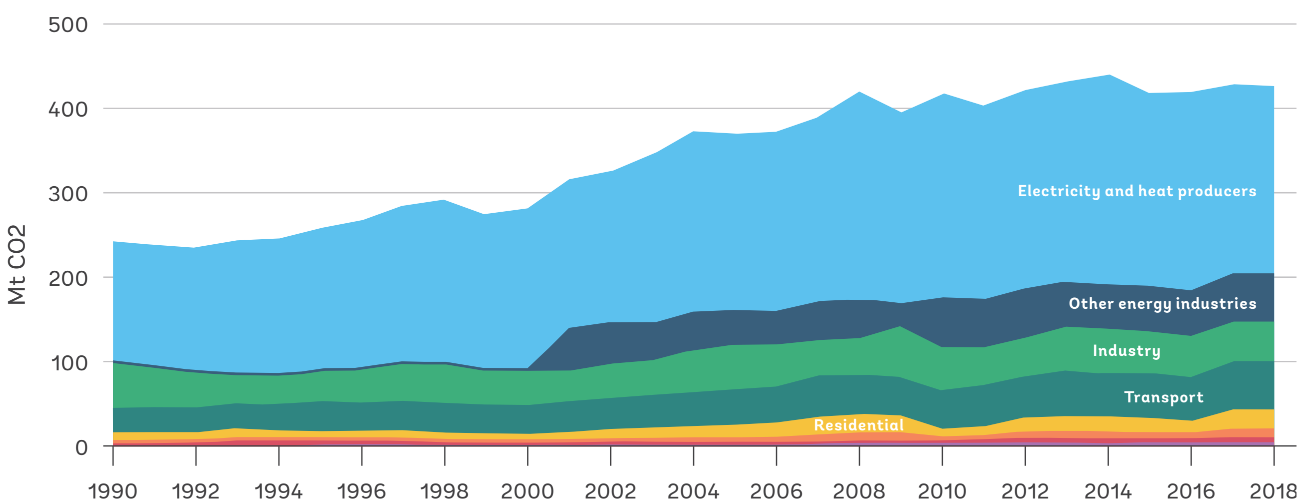
[62] Source: "Attracting private investment to fund sustainable recoveries: The case for Indonesia's power sector", World Energy Investment – Country Focus, Country report July 2020, Energy Supply and Investment Outlook (ESIO) Division of the Directorate of Sustainability, Technology and Outlooks, International Energy Agency.

Future prospects for South African coal are uncertain. With respect to exports, South Africa's reliance on Indian demand in particular has served it well in the past, but this may change. The cancellation of more than 50 percent of planned coal-fired power plants in India suggests the possibility of a long-term stagnation in export demand, which would intensify as India transitions to alternative energy sources. Domestic demand is also facing challenges, especially as a result of recent price increases. Eskom's cost of coal increased ninefold over the last two decades, from R42,79/ton in 1999 to R393/ton in 2017 (Eskom 1999; 2017b).[63] New renewable capacity such as wind and solar generation is now considerably less costly (about 40 – 50 percent less) than the Eskom coal-fired power plants under construction (CSIR 2016; Steyn et al. 2016; Garg et al. 2017; Burton et al. 2018a). The Government of South Africa's 2019 Integrated Resource Plan (IRP 2019) articulates plans for a more diversified energy mix with increased reliance on renewable energy and natural gas.

South Africa's dependence on coal as its primary energy source contributes the largest share of national greenhouse gas emissions. South Africa is the world's 14th largest emitter of greenhouse gases (GHGs) and has the second lowest share of renewables in the G20 (after Saudi Arabia). Carbon dioxide emissions from electricity have increased by 64 percent since 1990. Today, electricity and heat producers account for the greatest share of carbon dioxide emissions, followed by other energy industries, transportation and industry (Figure 4.36). Changes in total energy use since 2010 were largely due to increased economic activity, although some energy efficiency savings between 2014 and 2018 helped offset the aggregate gain (Figure 4.37).

Figure 4.36

South Africa's CO2 emissions by sector (Mt CO2)

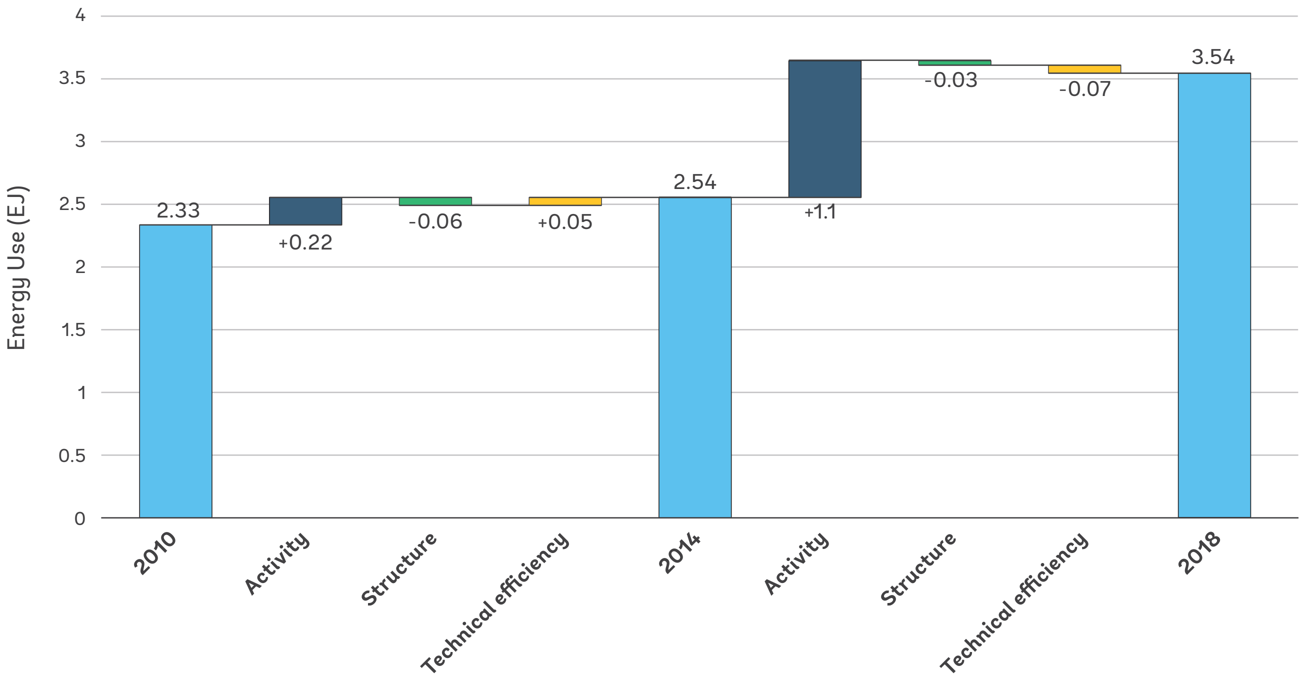


Source: IEA data for South Africa

[63] Price increases were partly due to increased production costs as easier-to-access mine deposits have been depleted, and partly due to Eskom's weak management, inefficient coal purchasing and uncompetitive practices, all of which have undermined its financial position (Burton et al. 2018a; Baker et al. 2015).

Figure 4.37

Decomposition of increased energy use in South Africa between 2010-2014 and 2014-2018



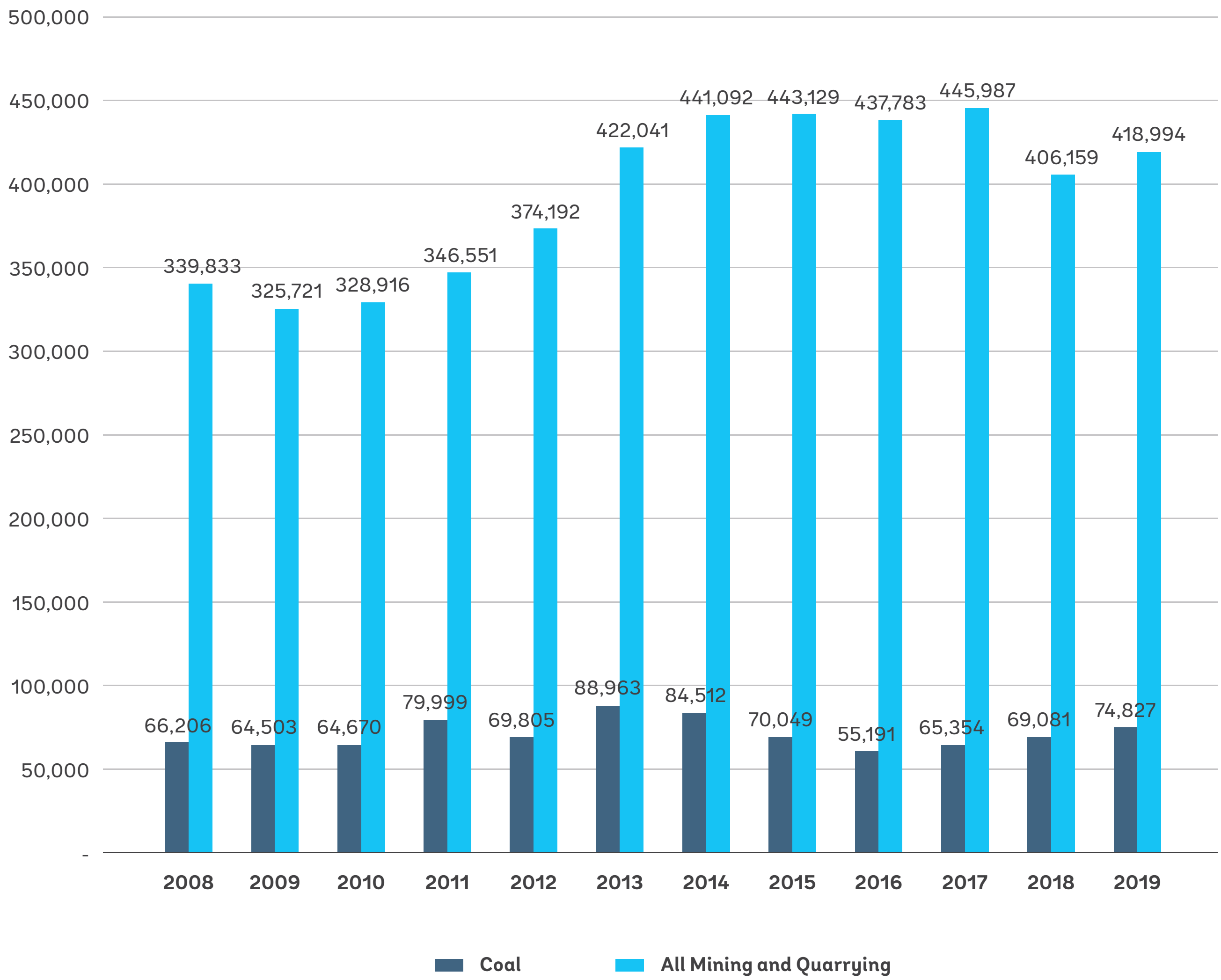
Source: IEA data for South Africa

Despite Government efforts to diversify its energy sources, coal retains its influential position. The state's target to create an additional 26 GW of electricity generation capacity from renewables and natural gas by 2030 (in addition to the current 5.6 GW from hydro, wind and solar) is coupled with plans to reduce coal-fired generation capacity by decommissioning 10.5 GW of coal-fired power capacity by 2030 and another 20 GW by 2050 (compared to current coal-fired generation capacity of 42 GW; IRP 2019). Eskom's 2017 announcement of plant shutdowns was met with protests and opposition by multiple coal-related unions, eliciting calls for better planning and stakeholder consultations (Burton et al. 2018a). Concurrent with plant closure plans, which are primarily driven by 'end of design life considerations' (IRP 2019), the Government has committed to new coal-fired generation capacity to meet projected demand during the transition to low-carbon energy.[64] Coal's continued dominance is linked to its long history as an abundant and low-cost energy source – which facilitated energy-intensive economic development and the emergence of multiple coal-dependent industries – as well as the state's direct intervention in the sector and the presence of politically-connected unions, inter alia. Together, these aspects of South Africa's coal sector render decisions about future coal phase-out highly politicized (Baker et al. 2015).

[64] A further 8 GW of coal-fired generation capacity is either under construction or has been announced (End Coal 2021), although some of these projects may encounter financing challenges (IRP 2019).

Figure 4.38

Employment trends in coal and other mining and quarrying



Source: South Africa's QLFS data 2008–2019 3rd quarter, authors' calculation

While coal production has risen in past decades, coal mining employment trends have been more variable. From an average of 65,000 jobs in 2008–2010, coal mining employment expanded thereafter to peak at 89,000 in 2013, subsequently declining to 55,000 in 2016 and recovering thereafter (Figure 4.38). The broader mining and quarrying sector posted above average job growth over the last decade, peaking in 2017 at 446,000 jobs, equivalent to only 3 percent of total employment. To understand the labor impact of South Africa's coal industry in recent decades and what it might portend for the future, especially in a context of diminishing coal demand, it is essential to understand the broader labor market context within the country.

The most notable features of South Africa's labor market are its large and rapidly growing youth population that is not being adequately absorbed into employment – good jobs or otherwise, and a high degree of segmentation that creates frictions to worker mobility into and between different types of jobs and work status.[65]

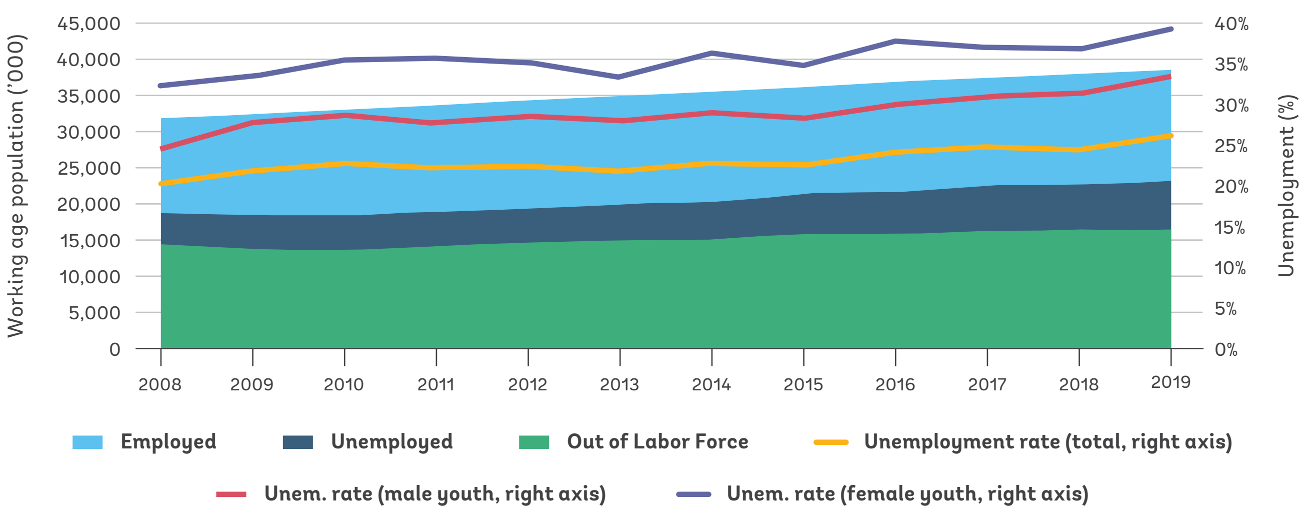
- **South Africa is in the midst of a demographic transition, which creates pressure on the labor market.** South Africa's youth population (ages 15 – 35) numbers 20 million, making up 36 percent of the country's total population. The working-age population expanded by nearly 7 million between 2008 and 2019 and UN projections suggest that the working-age share of total population will remain around 66 percent until 2030.

The large anticipated influx of youth into the labor market creates an opportunity to accelerate economic growth and raise living standards. South Africa is not an outlier in this regard; much of the Africa region is in a similar position. By 2050, Africa will be home to a billion youth, on its way to becoming the continent with the largest number of young people, nearly double the youth population of South Asia, Southeast Asia, East Asia, and Oceania combined (World Economic Forum 2020). For countries to achieve the potential "demographic dividend", however, youth need to be absorbed into productive paid work.

- **Only a small share of South African youth finds work, and an increasing number are choosing to remain outside the labor force.** Unemployment rates are extremely

Figure 4.39

Trends in labor force participation and unemployment status



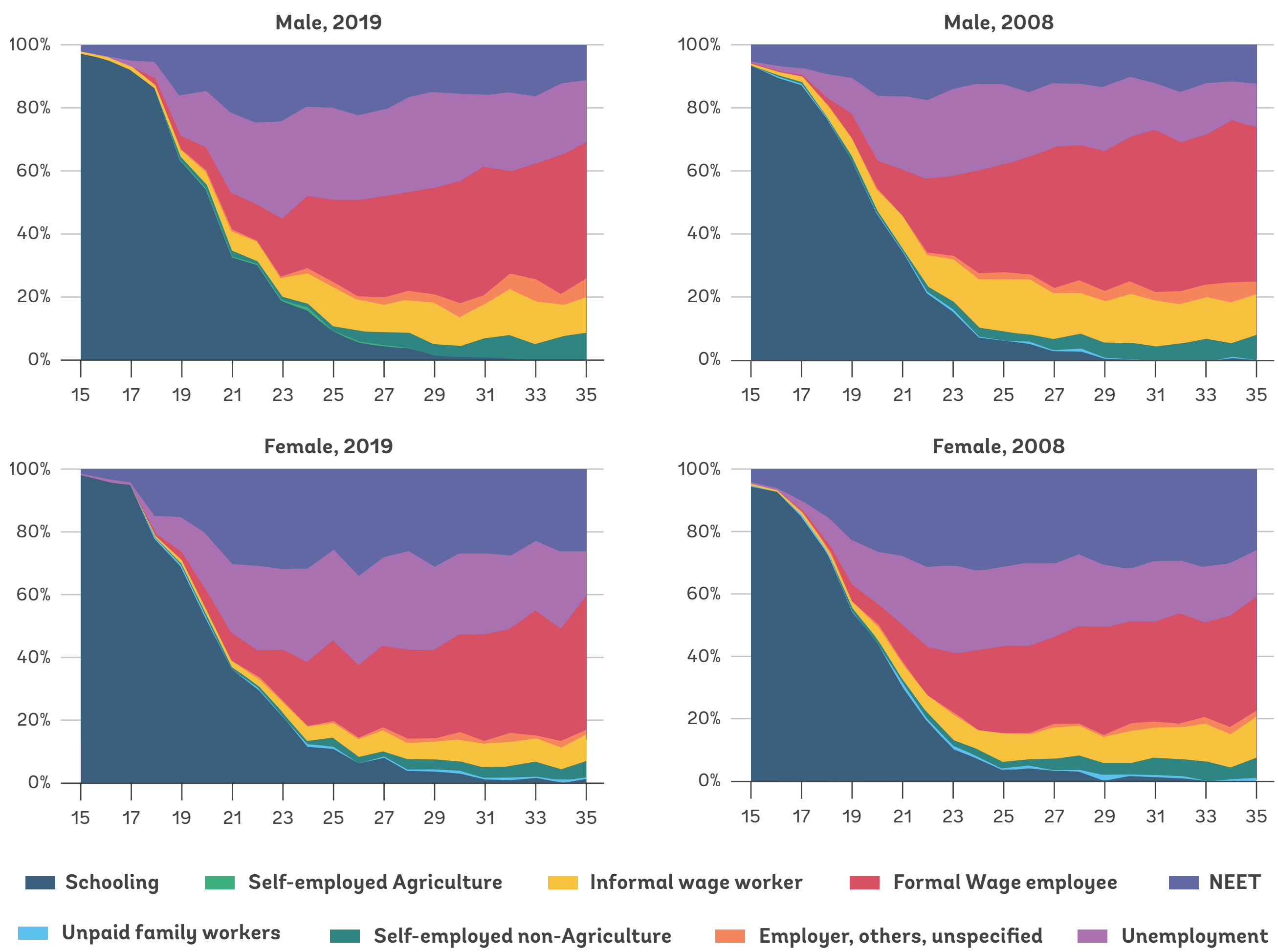
Source: South Africa's QLFS data 2008-2019 3rd quarter, authors' calculation

[65] The data used for this analysis is South Africa's Quarterly Labor Force Survey (QLFS) conducted by Statistics South Africa (Stats SA). The data is representative at the provincial and metropolitan levels. Since 1993, Stats SA has collected labor market information with the October Household Surveys (OHS) conducted annually between 1993 and 1999, and the Labor Force Survey (LFS) conducted biannual between 2000 and 2007. Due to methodological and sampling issues, the QLFS was introduced to replace the LFS in 2008. The QLFS is available quarterly from 2008 – 2020. We have utilized the 3rd wave of the QLFS for all available years excluding 2020 due to a drop in the sample size as a result of COVID-19 mobility restrictions. Note that households without telephones were excluded from the sampling framework.

high by international norms and have risen persistently over the last decade (Figure 4.39). Youth unemployment rates in 2019 reached 37 percent for males and 44 percent for females. Broken down by age cohort, the unemployment rate among 15 to 25 year-olds is 58 percent, compared to 36 percent for 25 to 35 year-olds. These statistics indicate severe stagnation in the labor market, as the economy fails to create enough jobs to absorb the existing pool of unemployed workers or the annual inflow of school leavers and graduates seeking work. Between 2008 and 2019, the labor force expanded from about 19 million to 23 million but employment increased more slowly, from 14.5 million to 16.4 million, driving up unemployment and pushing youth out of the labor force. The difficulty of finding work, especially work that meets youth's expectations in line with their education levels, discourages youth from participating in the labor force. Nearly two in ten young people are not in employment, education, training, or

Figure 4.40

School-to-work transitions by age (2019, 2008)



Note: This graph shows a static plot of male and female youths' work status by age, and does not capture dynamic transitions. Formal employment status is defined as having a written contract. Patterns are similar when formality is defined as having access to a pension, but with lower formality shares.

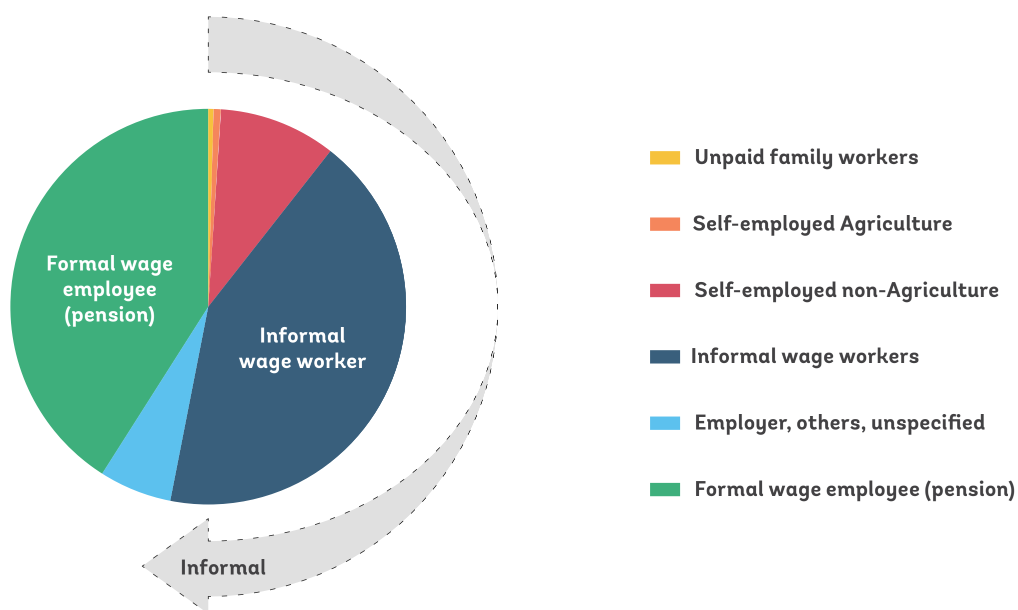
Source: South Africa's QLFS data 2008–2019 3rd quarter, authors' calculation unemployed (NEET[66]), and the female NEET rate exceeds that for males (23 percent compared to 15 percent; Stats SA 2019). These data reflect a significant deterioration since 2008, especially for males (Figure 4.40).

- **Youth typically struggle to access formal employment immediately after school but gain some access with age.** Female youth have achieved improved access to formal employment over the past decade, while their male counterparts have lost access over time. Despite this progress by female youth, a higher share of male youth are in formal work compared to female youth. On a positive note, female youth are remaining in school longer compared to a decade ago.

- **South Africa's labor market is segmented along multiple lines** – formal versus informal; public versus private; union versus non-union; white, black, mixed race and others (Figures 4.41-4.43). These categories are sometimes overlapping, and sometimes they compound the segmentation. For example, significant racial disparities in work status compound income disparities, given that non-white South Africans – and especially black South Africans – are less likely to access well-paid formal work. Even though white South Africans account for only 9 percent of the population, they account for 30 percent of the formally employed (Figure 4.45).

Figure 4.41

South Africa's labor force is segmented between formal and informal work status



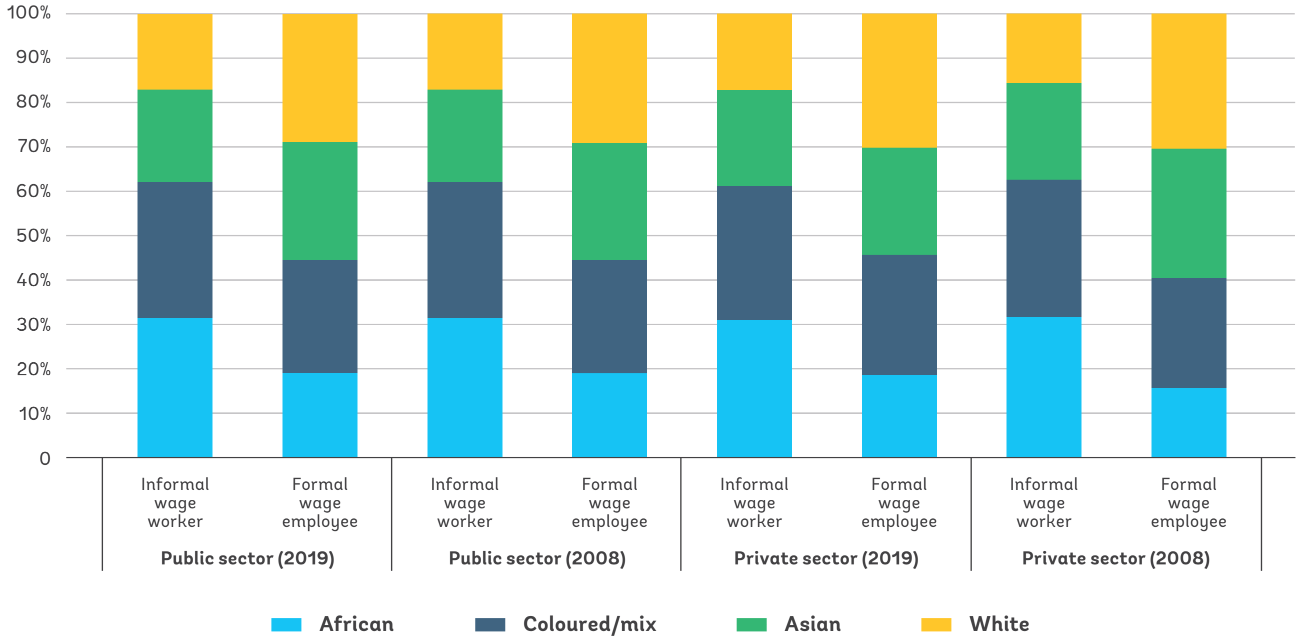
Note: Formal status defined here based on pension access.

Source: South Africa's QLFS data for 2019

[66] NEET is defined as those outside the labor force (and therefore neither employed nor unemployed and looking for work) and not in school or other types of education or training. Note that South Africa's Department of Higher Education and Training includes those who are unemployed (and therefore inside the labor force) in their definition of NEET ("Fact Sheet on 'NEETs'", Department of Higher Education and Training, 2017. https://www.dhet.gov.za/Planning%20Monitoring%20and%20Evaluation%20Coordination/Fact-sheet-on-NEETs-Final-Version-27-Jan-2017.pdf)

Figure 4.42

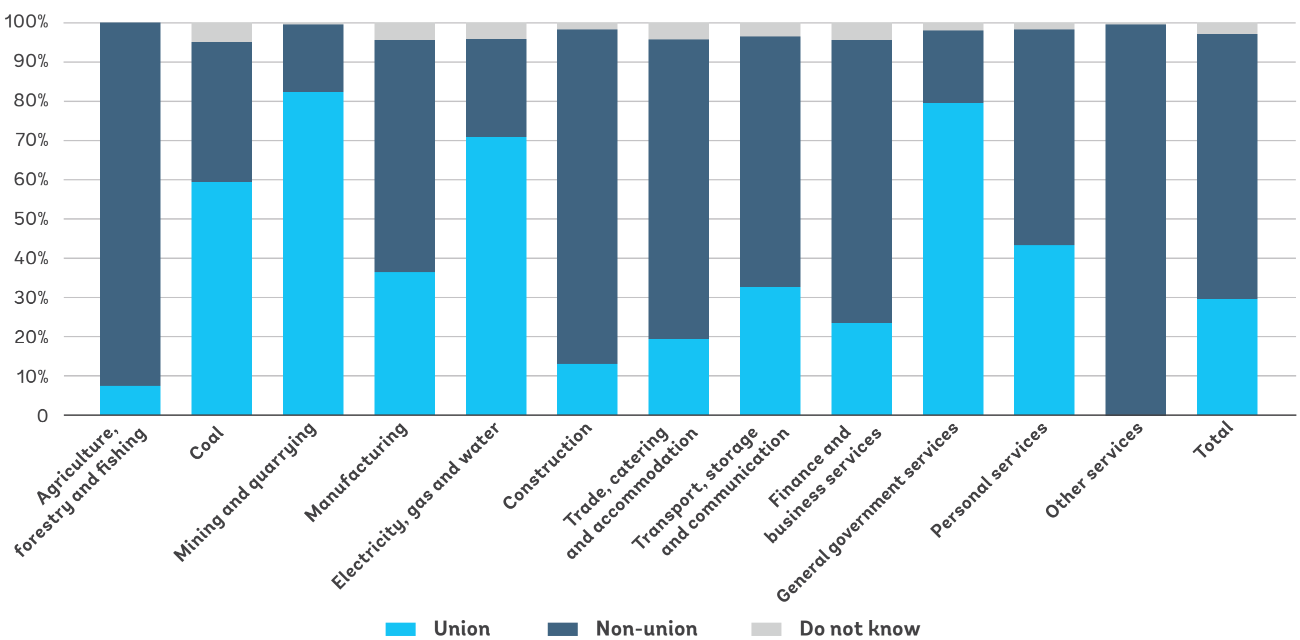
Formality by race, public versus private sectors



Note: Formal status defined here based on pension access.
Source: South Africa's QLFS data for 2008, 2019

Figure 4.43

Share of union membership by sector



Source: South Africa's QLFS data for 2019

South Africa experienced tepid economic performance over the past decade, accompanied by weak job growth as employment shifted increasingly to the services sectors. South Africa is an upper middle-income economy in the late stages of structural transformation. Over the last 10 years, labor continued to shift away from manufacturing and towards the services sectors and construction. The fastest growing services subsector was finance and business services, which has moderate labor productivity levels on average, employing a mix of skilled and unskilled workers. In fact, much of this sector's growth was driven by the expansion of temporary employment agencies, which act as third-party contractors, placing employees in temporary positions across various occupations (such as cleaning, accounting, secretarial, and security services; Burton et al. 2018a).[67 68] Most services sector growth was in low productivity sectors such as personal services and construction, as well as in moderate productivity sectors transport and finance (Figure 4.44). Government services and utilities also expanded at a robust pace. Between 2008 and 2019, the manufacturing sector contracted, declining from 16 percent to 12 percent of total employment during the period, while the wholesale and retail trade sector – by far the largest – grew only marginally. In terms of number of jobs created, personal services and financial and business services together accounted for 78 percent of the 1.9 million net jobs added to the economy over the last decade, while the manufacturing sector shed nearly 300,000 jobs.

Figure 4.44

Job growth in low- and high-productivity sectors (2008 - 2019)

Notes: Bubble size reflects sector employment in 2008.
Source: South Africa's QLFS data 2008-2019 3rd quarter and SA STAT GDP P044 and P0441, authors' calculation

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[67] Note that these Temporary Employment Services "employees" would be more accurately classified into other services sectors.

[68] This trend is consistent with the observed increase in formal employment (defined as workers with a written contract), which does not reflect a significant improvement in average job quality, but rather a more modest improvement.

Most of the new jobs added to the economy in the last decade were either informal or quasi-formal temporary jobs, pointing to labor market rigidities. For instance, the number of temporary jobs increased by 30 percent from about 1.4 million to about 1.8 million between 2008 and 2019, while permanent jobs increased at a much slower pace. Net employment among youth (ages 15-35) declined during this period by 546,000 jobs, while those aged 35-45 accounted for three-fifths of the new jobs created. Youth struggle to access permanent formal employment, especially when we define "formal" as having access to a pension (Figure 4.45). Much of the "improvement" in rates at which youth transition to formal wage work depicted in Figure 4.40 above in fact reflects the emerging prevalence of temporary contracts.[69] The pressure from this stress found different outlets. Some youth gave up and became NEETs. Some invested in more schooling to compete for public sector jobs. Many took up temporary work, either to earn a basic livelihood or as a pathway to a permanent contract. The result, unfortunately, is increased segmentation and rigidity. This not only further reduces the opportunities for outsiders (e.g., youth) to access better jobs, but it also makes it harder for policymakers to correct.

Figure 4.45

Temporary versus permanent employment by age group (2019)

Source: South Africa's QLFS data 2019 3rd quarter

[69] Note that temporary contracts tend to be written, so that employers can clearly stipulate the time-bound terms of employment.

South Africa is a highly unequal society, not coincidentally, and poverty rates have deteriorated in recent years. Nearly 38 percent of the population fell under the $3.20 per day threshold in 2014/15 (up from 36 percent in 2010/11) and 19 percent were in extreme poverty (World Bank 2020c). Racial and gender inequality is pervasive. Our regression analysis on labor market outcomes shows that: being a black South African reduces the likelihood of being employed compared to other races; females have worse employment outcomes than males; and low educational attainment reduces the likelihood of being employed (Annex 3 Table 1). Large wage disparities are prevalent between the different labor market segments. Even controlling for individual characteristics and sectors, regression analysis suggests significant implicit discrimination along racial and gender lines, and a large wage premium for those in formal employment.[70] Throughout the course of their working lives, workers must navigate these racial/gender/formality/union barriers to find the best-quality jobs.

Where do coal sector jobs fit within this labor market context? Ninety-nine percent of coal mining jobs are formal (employed with a written contract), on par with the public sector (which includes general government services and electricity, gas and water[71]), and 77 percent of coal mining workers have access to some form of pension benefit – nearly double the national average of 41 percent.

Coal mining workers are largely permanent workers (73 percent), although this is much lower than during the late-1980s, when coal mines began to shift increasingly to contract workers (Burton et al. 2018a, citing Baartjes 2009). Workers in the coal mining sector tend to have above-average levels of education: 70 percent have completed at least a secondary education, compared to 56 percent of manufacturing workers, 34 percent in construction, and less than 20 percent in agriculture (Figure 4.46). Six in ten coal mining workers are union members (above the national average of 30 percent), enabling collective bargaining to negotiate compensation and working conditions. Other mining and quarrying employment have even higher union membership (80 percent) and collective bargaining, similar to the public sector (Figure 4.47).[72] Coal mining workers are mostly black South Africans (82 percent in 2019), in prime working age, and disproportionately male (83 percent). Most engage in production and machine operation occupations (Figure 4.48).

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[70] Results from OLS regression estimates of the correlates of hourly wages show that black South Africans earn less than other races even when accounting for education level and controlling for other characteristics. The gender wage gap is estimated at 18 percent, all else being equal, and formal workers earn 34 percent more than informal workers (not controlling for sector, due to extreme segmentation). Details of regression results are in Annex 3 Table 2.

[71] Electricity, gas and water utilities are majority owned by the government (i.e., SOEs).

[72] Note that coal mines are privately owned, similar to other mining and quarrying mines in South Africa.

Figure 4.46

Education breakdown by sector

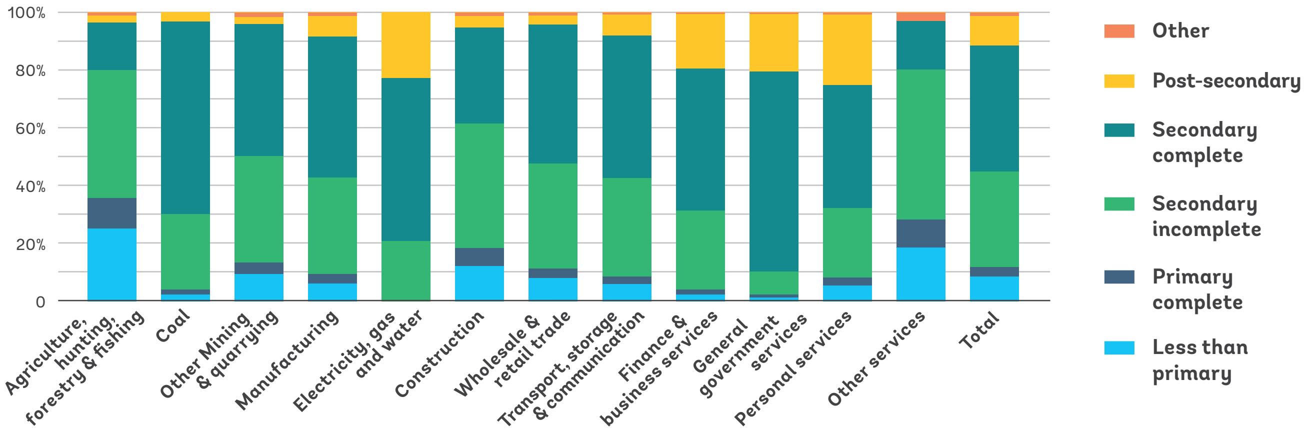


Figure 4.47

Wage bargaining power by sector (2019)

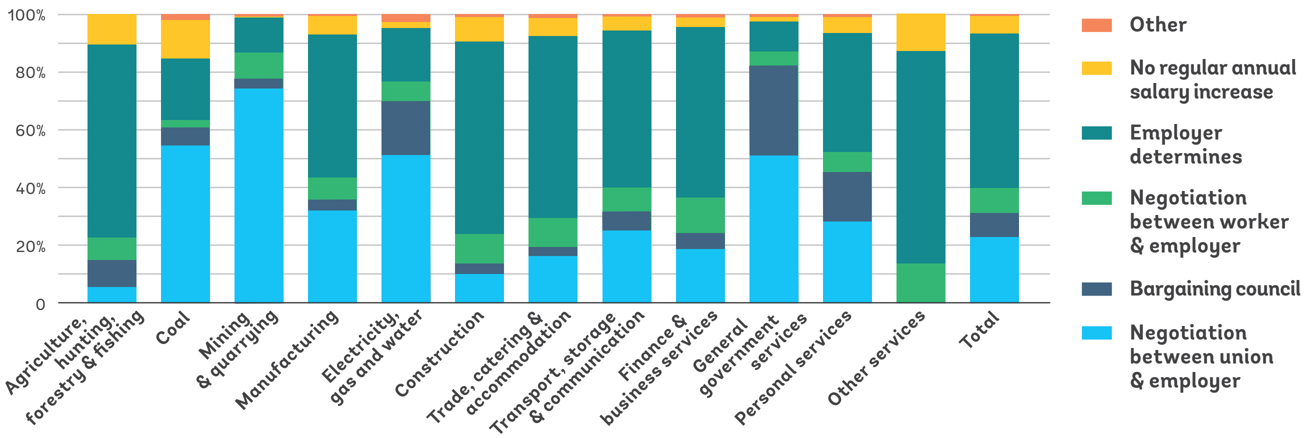
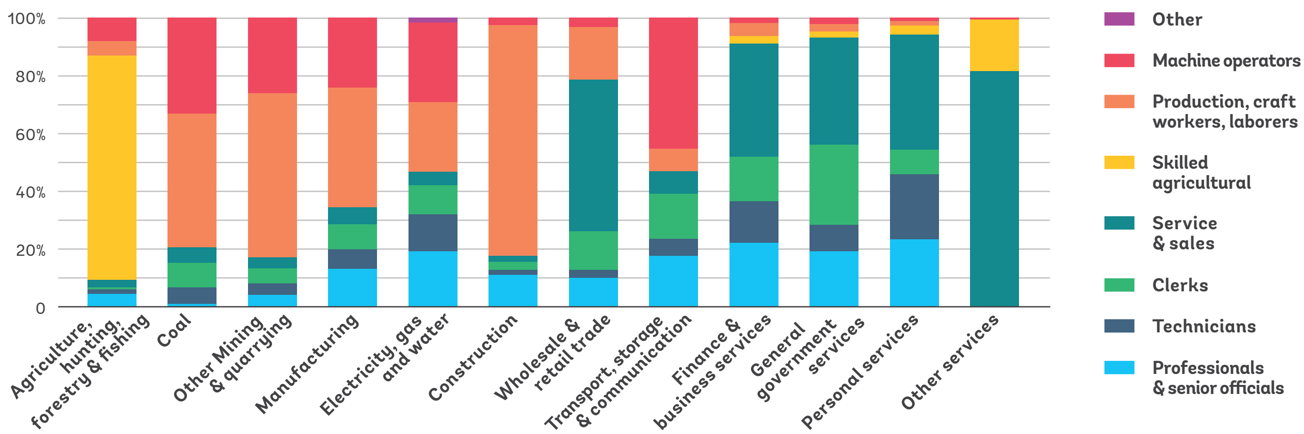


Figure 4.48

Occupation by sector (2019)

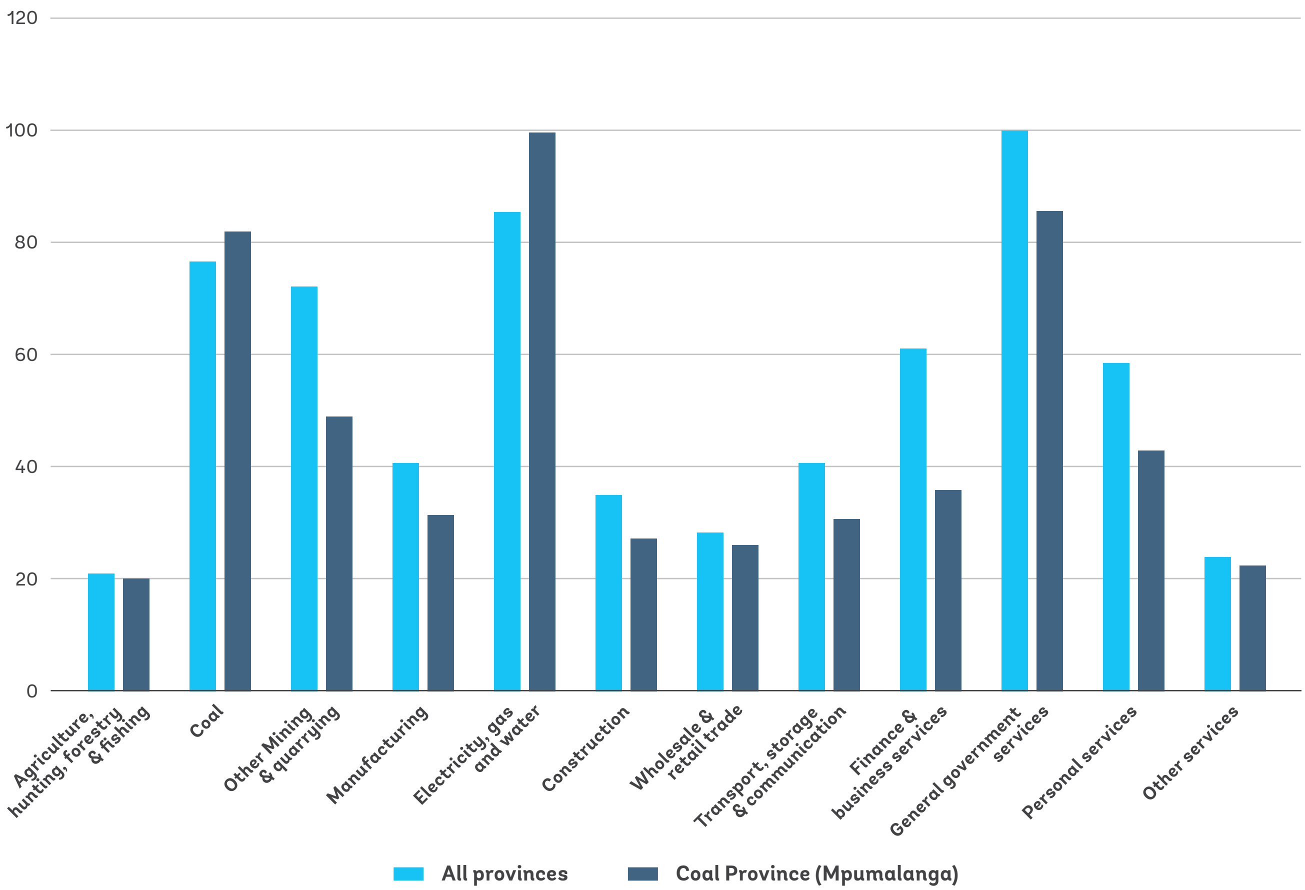


Source: South Africa's QLFS data 2008–2019 3rd quarter

The spillovers from a coal job can raise household incomes and reduce poverty, at least for the miner and his family. Jobs in the coal mining sector, like jobs in other types of mining, pay significantly more on average than most sectors in the economy: 3.7 times the average agriculture wage, 2.2 times the average construction wage, 2.7 times the average wholesale and retail trade wage, and 1.9 times the average manufacturing wage in 2019 (Figure 4.49). Only predominantly public sectors pay more. The returns to working in the coal mining sector are higher than all other sectors, according to regression estimates that control for factors such as education level, gender and race, among others.[73] A recent World Bank study on the poverty effects of job creation in different sectors using South Africa data finds that mining and agriculture have the highest poverty-reducing impact; one additional job in these sectors is estimated to lift 1.3 people out of poverty (World Bank 2017).

Figure 4.49

Nominal hourly wages by sector (2019 Rand)

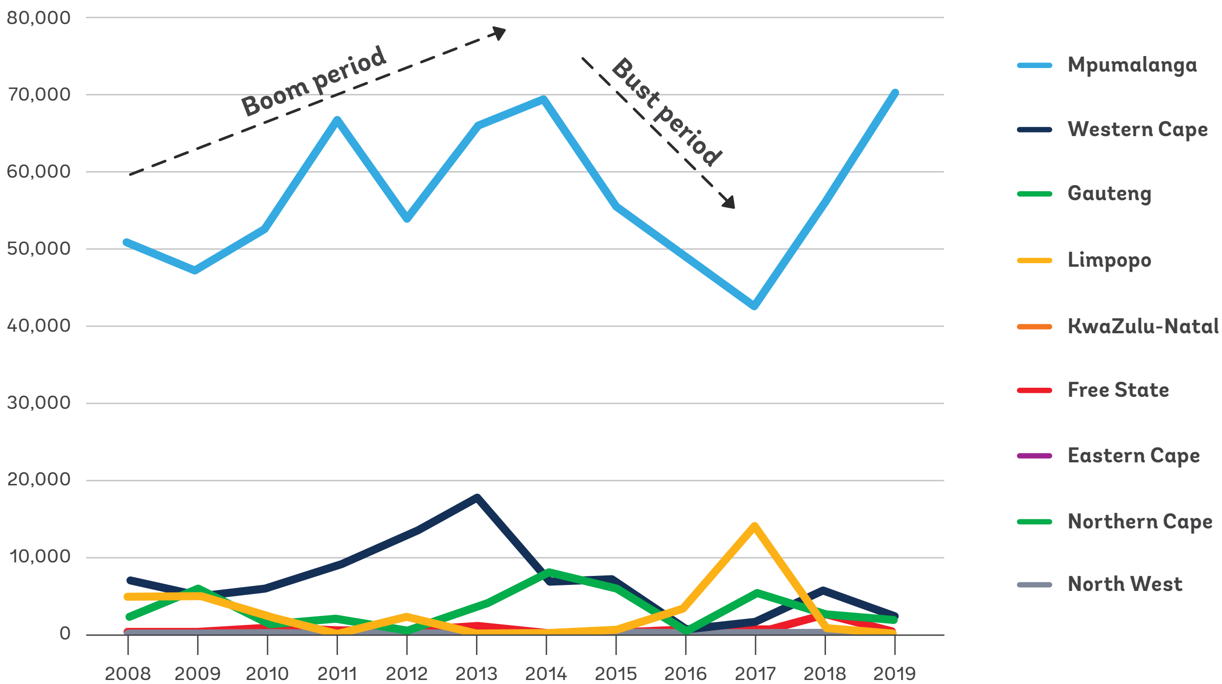


Source: South Africa's QLFS data 2019 3rd quarter

[73] Refer to wage regression results in Annex 3 Table 2.

Figure 4.50

Coal mining employment by province (2008-2019)



Source: South Africa's QLFS data 2008-2019 3rd quarter

Coal activity is concentrated in Mpumalanga province, with more modest mining activity in Free State, Gauteng and Kwazaulu-Natal provinces (Figure 4.50). Mpumalanga is relatively rural and is home to 93 percent of South Africa's coal mining employment. Coal mining jobs account for 6 percent of Mpumalanga's total employment and are most highly concentrated in four municipalities: eMalahleni (26 percent), Steve Tshwete (17 percent), Msukalingwa (14 percent) and Govan Mbeki (11 percent; TIPS 2020). In 2015, coal contributed 19 percent of the region's gross value added (Strambo et al. 2019).

The growing presence of coal mining jobs helped Mpumalanga's economy grow, but these positive growth spillovers were undercut by the distorting effects of high coal wages. The economics literature has documented the negative dynamic effects associated with boom and bust extractive industries, as discussed above, and illustrated in the case studies on the US and Indonesia. Is the situation different in South Africa? We answer this question by testing for statistically significant spillover effects within Mpumalanga province using a methodology similar to Black et al. (2005) and described in Annex 3. Our regression results suggest that, over the last decade, coal mining jobs had positive spillover effects in terms of spurring more job creation in Mpumalanga's non-mining sectors – particularly in the services sector (also in manufacturing, albeit with lower explanatory power, and no significant spillovers in agriculture or construction).[74] The effects were not uniform over the entire period, however, because the sector experienced a mini-boom between 2008 and 2014, and a mini-bust from 2015 to 2017, after which coal employment rebounded. We exploit this variation to test whether coal jobs crowded out other sectors during the boom period, which would be reflected by faster non-mining employment growth during the bust period. The regression findings indeed point to accelerated job growth in all non-mining sectors during 2015-2017, suggesting a potential crowding out (full regression results in Annex 3 Table 3). The rise in agriculture employment during the coal bust could partly be the result of displaced coal workers being absorbed into farm work, but this does not appear to be the case in construction.

Any future transition away from coal production will leave coal regions and their communities vulnerable to negative employment effects, at least in the short run. Mpumalanga's coal-intensive municipalities may be especially hard hit, given their high shares of coal employment. A more diversified economy that offers alternative local employment opportunities is crucial for absorbing future declines in labor demand for coal workers. Since the average miner in Mpumalanga supports three dependents (Strambo et al. 2019), coupled with the fact that alternative jobs are likely to pay significantly lower wages, displaced miners and their families will experience large income shocks even if alternative work is found quickly. The degree to which lost coal jobs exacerbate inequality in the long run is unclear, however, given coal workers' above-average incomes and, for most, formal employment status, union representation and pension access. In the post-transition context, wage distortions created by coal sector jobs will no longer be present to skew local labor market opportunities in Mpumalanga's principal coal centers.

Policies to ease the transition for displaced coal workers have an essential role to play. Although South Africa's national dialogue on just transition is well advanced (WRI 2020)[75], it is encumbered by a very challenging labor market context and complex institutional setting.

[74] Note that other mining employment is not significant, implying that the observed distortion effects come from coal rather than other resource extraction jobs. This is consistent with the fact that other mining employment accounts for a very small employment share in the province.

[75] In September 2020, the Government established a Presidential Climate Change Coordinating Commission to 'coordinate and oversee the just transition' across government ministries and public agencies (Department of Forestry, Fisheries and the Environment media release September 13, 2020).

4.6 India: Producing to Meet its Own Massive Demand

India's coal production has grown steadily over the past 40 years, increasing nearly five-fold. In 2019, India accounted for 9 percent of global coal production (BP Statistics). Most of India's extracted coal is non-coking bituminous coal, and is consumed (in final use) primarily by the industrial sector (Figure 4.451). The industry sector also significantly increased its electricity consumption in the last two decades (largely coal-fired), a time of robust and sustained economic growth. Between 1980 and 2019, GDP growth averaged 6 percent per year in real terms, – accompanied by similar per capita income gains. During this period, India's population grew by 670 million, representing a massive increase in potential energy consumers.

Coal dominates the electricity mix, and even expanded its share in the last decade. Electricity generation grew five-fold between 1990 and 2019, and coal-fired electricity expanded even faster (Figure 4.52). In 2019, coal accounted for 71 percent of total electricity supply. Natural gas and hydro power made some headway beginning in 2000, and wind and solar have recently picked up, but none yet as a replacement to coal. According to the Global Energy Monitor, India's 281 operational coal-fired power plants have annual generation capacity equal to 229 GWh, and 60 percent of these plants were built within the last nine years.[76] Although new plant construction continues, many plants were cancelled over the past decade (395 coal-fired plants with a total 565 GWh capacity), and a small number were retired.

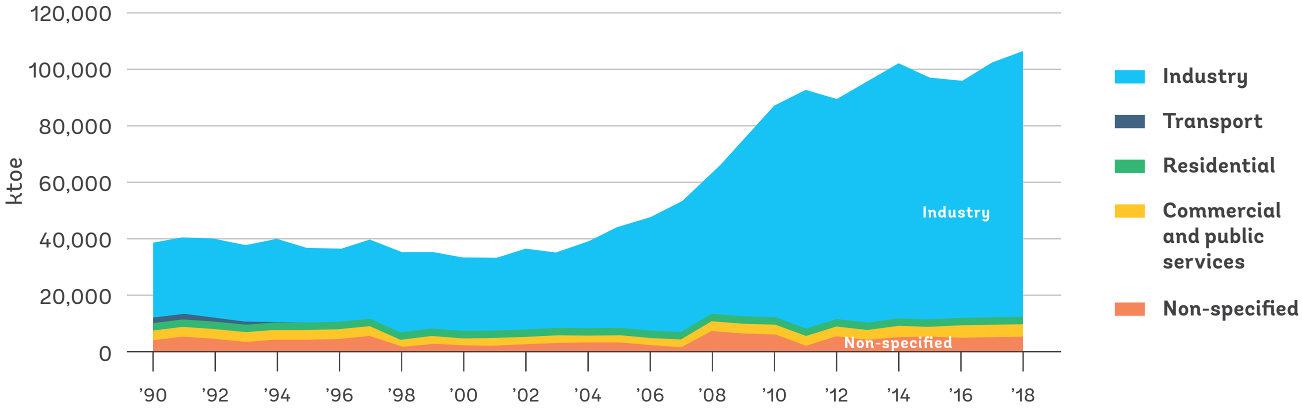
The coal sector's long history in India and its transformation from its roots under colonial ownership pre-Independence to being a strategic national priority provide insight into coal production patterns observed over the past half-century.[77] Coal played an important part in India's industrialization, both as a raw input to production as well as for power generation. With rising residential electrification as well as households switching to coal-fired cooking ovens in the 1960s, the demand for coal rose sharply. Until the mid-1990s, India's rising coal consumption was met by domestic production, but thereafter, coal was increasingly imported (Figure 4.53). By 2019, over 30 percent of total coal consumption was supplied by external sources, predominantly by Indonesia and South Africa (BP Statistical Review of World Energy 2020).

[76] More than half of these plants risk being stranded after 2030 if India were to pursue policies in line with the Paris Agreement (Malik et al. 2020).

[77] Lahiri-Dutt (2016) provides a rich historical perspective of the economic, political and socio-cultural drivers of coal activity.

Figure 4.51

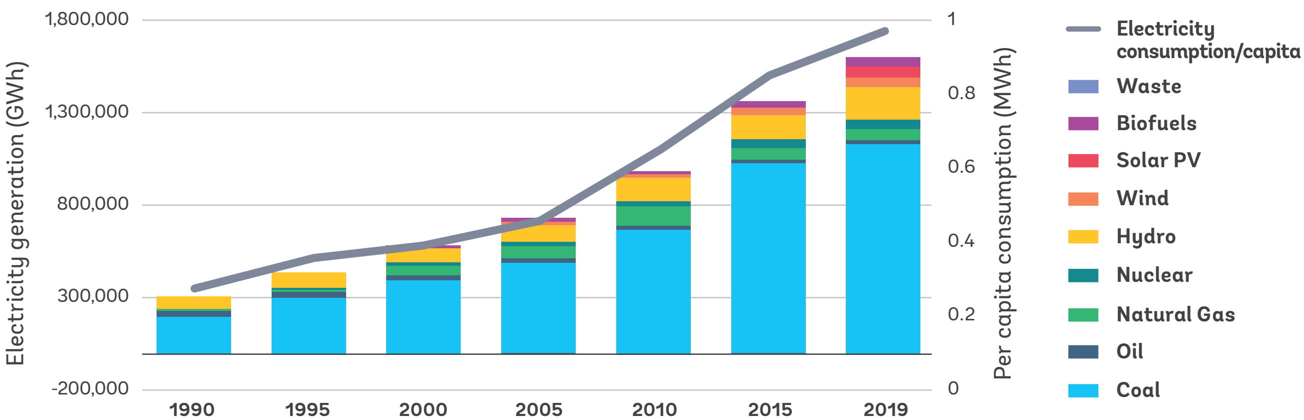
Coal final consumption by sector (ktoe)



Source: IEA data for India

Figure 4.52

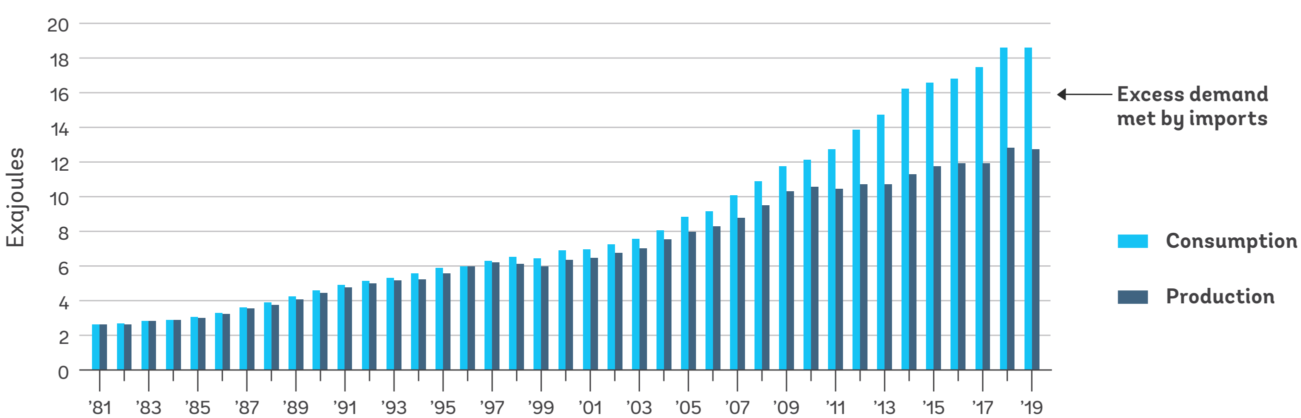
India's electricity generation by source (GWh)



Source: IEA data for India

Figure 4.53

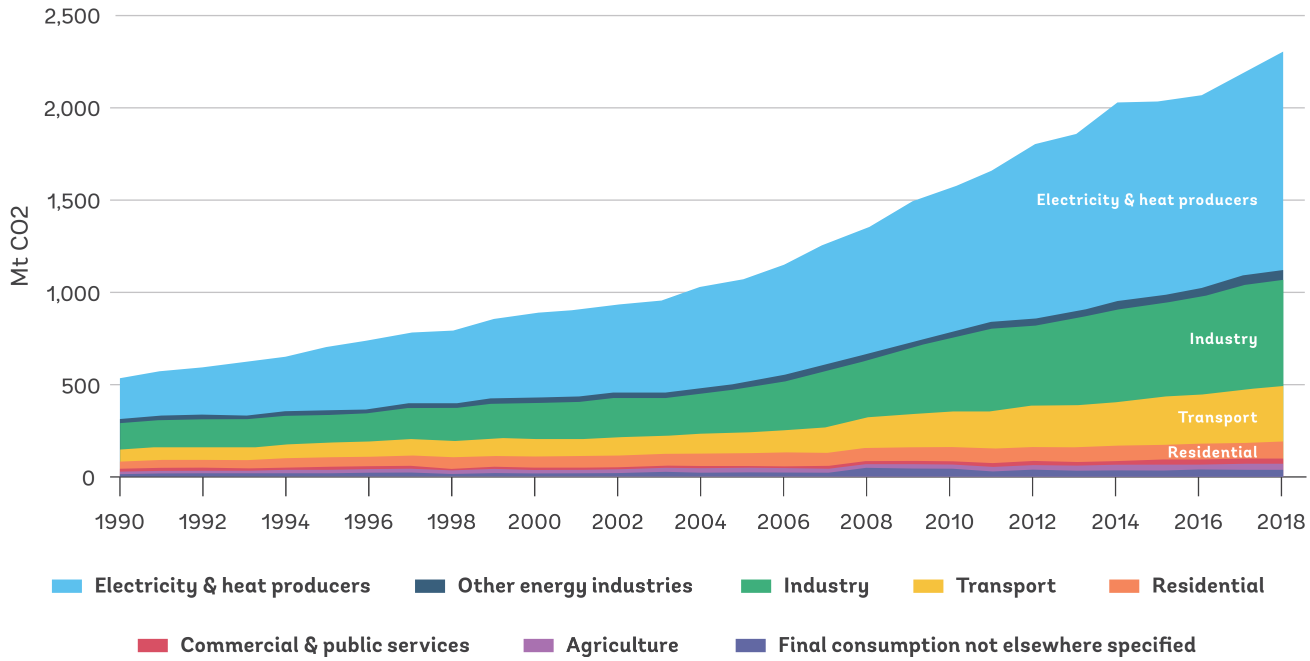
Coal demand outstrips supply



Source: BP Statistical Review of World Energy June 2020

Figure 4.54

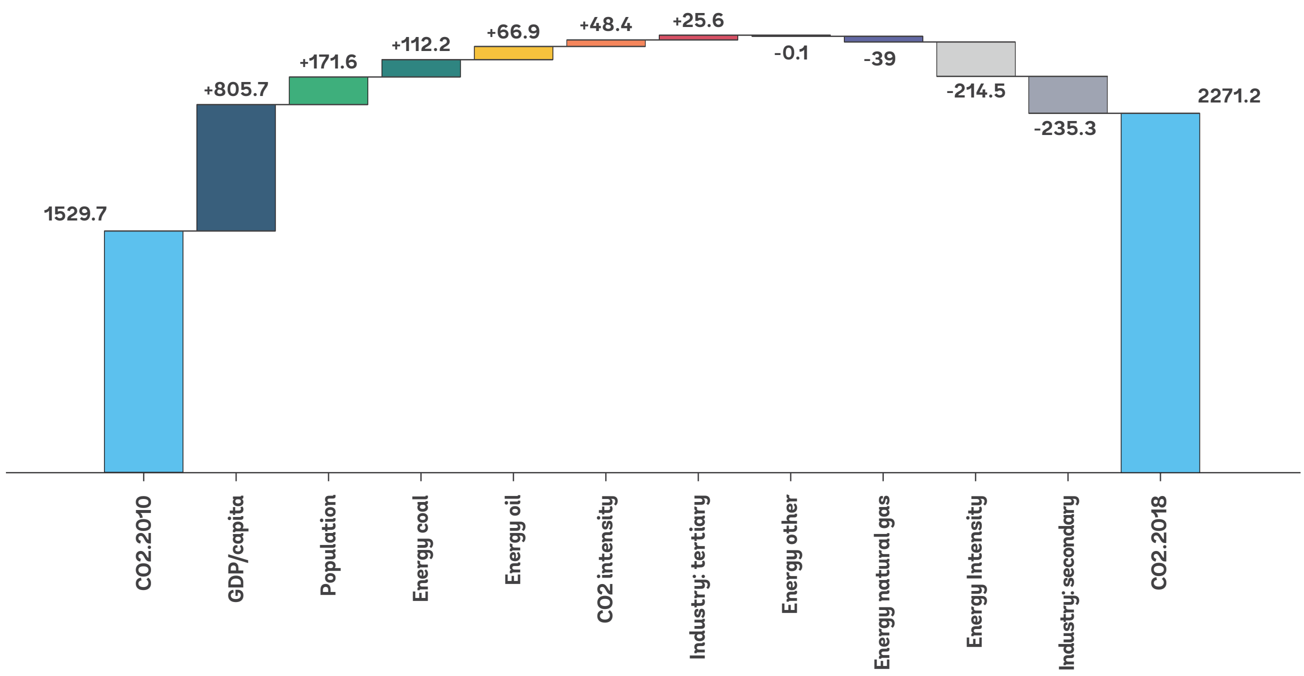
India's CO2 emissions by sector (Mt CO2)



Source: IEA data for India

Figure 4.55

Factors behind India's rising CO2 emissions (2010-2018)



Source: Guan et al. (2021)

State control of the coal sector has shaped its trajectory and central role in India's energy policy. Coal mining was accorded priority status by the state in 1957[78], and coal mining was nationalized in the early 1970s, ostensibly to ensure energy security in the context of global oil price shocks and increase the efficiency of and control over diffuse and inefficient production practices (Coal India Ltd.). Coal India Ltd., the state-owned enterprise created to manage all coking and non-coking mines, is the dominant producer today, accounting for over four-fifths of total coal production (2019 data from Coal India Ltd). Coal India Ltd. operates 364 mines[79], of which 166 are underground, 180 are opencast and 18 are mixed mines (IEA 2020). While much of India's economy has undergone liberalization, the state remains heavily involved in the sector and Coal India Ltd. has retained a quasi-monopoly position. The coal sector, and the Ministry of Coal specifically, are influential in India's national energy policy, which helps explain the country's reluctant shift to alternative energy sources, even when they are cheaper (Spencer et al. 2018). Montrone et al. (2021) point out several obstacles to reforming the sector, including the politically popular subsidy of electricity through low tariff rates (also noted in Mahadevan 2019 and Min and Golden 2014; note that power generation and distribution are also state-controlled), as well as job-creating public investment projects along the coal supply chain, especially in the railway sector.[80]

India's rich coal deposits are a long way from being depleted. The Ministry of Coal reports that even during the past five years, significant new reserves have been identified. The 2020 figures indicate coal reserves of 344 billion tonnes – 162 billion tonnes proved, 151 billion tonnes indicated, and another 31 billion tonnes inferred. Jharkhand, Orissa and Chhattisgarh states have the largest reserves, together accounting for 70 percent of total national reserves (MOSPI 2021).

Coal-based power generation has large negative health and environmental effects on the Indian population. In line with rising coal consumption, India's carbon dioxide emissions have quintupled since 1990 (Figure 4.54), although its contribution to global emissions has been relatively modest (IEA 2021a). Electricity and heat producers are the largest emitters, followed by the industrial and transport sectors. Emissions from coal-fired power plants result in between 80,000 and 115,000 premature deaths per year (Urban Emissions et al. 2013). Decomposing CO2 emissions into its contributing factors shows that for the period 2010 to 2018, the increase in CO2 emissions was due in greatest measure to rising per capita incomes and the growing population; these pressures were partially offset by declines in energy intensity and energy use by the industrial sector (Figure 4.55).[81]

[78] Coal Bearing Areas (Acquisition and Development) Act 1957, cited in Lahiri-Dutt (2016).

[79] Out of a total 459 operational mines (Pai and Zerriffi 2021).

[80] Kamboj and Tongia (2018) and Tongia and Gross (2019) argue that coal provides an important revenue stream for central and regional governments and non-coal SOEs, notably Indian Railways (India's largest employer; Montrone et al. 2021).

[81] India's energy intensity, defined as energy consumption per unit of GDP, declined from 1990 to 2016, which helped to constrain the upward pressure on CO2 emissions (Worldindata 2021). The reduction in industrial demand for coal from 2010 onward coincides with the flattening consumption curve in Figure 4.6.1.

India's coal sector has long been considered an important source of employment, but labor demand is declining. According to estimates using the national Employment-Unemployment Survey (EUS) and Periodic Labor Force Survey (PLFS) data[82], the coal mining sector[83] accounted for 888,000 direct jobs in 2004, following which the sector's employment steadily contracted, falling by more than half to 416,000 in 2017 (denoted by blue bars in Figure 4.56). Other estimates of coal mining employment are much higher. Lahiri-Dutt (2016) puts the number at nearly double these figures, suggesting that the EUS and PLFS do not fully capture informal coal workers, especially in remote rural communities. Pai and Zerriffi (2021) estimate total coal mine employment at 745,000 in FY2020, based on a new database they compiled using labor-intensity factors.

The decline in coal mining employment observed since 2004 was particularly driven by a reduction in formal rather than informal coal jobs as Coal India Ltd. shifted increasingly to informal contract labor (Figure 4.57). This reduction coincided with improvements in labor productivity associated with mechanization and other efficiency improvements including those related to increased reliance on opencast rather than underground mining (Henderson 2015; Chikkatur et al. 2009). Between 2000 and 2014, the sector's labor productivity increased by an estimated 6.6 percent annually (Spencer et al. 2018). As coal mining becomes less labor-intensive – even if coal production levels remain unchanged – the sector offers fewer formal and/or well-paid employment opportunities, including for India's large pool of young workers.

Formal coal mining jobs – defined here as having a written contract[84] – are concentrated in but not limited to Coal India Ltd. Employment in Coal India Ltd. accounts for the largest share of coal mining jobs – between one-half and three-fourths – and this share has grown over the last decade, implying that Coal India Ltd. shed jobs at a slower pace compared to the rest of the sector. It is important to note that these figures exclude the large number of sub-contract workers performing mining-related services for Coal India Ltd. but hired on informal terms by "job-companies" (Lahiri-Dutt 2016). The past three years have seen more rapid shedding of direct employees by Coal India Ltd., where employment fell to 260,807 at end December 2020 (Coal India Ltd.). Figures 4.56 and 4.57 illustrate that other types of mining and quarrying provide significantly more employment than coal mining, and that these non-coal jobs are most likely to be informal.

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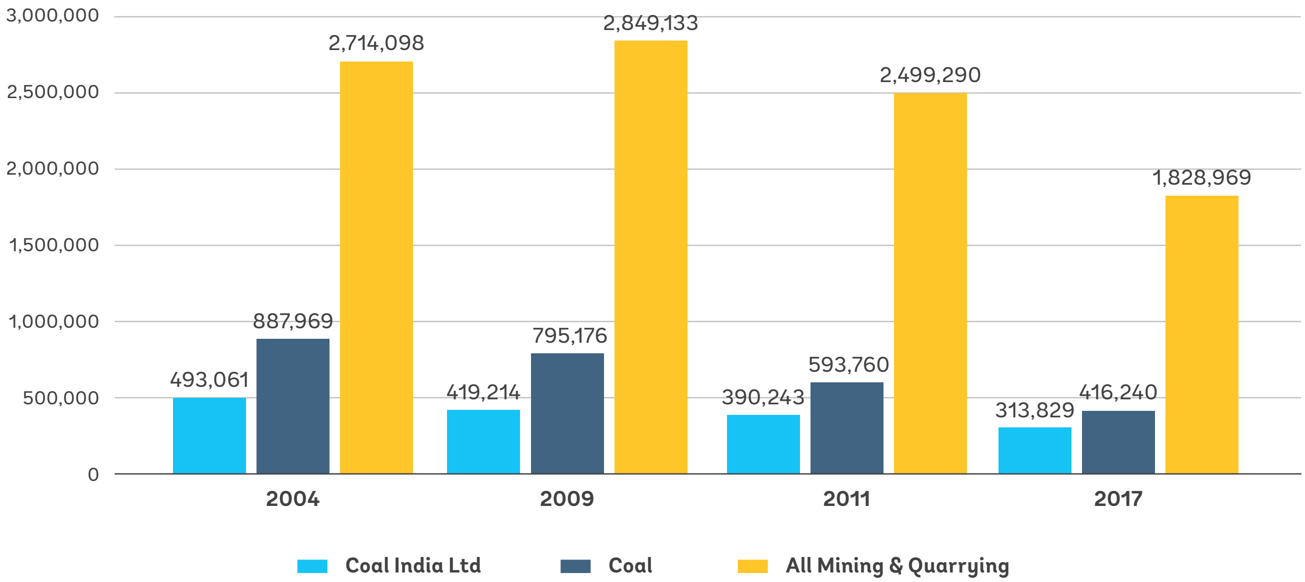
[82] India's employment data comes from the World Bank Jobs Group's Global Labor Database (GLD), which harmonizes national and subnational surveys across a set of labor market variables. The GLD pulls data from India's Employment-Unemployment Survey (EUS) and the Periodic Labor Force Survey (PLFS), both conducted by the National Sample Survey Organization (NSSO). Data are representative at the state level. Since 1972, NSSO has collected labor market information with the EUS every five years. In 2017, the PLFS was launched to replace the EUS and provide higher-frequency data on broad labor-force indicators. The EUS and PLFS are the most comprehensive household-level sources of employment data in India, albeit with well-documented sectoral and geographical coverage limitations. For example, neither data set reports any workers in subsistence coal mining activities, although field work by Lahiri-Dutt and Williams (2005) documents significant informal employment in the coal sector. Srinivasan (2006) provides details on coverage limitations in EUS. The change in states' geographical composition between survey rounds complicates consistent state-level comparisons over time; we addressed this by creating a new state ID that re-constitutes the original state-district mapping. For example, Telangana split from Andhra Pradesh in 2014, but in our analysis we retain Andhra Pradesh's district composition before the split and apply it to the 2017 survey data. Finally, we adjusted the survey weights of each state to align with more recent state-level population estimates by the Office of the Registrar General and Census Commissioner (https://www.censusindia.gov.in/).

[83] Coal mining sector includes hard coal as well as lignite.

[84] The PLFS does not include information on pension or social insurance coverage, criteria typically used to define formal employment.

Figure 4.56

Mining sector employment trends

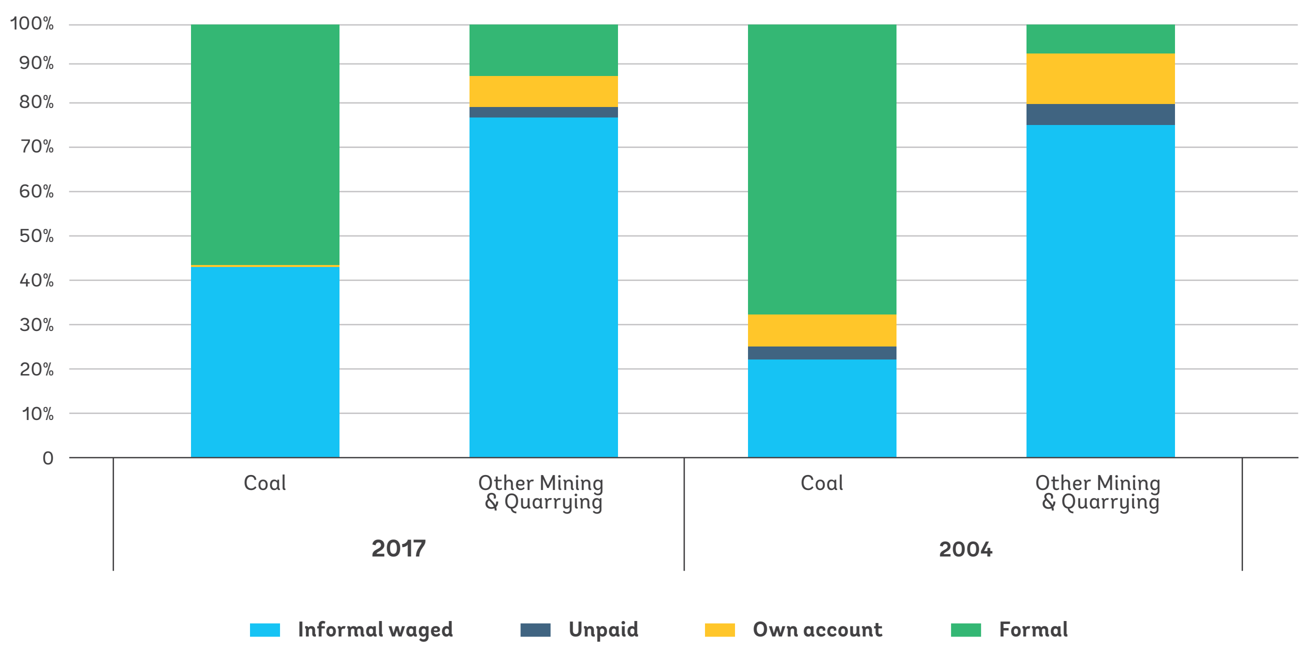


Note: Coal India Ltd data are administrative data, whereas the EUS and PLFS are survey-based, so the relative magnitudes may not be consistent.

Sources: Coal India Ltd.; Global Labor Database (India), World Bank Jobs Group (forthcoming)

Figure 4.57

Formality breakdown of coal and other mining jobs



Note: Formal defined as having a written contract.

Source: GLD (India), World Bank Jobs Group (forthcoming), authors' calculation

India's coal sector is segmented; parallel to the state's direct engagement in coal mining, coal is also mined by a range of private producers, at both large (formal) and small (informal) scales. Beginning in 1976, coal mining was allowed by private firms producing iron and steel (World Bank 2021c). And since 1993, mining leases have been granted to private "captive" operators that supply thermal power plants (on concessionary rather than competitive contracts); these operations – which account for an estimated 6 percent of total coal production – report relatively low formal employment, are owned by Indian entrepreneurs, and at least some have significant foreign investment (Lahiri-Dutt 2016).[85] Artisanal and subsistence coal mining also takes place, whether on privately-owned land or rural commons, both of which are unregulated and thus illegal.[86] A fourth category of mine producers identified by Lahiri-Dutt (2016) comprises private land owners and local indigenous communities in the remote state of Meghalaya, which was granted special status for political economy reasons. Coal producers in Meghalaya therefore fall outside the regulatory framework. Own account and subsistence coal workers (sometimes called coal collectors) have much lower productivity than large mining operators[87], and tend to sell in small quantities to local consumers. It is unclear the degree to which the EUS and PLFS accurately capture these small artisanal or subsistence coal producers; most likely, they are underrepresented in the labor market data.[88]

Finding formal paid work in any sector is a challenge across India's economy, especially for the growing youth segment of the labor force. Over nine-tenths of India's workers are informally employed, whether in farming, own account work, or as informal wage workers (Figure 4.58). Moreover, the rate of informality seems to be increasing; between 2004 and 2017, 99 percent of the 23 million net jobs added to the economy were informal. In net terms, 26 million fewer youth aged 15-35 were employed in 2017 than in 2004. With 1.37 billion people, India is the world's second most populous country, and its population is expected to rise to 1.5 billion by 2030. In terms of demographic structure, India has one of the world's youngest populations, with more than 54 percent under 25 years old (Figure 4.59; Sharma et al. 2019). Despite its young population age structure and rising educational attainment, only 24 percent of the working age population in 2017 had completed secondary schooling (albeit a marked improvement over 2004, when the share was only 14 percent).

[85] Note that captive coal mining is also permitted to support cement production (World Bank 2021c).

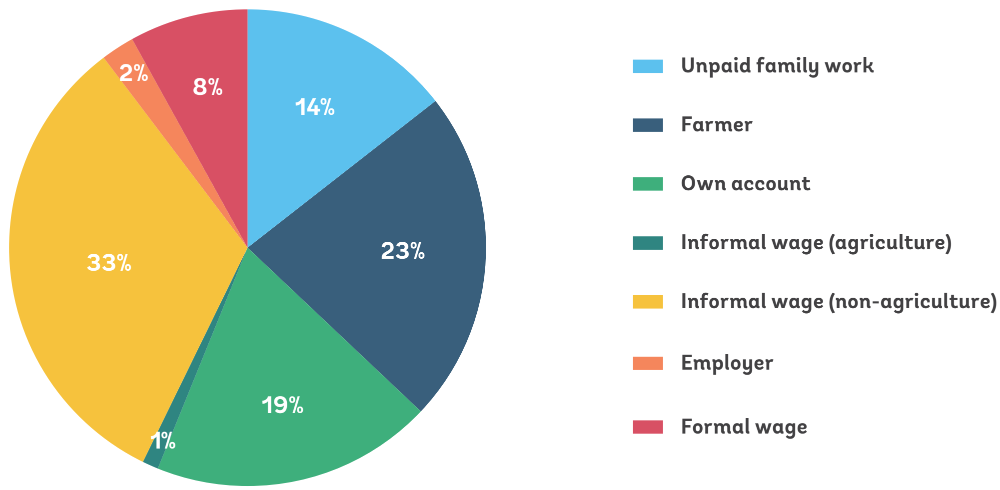
[86] There is a large literature on the impact of extractives on the residents of local rural communities in India, including in coal regions where many have been displaced from traditional farming and forestry activities on their own (non-deeded) land or community commons (Lahiri-Dutt and Williams 2005; Padel and Das 2010). Indigenous and tribal communities have been particularly affected (Lahiri-Dutt 2016).

[87] Lahiri-Dutt (2016) estimates labor productivity among the larger producers (Coal India Ltd and the private collieries supplying power plants) at 1200 tonnes/worker annually, 33 times the estimated production of an informal subsistence coal collector delivering locally with his bicycle (36 tonnes/worker annually).

[88] According to PLFS 2017, 86 percent of coal sector workers are public employees (and therefore mostly work for Coal India Ltd.), and 90 percent report a firm size over 20 workers.

Figure 4.58

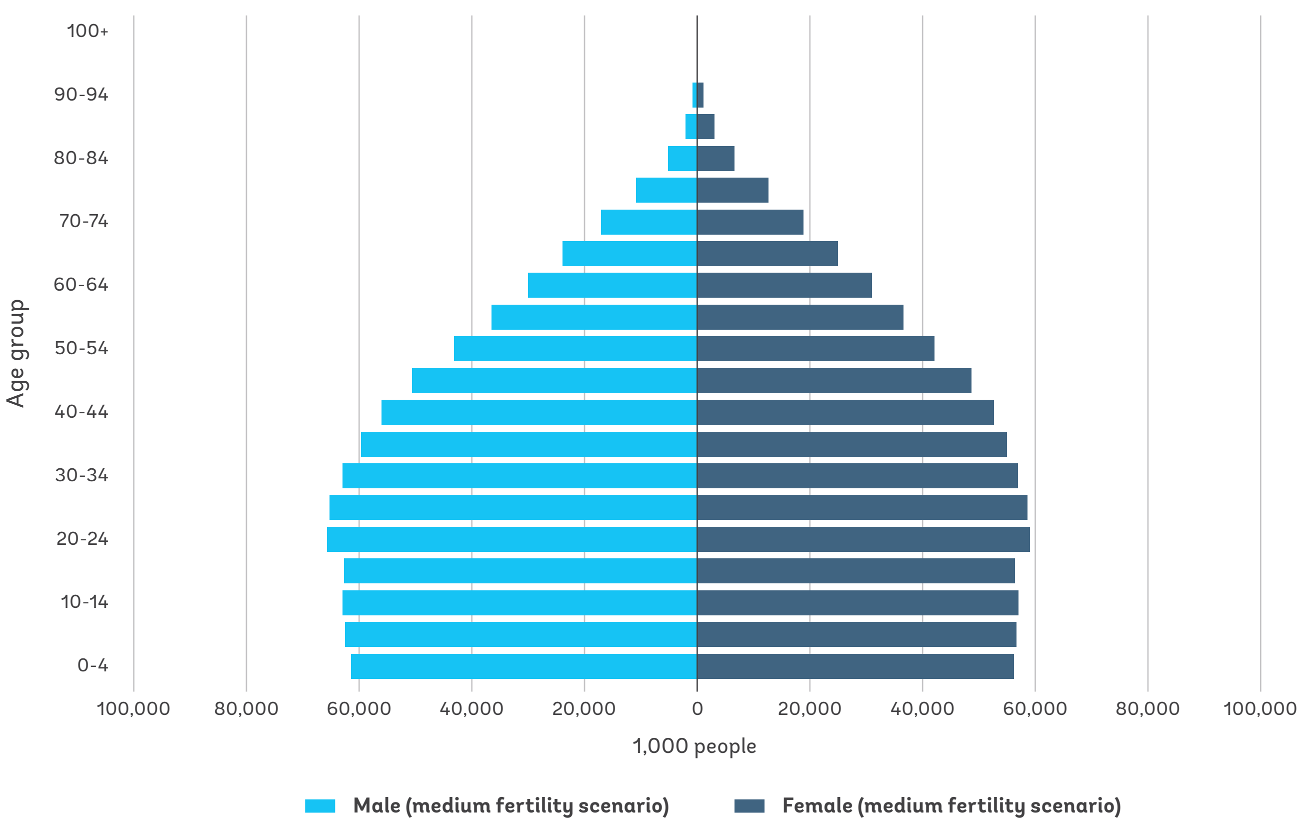
Labor force breakdown by work status (ages 15 - 64), 2017



Source: GLD (India), World Bank Jobs Group (forthcoming), authors' calculation

Figure 4.59

Population by five-year age groups, 2030 projection

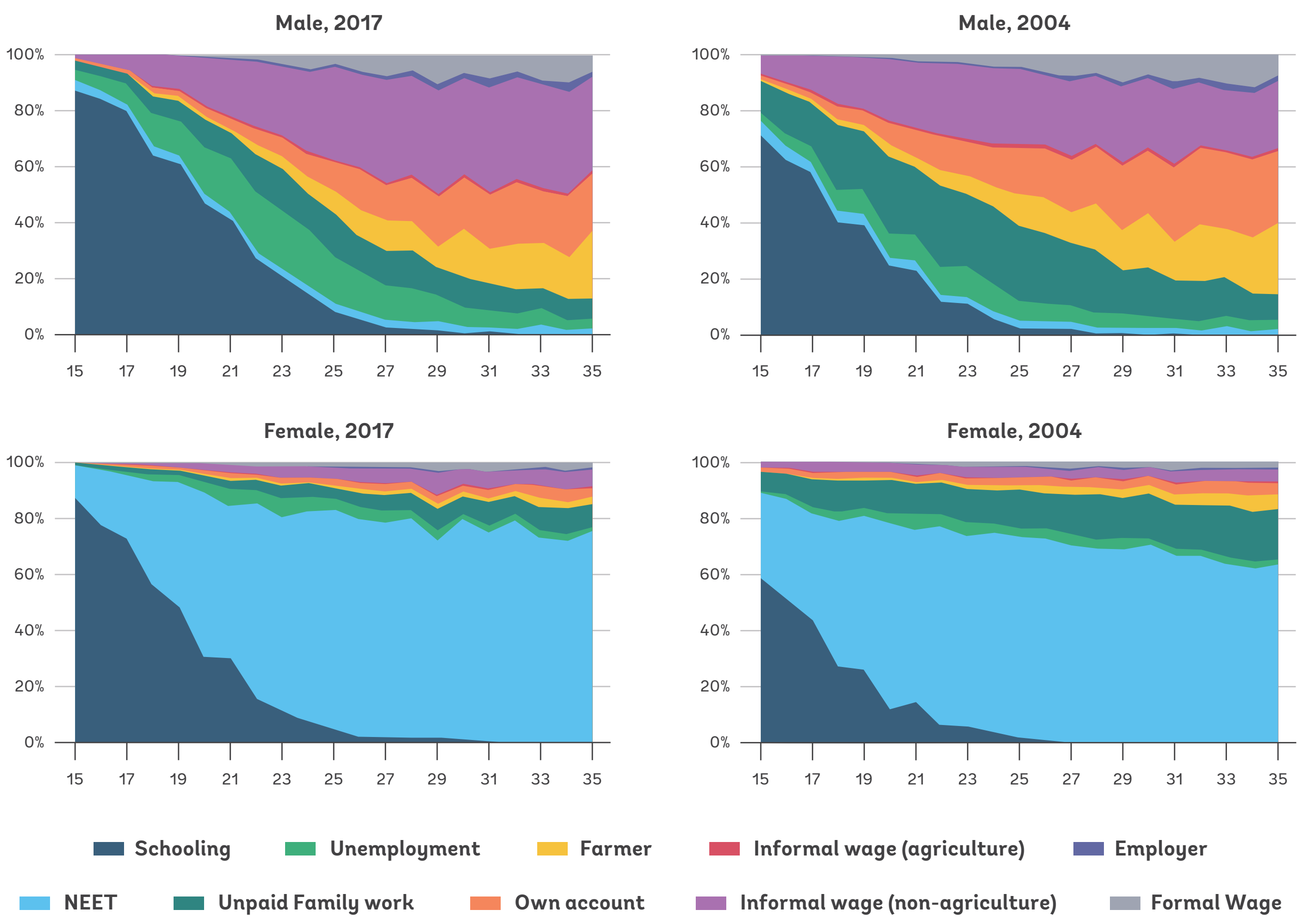


Source: Jobs Group Demographic Tool, using WDI data

This difficult labor market environment provides limited opportunities for youth, who are increasingly opting to remain outside the labor force. Female youth in particular have very low participation rates, and these have deteriorated over the past 15 years. About 30 percent of young people are neither in employment, nor in education or training, nor unemployed (NEET). The NEET situation is far worse for young females, 62 percent of whom are NEET compared to 3 percent of male youth (Figure 4.60). Youth who do enter the labor force are disproportionately in unpaid family work compared to older age groups. Male youth are most likely to find informal wage work – often after a spell of unemployment – and their access to formal work improves when in their late 20s and early 30s. These patterns of school-to-work transition represent an improvement compared to 2004, when larger shares of male youth were farming or self-employed. Female youth, by contrast, are less attached to the labor force today; on the positive side, more female youth are accessing informal wage jobs.

Figure 4.60

School-to-work transition by age (2017, 2004)



Note: This graph shows a static plot of male and female youths' work status by age, and does not capture dynamic transitions.

Source: GLD (India), World Bank Jobs Group (forthcoming), authors' calculation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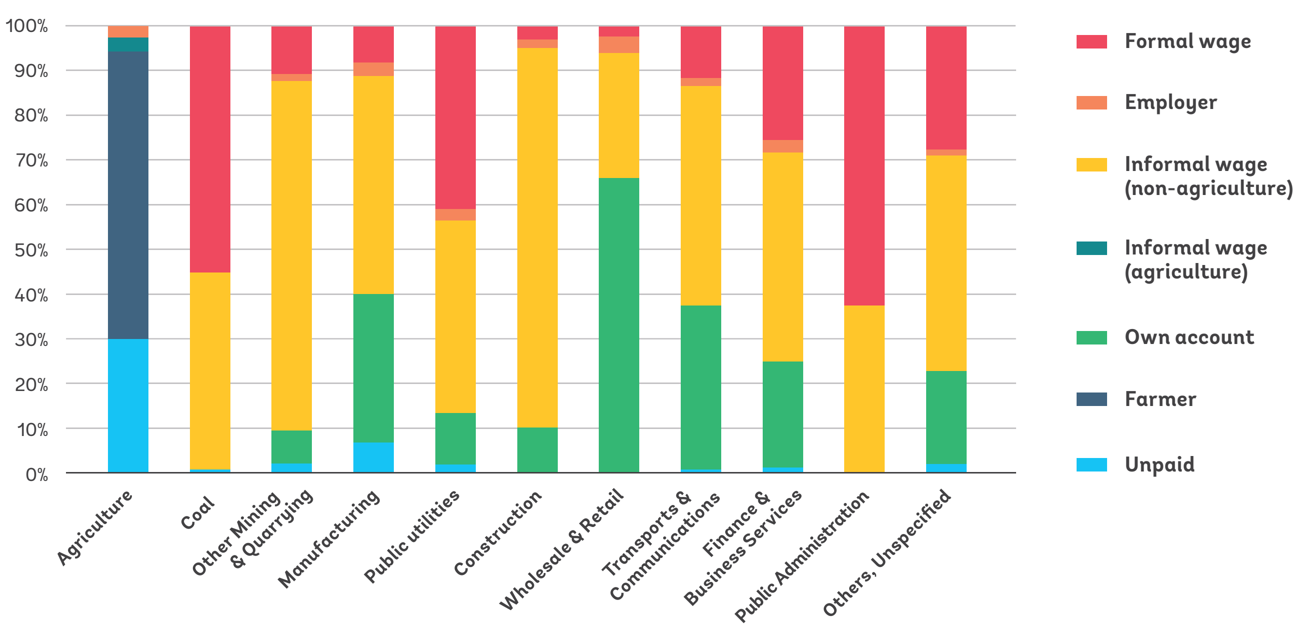
Coal mining jobs are of relatively high quality on average compared to most other sectors. Jobs in the coal mining sector are more likely to be formal (only the government sector has a higher share of formal employment) and they pay higher wages on average (Figures 4.61 and 4.62). Workers formally employed by Coal India Ltd. benefit from union representation and public sector wage setting and other job protections. Regression analysis on the correlates of wages for wage earners captured in the PLFS (that is, excluding subsistence workers and own account workers and possibly undercounting informally employed wage workers in the coal mining sector) indicates that coal wages are sharply higher than all other sectors, controlling for education level and other characteristics (regression results reported in Annex 4 Table 1). Even controlling for formality, coal mining workers earn a wage premium around 80 percent compared to commerce or construction sector workers, and 70 percent compared to the manufacturing sector. This positive and strongly significant correlation is even larger when we restrict the estimation to the six main coal states, highlighting coal's relative importance within these regional labor markets (Annex 4 Table 2).

Coal mining waged jobs – whether formal or informal – are mostly taken up by men (94 percent)**, and tend to engage workers with relatively less education and in relatively lower-skilled occupations.** According to the PLFS 2017 data, coal mining workers have lower than average educational attainment, on par with the wholesale and retail trade sector and the transport sector; 69 percent have less than a complete secondary degree. About a third of coal mining employees are craft workers, 23 percent are machine operators and 28 percent engage in elementary occupations.

Figure 4.61

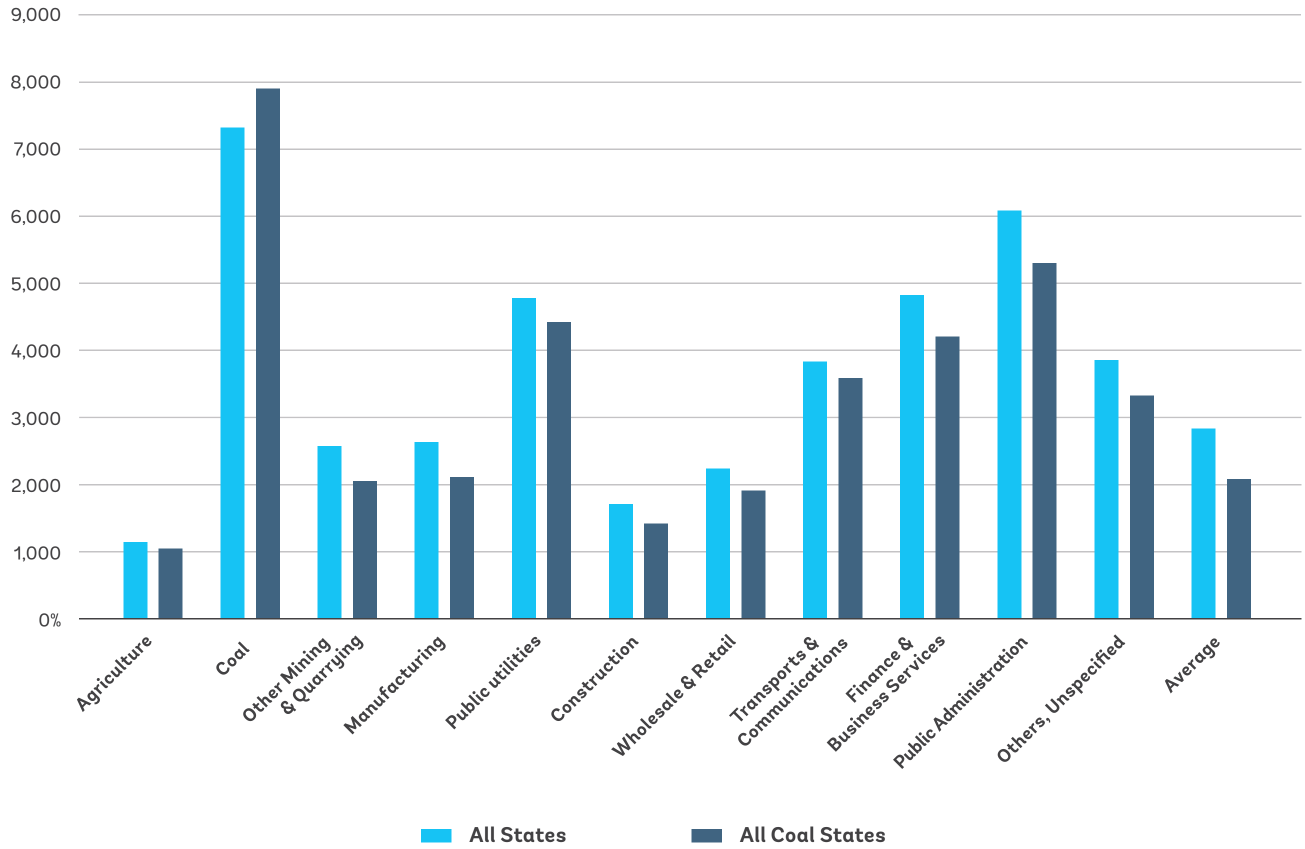
Work status breakdown by sector (2017)



Source: GLD (India), World Bank Jobs Group (forthcoming), authors' calculation

Figure 4.62

Nominal weekly wages by sector (2017 Rupees)



Source: GLD (India), World Bank Jobs Group (forthcoming), authors' calculation

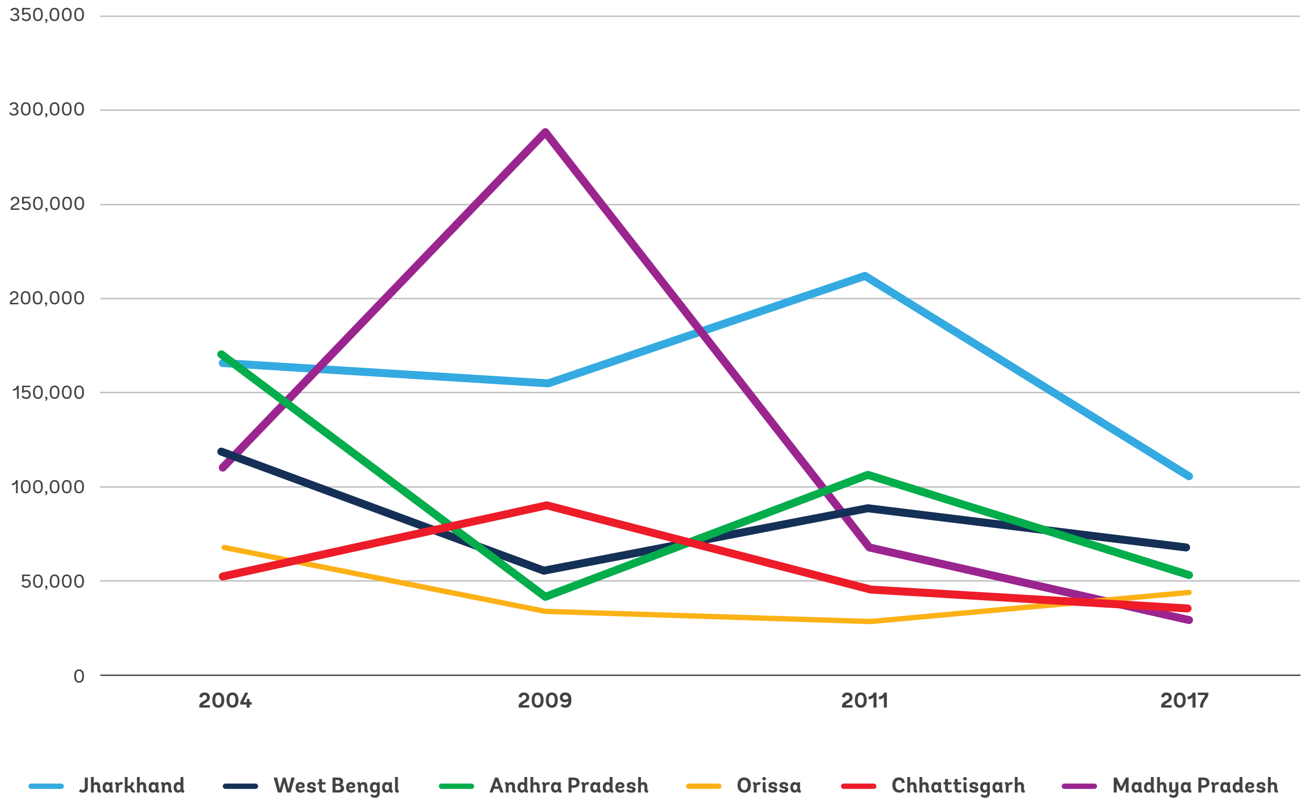
Coal mining activities are geographically concentrated in six states: Andhra Pradesh,[89] Jharkhand, West Bengal, Orissa (also referred to as Odisha), Chhattisgarh and Madhya Pradesh, hereafter referred to as "coal" states.[90] Jharkhand alone is home to a quarter of India's coal reserves. Each state has experienced fluctuations in coal mining employment since 2004, but a declining trend on net (Figure 4.63). Jharkhand experienced significant coal mine closures, especially among older mines and underground mines that were no longer profitable; moreover, about half of the mines currently operating in Jharkhand are not profitable (World Bank 2021c). Despite a significant presence of coal mining activity, the share of coal mining jobs in total state employment was only 2 percent in Jharkhand and even smaller elsewhere, suggesting limited coal dependence at the state level (although with some highly coal-dependent districts).

[89] Note that Telangana split off from Andhra Pradesh in 2014, but we retain them in a combined state for this analysis to enable comparisons over time.

[90] Other states in which significant coal production takes place include Maharashtra (by volume) and Gujarat (by employment).

Figure 4.63

Coal mining employment in 6 states (2004, 2009, 2011 and 2017)



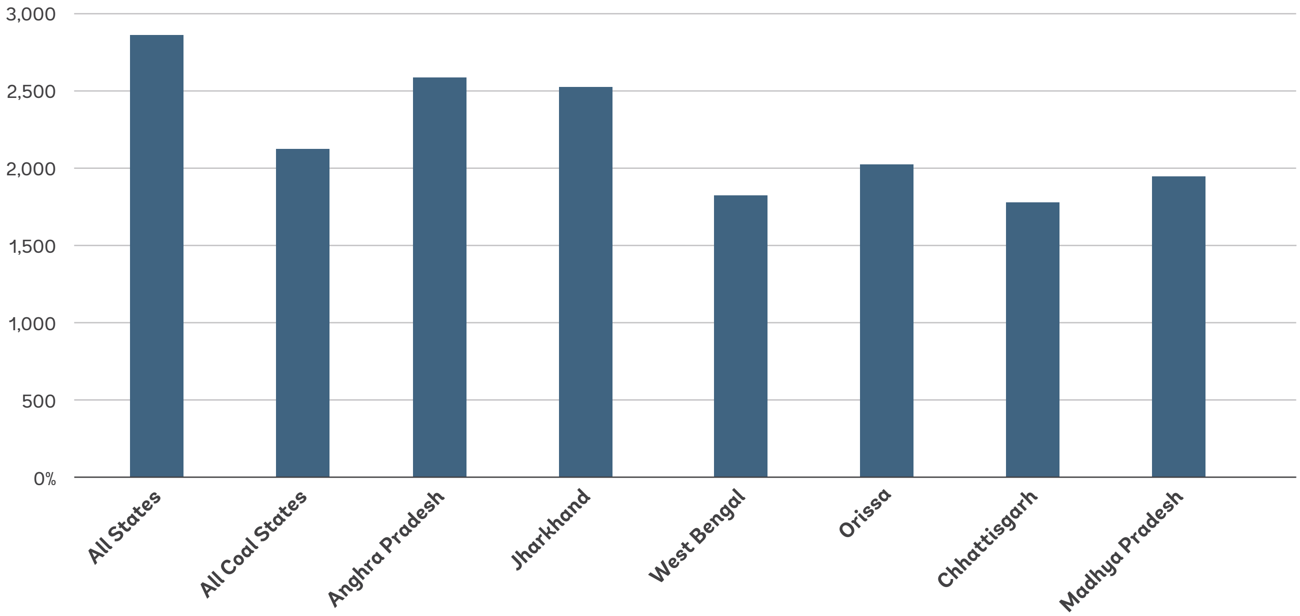
Note: Data for Andhra Pradesh includes Telangana.

Source: GLD (India), World Bank Jobs Group (forthcoming), authors' calculation

These "coal" states face greater-than-average economic development challenges, and are likely vulnerable to coal-related shocks. The "coal" states are characterized by weaker socio-economic performance compared to national averages, notably with respect to wage levels (Chhattisgarh and West Bengal are particularly low) and education, among others (Figures 4.64 and 4.65). Four of these "coal" states – Chhattisgarh, Jharkhand, Madhya Pradesh and Orissa – rank among the 10 poorest states in India (Reserve Bank of India 2019). Bhushan et al. (2020) find large negative economic outcomes – namely higher unemployment and poverty rates – in communities that experienced coal mine closures, specifically Bokaro, Jamtara, Hazaribagh and Ramgarh districts in Jharkhand. The survey data do not allow us to test for district-level economic spillovers of coal employment (similar to the analysis for Indonesia) because data are not representative at the district level. Nevertheless, it is likely that future coal mine closures risk upending workers' livelihoods, not only for those directly employed in mines, but also their families and those engaged in downstream industries reliant on coal, such as coal washeries, steel and cement plants (PEG-CPR Roundtable 2021).

Figure 4.64

Nominal weekly mean wage in coal states (2017 Rupees)

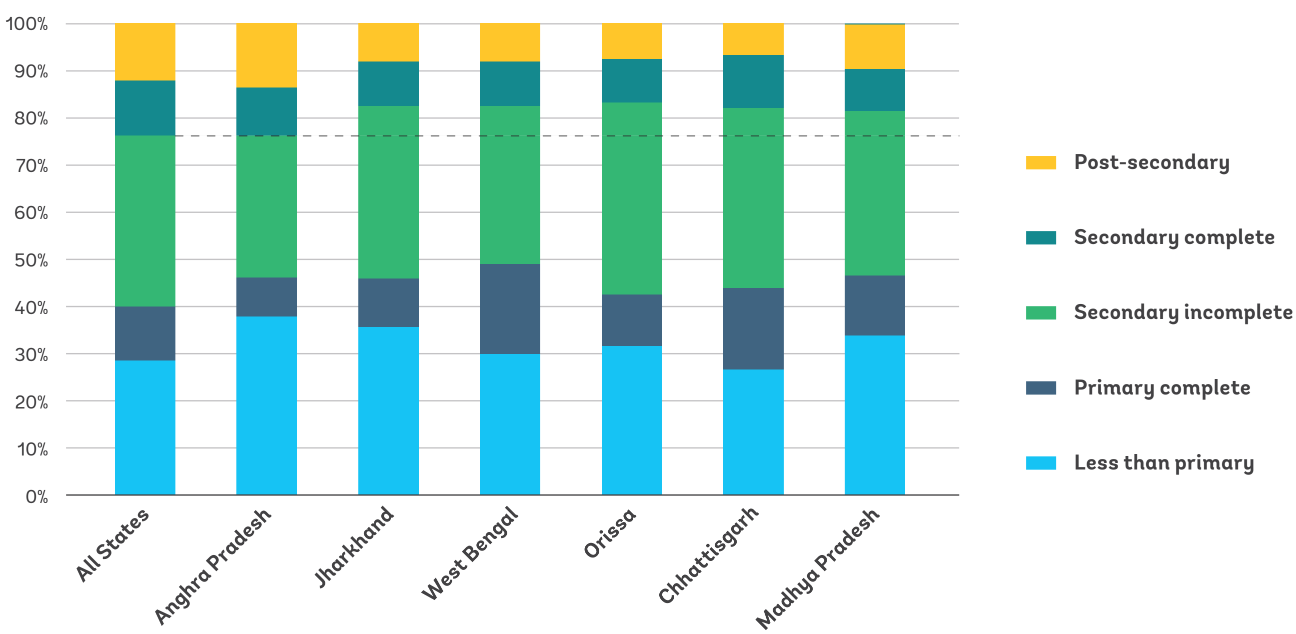


Note: Data for Andhra Pradesh includes Telangana.

Source: GLD (India), World Bank Jobs Group (forthcoming), authors' calculation

Figure 4.65

Educational attainment in coal states (2017)



Note: Data for Andhra Pradesh includes Telangana.

Source: GLD (India), World Bank Jobs Group (forthcoming), authors' calculation

The future speed of adjustment in the energy sector is uncertain, complicated by multiple governance-related factors. Based on India's "Stated Policies Scenario" developed by IEA consistent with current energy policies, energy demand is likely to grow by 35 percent by 2030, driven not only by increased (non-coal) transport activities but also increased use of air conditioning (IEA 2021a). The energy needed to keep up with India's projected population growth over the next two decades will require added power generation equivalent to the EU 's total current electricity generation capacity. But even with increasing demand for coal, India's coal sector faces productivity and efficiency challenges that in many cases render production unprofitable. And yet, the adoption of alternative energy sources has been slow. This is partly due to technological obstacles linked to storage capacity and the need to connect renewable energy to the grid and the need for interstate grid integration (CIF 2021), but it is also explained by the state's direct engagement in the coal sector and coal-fired power generation. Vested interests that spill beyond the coal sector add to pressures to maintain the status quo (CIF 2021). Coal-related taxes and levies also represent an important source of states' revenues (World Bank 2021c). The landscape is beginning to change, however, reflected in more ambitious Government targets for renewable energy capacity (227 GW by 2022 compared to 96 GW as of May 2021; IBEF 2021) and a number of recent Government regulatory and fiscal initiatives (such as an incentive scheme to support solar equipment manufacturing).

Coal's trajectory in India has created paradoxical effects. State ownership of reserves has facilitated coal's continued centrality in India's energy policy even in the post-liberalization period. The increasing energy needs of India's rapidly growing economy, together with the government's economic and energy security objectives, have been used to maintain reliance on coal. Coal production decisions are influenced by political objectives including sustaining direct and indirect public employment. A very high level of implicit subsidy is propping up unprofitable activities in India's large public sector, which also includes power generation, power distribution networks, and Indian Railways, among others.[91] Taken together, these factors have delayed the shift to cleaner energy sources, despite the environmental and economic rationale for doing so. Paradoxically, the positive spillover effects of coal mining jobs are offset by crowding out of alternative industries, limiting job creation and diversification of local economies and exacerbating dependence on coal.

[91] Tongia and Gross (2019) note that coal accounts for close to half of Indian Railways' freight revenues.

CHAPTER 5

Policies for Managing the Transition

5.1 Key Findings on the Magnitude of the Challenge

At the global level, coal-based energy production has risen steadily over the past 40 years, to a large degree driven by rising energy demand by the industrializing economies of the world. Increased electricity consumption is the main component of this energy demand, and coal is the largest fuel source for electricity worldwide. The developing world more than doubled its per capita electricity consumption since 1990, converging toward the high consumption levels prevalent in advanced economies.

Even as many of the former coal powerhouses in Europe as well as the U.S. are transitioning away from coal and shifting their priorities toward alternative sources of power generation, they have been replaced by rapidly scaling coal extraction in other regions of the world. China is by far the largest coal producer today, meeting not only the rising electricity needs of its massive population but also fueling its industrial sector, the engine of China's remarkable growth story. India similarly took advantage of its coal resources to facilitate industrialization through inexpensive energy, enabling energy-intensive firms to be more competitive and stimulating household demand for electricity. Indonesia's more recent scale-up of coal activity was motivated not only by rapid growth in domestic demand, but also in response to the flourishing coal export market. In a similar vein, Australia and South Africa have aggressively expanded their coal production, incentivized to a significant degree by potential export revenues.

Despite a rising awareness of the destructive effects of coal mining and coal combustion in exacerbating climate change, many countries rely on coal for a large share of their electricity needs through coal-fired power plants. Even among countries committed to transitioning away from coal, the marginal cost of continued coal extraction to power electricity generation is much lower than the cost to replace installed generation capacity. In addition to the enormous cost implications, other factors impede the transition away from coal, such as technical and logistical challenges to convert to new electricity sources, energy security concerns, foregone export revenues from coal and its derivatives, and the desire by governments to avoid dislocating current producers and affected workers along the coal value chain. In addition to coal's use in electricity generation, it is an input into many manufacturing supply chains, including as a direct or indirect input into metal and chemical manufacturing (e.g., steel), paper and wood products, construction materials, textiles and food processing, among others. The manufacturing sectors in emerging economies tend to be more concentrated in coal-intensive sub-sectors, but as countries progress toward an advanced stage of structural transformation, coal plays a relatively small role in increasingly services-based economies.

Globally, coal mining jobs number 4.7 million, accounting for less than one percent of employment even in the main coal producing countries. Over 2 million coal mining jobs have been lost over the last decade, reflecting coal phase-out in some countries, expansion in others, and sector productivity gains in most countries, as extraction technology has become more capital-intensive. Despite a modest role in national labor markets, coal jobs disproportionately affect local labor markets through positive spillover effects that at the same time limit or crowd out economic activity in other sectors because of wage distortions that depress labor demand.

Moreover, the boom and bust cycles associated with extractives industries in particular tend to limit economic diversification, making local economies vulnerable to large demand swings that undermine long-term growth.

The five case studies presented in this report illustrate these effects, albeit to different degrees, given heterogeneous country settings. Multiple factors affect the observed coal employment patterns, but some common features emerge that impede transition. These include: rising market demand for coal – whether domestic or external – to meet electricity needs; limited economic diversity in coal communities; weak regulation and sometimes regulatory capture; political economy pressures that shape government decision-making; and the potentially disruptive impact on livelihoods and the economic viability of coal communities.

Policymakers need to understand the ways in which a future transition away from coal may affect the welfare of both coal and non-coal workers and their surrounding communities, in order to create the policies and programs to manage transition effectively.

5.2 Lessons from Past Transitions

The experiences of past episodes of coal transition in the U.S. and Poland, and to a lesser degree in India, provide some lessons for policymakers and local development and planning authorities who anticipate future coal phase-out. There is no recipe for success, unfortunately; many of the transition experiences described in this report as well as those in other countries facing similar transitions were quite negative. The following lessons nevertheless provide insights and guidance for planning more effective and less costly transitions.

- **Transition takes a long time.** Most coal sectors developed over many decades, cultivating links across national economies. When many workers, businesses and communities are implicated, adjusting to a fundamental change in one industry cannot happen quickly, even with the best advance planning and post-closure transition policies in place.

- **Transition requires a comprehensive approach with complementary initiatives, policies and incentives to sway the many actors along the coal supply chain, from producers at the top (i.e., mine operators, power plants) all the way to consumers (buyers of coal for heating stoves or household electricity).** Policies need to be designed with the many stakeholders in mind, including those with vested interests like utility monopolies and manufacturers of mining equipment and coal stoves.

- **The timing and speed of transition are subject to political economy dynamics.** Uncertainty around commodity prices makes it difficult for communities to adjust for the "natural resource curse" because prices affect both willingness and capacity to diversify toward other industries. Where actors are public – such as in state-owned mines and power plants (e.g., in Poland and India) – governments have the power to act quickly but risk the future support of the electorate. Where actors are private but unions are strong (e.g., South Africa) and/or government capacity and regulatory authority are weak (e.g., Indonesia) or captured by private interests (e.g., U.S. coal communities captured by an "elite" of surviving coal-connected families), boom/bust cycles can be exacerbated, creating obstacles to both the design and implementation of effective transition policies.

- **Transition assistance programs targeting formal mine workers fall short of meeting the needs of informal workers in and around the mines.** Informal mine workers are at greater risk than their formal counterparts for several reasons: they lack severance rights and other basic labor protections such as advanced notice of layoff; they are ineligible for social insurance programs such as unemployment benefits; and they earn much lower incomes and are therefore less able to weather income shocks. Even large mine operators employ a significant share of their workforce on temporary and/or informal contracts. The risks are likely even greater for informal workers in the coal value chain or in other local sectors that are indirectly sustained by mine employees' spending. The displacement of informal workers dependent on the coal sector for their livelihoods is particularly harmful to low-income households.

- **Remoteness and small market size are mutually reinforcing impediments to transition.** When communities are not connected to larger markets, workers cannot access jobs elsewhere and local businesses are limited by their small local client base. "Bonding" social capital (what binds a community together; Lobao et al. 2021) may be strong, but "bridging" social capital (which fosters connectedness across groups) is needed to build cooperation and collaboration among local institutions, businesses, and governments.

- **The advantages of inducing voluntary job separations through generous compensation to miners are offset by the risk of inflicting long-term damage on local economies if prolonged income support further distorts local wages or ex-miners permanently exit the labor force.** High reservation wages dampen local labor demand and economic recovery through diversification, and premature labor force exit by a large component of the population (as observed in Poland) reduces the demand for local goods and services and can directly undermine public fiscal health if affected households qualify for long-term social assistance.

- **Severe social dislocation and local economic viability may pass a point of no return.** The risk is higher where long-term dependence on coal has delayed acceptance of transition. When local job losses – whether directly or indirectly the result of coal mine closure – are significant to the point of stimulating human capital flight while stranding those with the lowest capacity to find alternative work, the localized economic malaise can spill over to persistent labor productivity and welfare losses, deteriorating public services and outmigration.

- **Economic diversification is essential and requires help from both local and higher level government with respect to planning and financial resources.** Advance planning, investment in infrastructure, addressing environmental degradation and attracting private investment are key ingredients of economic diversification. These in turn require local and regional institutional capacity and coordination. A large negative shock requires financial support beyond local government capacity.

5.3 Policy Framework for Managing the Labor Impact of Coal Transition

The five country cases illustrate the significant and wide-ranging challenges posed by coal transition, and highlight the need for effective policies to address them. We use the lessons from past transitions in Poland and the US, together with the case study findings on coal sector and labor market dynamics in Indonesia, South Africa and India, to motivate the design of a multi-channel policy framework for managing the impact of coal transition on workers.

Large-scale coal mine closures risk wide, deep and prolonged negative effects on local communities and their economic viability; addressing these challenges effectively requires a solid understanding of the scope and nature of the potential impacts. As we consider the future prospects for coal-related jobs in the context of eventual downscaling of coal production to mitigate the effects of the climate crisis, it is essential to identify who may be impacted and the potential magnitude of their loss. Governments need to understand how many workers are directly employed by the coal mine, and whether their skills profile enables them to move easily into alternative jobs. More difficult is to understand how many additional jobs and businesses will suffer income losses. Are alternative employment opportunities available locally or within easy commuting distance, and how does the wage in alternative jobs compare to the lost job? Are retrenched coal-mine workers entitled to severance, health or early retirement benefits paid by the mine company? Will the existing safety net support all affected workers, or will some be left out? Are existing employment services such as job search assistance and training programs effective in matching jobseekers to vacancies, and do they have the capacity to absorb all potentially displaced workers? How well communities adjust to the shock will depend on many factors including the size of the shock relative to the local economy, workers' capacity to access alternative jobs, the local economy's ability to attract investment in alternative business ventures, and connectivity to larger markets, inter alia.

A comprehensive policy approach must be multifaceted, multi-stakeholder, and span several layers of government and several government ministries – and all of this requires planning, coordination, and strategic, risk-informed decision-making in advance of the mine closure and throughout the closure process. Developing an effective policy framework is further complicated by the reality that informal workers – an important segment of the coal sector value chain – fall beyond the reach of many policies. Herein lies a fundamental challenge.

Achieving an effective and just transition for all necessitates addressing the informal and formal segments of the affected workforce through a combination of local and national policies and programs. The concept of "just transition" under a broad conceptualization should extend to national priorities of inclusive, sustainable and broad-based economic growth. Coal transition – similar to other sector adjustments driven by technology or productivity gains that ultimately replaced obsolete production structures and jobs – represents an existential threat to some segments of the economy that, although small, have potentially wide-reaching impacts. Understanding the potential welfare losses by workers is only part of the challenge, albeit a big challenge regarding informal workers. Weighing the trade-offs and risks of prioritizing some stakeholders over others is the fundamental task of strategic policy design. Risks include poor economic outcomes in terms of deeper crisis and slower recovery, costly transition support programs that yield inadequate economic stimulus and job creation, worker transitions into unsustainable jobs or activities with negative environmental or other externalities, and potential derailment of transition due to vested interests or powerful interest groups, resulting in minimal abatement of CO_2 emissions, for example. Given the complex systems of implicit- and cross-subsidy of energy generation and its links to industrial sector production and jobs, it is important to understand who currently benefits from these existing systems, and the economic and fiscal costs and benefits associated with these systems. A just transition is one in which the costs and benefits are shared more equitably. When implicit environmental costs of coal-linked activity are added to the equation, the cost-benefit analysis is likely to favor a realignment of public resources and policies toward more socially inclusive and sustainable structures of economic production.

Traditional labor policy instruments that support the transition of displaced workers to new jobs are necessary but not sufficient in this context. Past experience illustrates what can go wrong when, for example, there is insufficient labor demand in remote or lagging regions, or when transition packages distort incentives to work, or when training is not aligned with private sector needs, or when only some workers receive support while others – perhaps even the majority – struggle to make ends meet. Ensuring that informal mine employees can access the active and passive labor market programs offered to formal mine employees is an important step, but non-mine workers or artisanal/own-account miners can also suffer severe income shocks. Temporary income support through the national safety net should be the minimum policy response, with a view to accommodating a long adjustment period where shocks are systemic in nature, such as in settings where the local economy is dependent on the closing mine. Income support not only smooths consumption; it also helps to sustain demand for local goods and services and the businesses that provide them. Whereas income support can address immediate and short-term needs, longer-term interventions are required to help workers move into alternative employment and to create an environment conducive to business diversification and private job creation.

There are five main channels through which public policies and programs can facilitate workers' transition. Some policies target workers, some target firms:

(i) temporary income support (e.g., employer severance pay, national social safety net)

(ii) increasing workers' capacity to qualify for jobs in new sectors (e.g., through skills or entrepreneurship training)

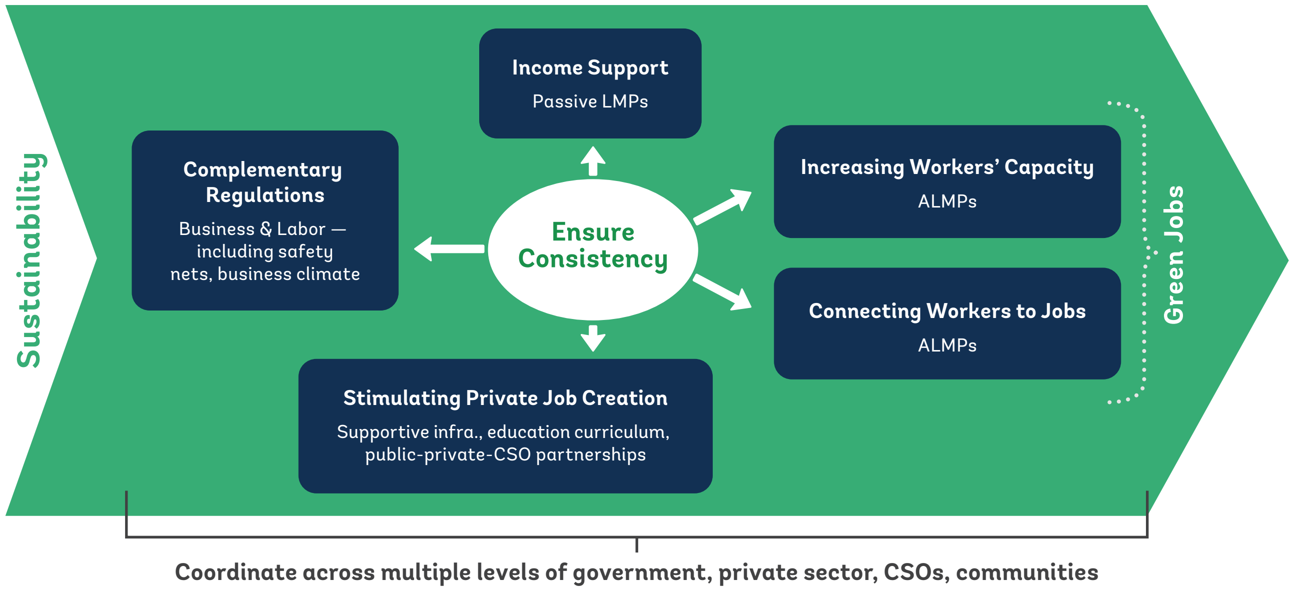
(iii) connecting workers to potential employers (e.g., through job search assistance, mobility grants)

(iv) stimulating private sector labor demand and local or regional business development (e.g., through investment incentives aligned with strategic national, local and/or regional priorities, matching grant programs); and

(v) ensuring the business environment and labor regulations are conducive to private sector investment and job creation.

Figure 5.1

Five policy channels to support transition



A sustainability lens could be added to these policy channels to ensure that workers displaced from coal sector jobs do not simply transition to alternative but equally unsustainable sectors. Jobs in environmentally sustainable activities are likely to be more resilient to shocks and generate other positive externalities, for example related to worker and community health. Moreover, introducing sustainability criteria into these policy channels – such as building workers' capacity to qualify for green sector jobs, supporting green entrepreneurship, or incentivizing green investments that promote private sector job creation – would support the parallel objective of stimulating green economic transition.

These five policy channels are relevant across different phases of the transition, including before the transition begins. Income support and active labor market policies typically come in the last phases of the mine closure and worker transition process.

The first phase – long before the closure itself – should focus on broader economic development planning to lay the groundwork for absorbing the negative economic shock. This entails measures to enhance the capacity and resilience of the local economy through diversification toward new economic sectors and new occupations requiring different skills. Given the wide-reaching and complex nature of economic development and the many actors involved, developing and coordinating the various elements of an effective strategy is extremely difficult, and requires a combination of leadership and partnership across local, regional and national governments, private sector, CSOs and communities.

The policy framework presented here is organized into four phases ranging from before the mine closure decision is taken through to the period following layoffs and closure. Even focusing only on the labor aspects of coal transition – the objective of

this report – calls for a broad approach to address the needs of affected workers and local communities. The proposed framework, summarized in Figure 5.2, builds on the labor policy approach developed by Cunningham and Schmillen (2021) and Fretwell (2017) for addressing the transition of formal mine employees. Our framework incorporates two additional dimensions. Firstly, it covers a wider universe of affected workers, formal and informal, whether direct mine employees on temporary informal contracts, for example, or workers in the coal value chain or businesses that meet the consumption needs of coal mine employees and their families. And secondly, it incorporates policies that go beyond labor to target private sector incentives and capacities to create jobs. The framework is informed by the strategic lessons presented in World Bank (2018a) as well as the lessons from past coal transitions described above. The framework's motivating objectives are to enhance the welfare of affected workers and ensure that viable medium-term employment outcomes emerge, whether in the local economy or beyond.

Phase 1: Economic development strategy before the mine closure decision is taken. In advance of the decision to close operations, policymakers should be considering measures to bolster local economic prospects in case of mine closure, which may not be imminent but is ultimately expected. Taking actions in advance to diversify the types of businesses and jobs available would help cushion the negative shock of mine closure. Efforts to improve the business environment and foster entrepreneurship can increase profitability and attract new firms. Investment in physical infrastructure and physical and digital connectivity will enhance the appeal for investors by reducing transport and other operational costs. Revising and reorienting curricula in schools and training centers toward emerging sectors at the national level (e.g., IT, green construction) and increasing focus on STEM and soft skills will build local human capital and prepare future graduates for higher productivity occupations. The policies and programs implemented in this first phase are essential to providing the necessary impetus to local demand, especially in remote and/or lagging regions. Experience from earlier transition episodes illustrates that local governments and institutions cannot manage alone, requiring regional and sometimes national support – with planning, policy coordination, and financing – as well as the cooperation and expertise of non-government organizations (e.g., charitable organizations, cultural and academic institutions, community entities and partners in the private sector).

There are significant risks of inadequate preparation or insufficient investment in upstream mitigation efforts, and these can ultimately prove costly. Policymakers and local stakeholders need to recognize the many and varied costs and take the necessary preventative steps. In addition to the costs imposed on workers and firms, prolonged economic recession leads to high fiscal outlays for social assistance, low fiscal revenues and reduced investment in schools, health centers and infrastructure maintenance; the result is weakened local institutions, diminished government effectiveness, and loss of community confidence and cooperation. Delayed transition can give rise to even higher costs and more political pressure. Authorities need to consider the long time horizon of transition; even without inertia and delay, it takes a long time for communities and economies to change. In addition to cross-cutting measures to enhance local economic opportunity, governments need to increase their engagement with and oversight of the

Figure 5.2

Policy framework for managing labor transition

1 Economic Development Strategy (Pre-closure decision)	• Foster diversification through business climate reforms, entrepreneurship initiatives • Invest in supportive physical and digital infrastructure incl. enhanced connectivity • Align education and training curricula toward emerging economic sectors (national not just local; STEM plus soft skills) • Establish partnerships and strategic oversight bodies comprising national/regional and local government officials, academic institutions, private sector associations, civic organizations and other community groups • Strengthen oversight of and partnership with mine operators (to minimize disruption post closure re: worker protections and land/infrastructure repurposing) • Partner with unions and/or employer organizations to design and deliver staff re-skilling for post-coal economy
2 Analysis & Planning (Pre-closure)	• Identify workers likely to be directly and indirectly affected by the mine closure process, profile existing skills and potential mismatch with current labor demand • Review social protection and ALMP programs and labor regulations related to layoffs • Assess eligibility for unemployment benefits and other social services (distinguishing by worker characteristics such as age, household income), identify coverage gaps, estimate potential needs for assistance • Revise income support programs, ALMPs and productive inclusion interventions to accommodate a systemic shock and build capacity of service provider agencies • Begin communications/community consultations, accompanied by positive cultural signaling around a new social contract not centered on coal
3 Announce Layoffs & Assistance	• Issue advance notification of layoff • Inform mine workers and community members of assistance options, offer packages targeted to mine employees and to other workers (e.g., productive inclusion, public works) to encourage self-selection into the best fit to facilitate reallocation into new jobs. Requires government to scale up its outreach • Help workers clarify their benefit entitlement with mine operator, union • Establish a network of worker advocates to promote assistance and steer workers to appropriate programs • Begin provision of certain services (e.g., career counseling, psycho-social outreach, job search assistance)
4 Post-layoff Assistance	• Provide temporary income support • Implement active labor market policies in phases/based on screening; ALMPs can include job search/technical/softskills/entrepreneurship training, job search grants, wage subsidy, business incubator, mobility grants • Monitor assistance take-up and job placement; adjust program parameters to improve effectiveness • Consider auxiliary services in response to community needs

Source: Authors' extension of the (formal) labor policy approaches developed in Fretwell (2017), World Bank (2018a) and Cunningham and Schmillen (2021) coal mine operator to ensure it meets its obligations to workers (in terms of severance or health benefits, for example) and to the local community in terms of pollution remediation to facilitate future land repurposing.

Unions and employer organizations may try to impede transition, but could be effective partners if engaged early. If unions or employer representatives believe that maintaining the status quo is the best way to protect their members, then when the coal operation ultimately closes, displaced mine workers are in reaction mode, scrambling to find alternative jobs. If, instead, they are invited into the planning process to design and deliver re-skilling for the post-coal economy (including in dynamic sectors like renewable energy), then their members will be prepared to move –even before mine closure – and have access to better jobs or business opportunities at the outset rather than waiting until after new dynamic firms have already attracted younger or more skilled workers, and miners face greater competition.

Phase 2: Pre-closure analysis and planning starts with diagnostics and program review. When the likelihood of future mine closure becomes clear, national and local authorities need to begin more specific planning to line up the right programs and make any necessary policy changes. Pre-transition diagnostics of the local labor market will be useful for identifying the number of workers likely to be affected – direct coal mine employees, mine sub-contractors, local or regional workers in the coal supply chain, and indirectly affected workers – as well as their skills profiles and occupations, which can then be compared to existing employment opportunities in the local and regional labor markets. The size and nature of any identified mismatch or implied wage differences between coal and non-coal occupations requiring similar skills will be key inputs for designing public policy responses. Given the extent and depth of impact on workers, and the different types of affected workers – ranging from informal unskilled coal collectors to semi-skilled workers in the coal supply chain to micro-entrepreneurs and small business owners providing services to coal mine workers and their families to formal mine employees themselves – a wide range of programs will be needed. A first step is to assess whether the existing safety net and employment services can meet identified needs, and if not, governments need to introduce program changes or additions to address the gaps. This diagnostic should inform planning around the timing and speed of closure, and the public resources likely to be needed to finance the various passive and active labor market policies being offered.

Proactive reform of passive and active labor market programs and systems should be implemented well in advance of layoffs. Safety net programs such as social assistance or unemployment benefits may provide basic income support for a certain time period, but the level or coverage period or eligibility rules may be inadequate to meet the scale of layoffs, especially when these types of support are designed to protect against temporary idiosyncratic shocks rather than a systemic and persistent labor demand shock. High coal wages or partial income losses by coal supply chain workers may restrict access when income qualification thresholds are low. Union members may be entitled to receive some support from the mine operator, while non-union members are not. ALMPs designed to connect job seekers to vacancies, such as through job search assistance, job search training, technical training or wage subsidies, may not have the systems in place to handle the likely high demand for services following mine closure. On the basis of identified coverage needs and gaps, program parameters may need to be revised to address the anticipated demand, or new support programs may need to be introduced, perhaps to address spatial-related issues such as labor mobility constraints. Informal and especially low-skilled workers in the coal value chain may need offerings such as public works and productive inclusion programs. Service delivery agencies may require upgraded systems or other capacity building efforts. Governments need to provision budget resources to ensure the existing (or improved) safety net and ALMPs can meet the demand.

Armed with this information on skills mismatch, coverage gaps and new/revised support programs, governments need to build a communications strategy and begin communications outreach to workers and broader communities. Consultations with community groups will be an essential component. In settings where coal culture is embedded in social values, government efforts could include introducing revised cultural signaling of "new economy" or "green" alternatives and stimulating debate around a more inclusive social contract not centered on coal. In addition to these steps to diagnose the nature and scope of the jobs challenges and design and roll out the tools to address them, there are other measures not related to labor that are also important for effectively managing mine closures; World Bank (2018a) lays out guidelines for complementary planning related to, for example, stakeholder mapping, regulatory requirements for firm exit and property title transfer, and pollution remediation, inter alia.

Phase 3: Announcement of layoffs and assistance involves informing mine workers and the broader community that layoffs are coming, presenting the range of support options available, and providing preparatory support. During this phase, mine workers are given official advanced layoff notice, and the targeted packages of various support options are offered, potentially in sequenced rounds, in ways that encourage self-selection by workers into the best option for them to transition to their preferred job, whether in a similar occupation or new occupation, local or elsewhere, or in their own start-up enterprise. Once workers receive layoff notice, they need to clarify what separation benefits, health and pension benefits they are entitled to from the mine operator and/or the union. It would be helpful for workers to be able to seek guidance on how to navigate the various program options; this could be facilitated by establishing a network of worker advocates – e.g., under a partnership between local government and community/non-governmental organizations – to help steer workers to appropriate programs. Finally, pre-layoff assistance such as counseling services (career or psycho-social counseling), job search training and job search advice should be rolled out to mine workers, with a view to extending support to non-mine workers who may also be affected.

Phase 4: Post-layoff assistance comprises delivery of temporary income support to displaced workers and implementation of active labor market policies. ALMPS may include various types of training (e.g., job search training, technical, softskills or entrepreneurship training), job search grants, targeted wage subsidy programs, business incubator support, and mobility grants to connect workers to jobs in other regions. The set of ALMPs can be organized as a menu of options, or offered in a phased approach or on the basis of applicant screening to ensure good fit. Program offerings – whether passive or active – need to be monitored with respect to take-up and job placement rates. If programs are not working effectively, their parameters should be adjusted or redesigned to deliver better outcomes. Regular monitoring and evaluation as well as broader assessment of community well-being will enable stakeholders to identify and respond to emerging crises sooner rather than later, before they become intractable.

Government's role is multi-faceted and complicated, but more effective if proactive. A well-planned and systematic process of coal mine closure and layoffs is essential for supporting the reallocation of affected workers to alternative work, and – equally importantly – mitigating the economic and social and political costs of transition. This wide scope of impact requires coordination across sectors and across various levels of government. Moreover, the long time period of policy design and implementation, which spans the four phases described here, requires particular attention to intertemporal policy coherence. Governments alone do not have to deliver everything; they can provide strategic direction, coordinate across stakeholders, arbitrate competing interests, and provide leadership and motivation for transition. Governments' most fundamental responsibility is to mobilize adequate financing that represents an investment in transition, rather than simply reacting to a systemic labor demand shock by applying band-aids. The speed of transition will determine its ultimate cost. Each of the four stages of this policy framework is integral to and designed to facilitate an effective labor transition.

The accumulating forces for change – including increasing recognition of the climate crisis and the urgent need to reduce carbon emissions – are creating momentum for transition. This momentum takes different forms, but is more and more evident within transitioning countries as well as among some of the biggest coal players, such as China and India. Country context related to the nature and extent of coal reliance helps explain country motivation to accelerate or delay or avoid transition. The patterns of coal production, consumption and employment documented in this report offer insights for future decisions to reduce coal production and coal-dependent employment.

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ANNEX 1

Using Input-Output tables to estimate the coal content of sectors

Input-output tables provide a comprehensive picture of how sectors intertwine in an economy through backward and forward value chain linkages. For a given number of sectors, they record how the production of a sector's output depends on another sector's input. If sufficiently disaggregated at the sector level, they can be a useful tool to analyze how different sectors across an economy rely on the availability of a particular input, such as coal.

A global, standardized repository of input-output tables for 121 countries, each covering 57 sectors (among them coal), is available from the Global Trade Analysis Project (GTAP). We analyzed each to generate three measures of coal dependence for every sector in a given country.

(i) A coal dependency measure that considers only direct input-output links with the coal sector: This measure is calculated as a sector's share of coal in total intermediate consumption. The measure provides insight into which sectors are direct consumers of coal in the production process. In most countries these sectors will include the electricity sector and the metals industry.

(ii) A coal dependency measure that considers direct input-output links with the coal sector as well as indirect input-output links with the coal sector due input-output relationships along value chains: This measure is calculated by re-weighting the sector's share of coal in total intermediate consumption to take into account the consumption of coal along the sectors upstream value chain.[92] This measure can be used to identify sectors that are not themselves directly dependent on coal but depend on inputs that are coal dependent.

(iii) A coal dependency measure that considers direct and indirect effects as in (ii) but that excludes indirect input-output links to the coal sector when these emanate from coal being an input in electricity generation. This measure is calculated as in (ii) but without the electricity sector. The measure seeks to abstract from the fact that indirect coal content in sectors will be particularly high in countries that rely on coal for electricity generation. It therefore allows one to gauge sector's indirect reliance on coal other than through its importance as a source of energy.

[92] In practice, this is achieved by calculating the Leontief inverse of the input-output matrix in every country and re-weighing coal input requirement accordingly.

ANNEX 2

Technical Results for Indonesia

Methodology for estimating coal employment spill-overs to local non-coal sectors in Indonesia

We rely on the methodology developed by Black et al. (2005) to estimate the impact of coal sector jobs on non-coal employment in relatively coal-intensive regions, and we test whether the degree of coal-intensity affects the magnitude of this elasticity. For Indonesia, where data is representative at the district level, we estimate the following equation:

$$Ln(Y_{s,t,i})=\beta_0 + \beta_1 Ln\,(X_{t,i}) + \beta_2 Z_i + \beta_3 P_{t-1,i} + \alpha_v + \pi_t + U_{t,i}$$

where $Y_{s,t,i}$ is the number of jobs in non-coal sector s at time t in district i; $X_{t,i}$ is the number of jobs in the coal sector at time t in district i; and Z_i is a dummy variable for whether the district is in the treatment group of coal-intensive districts, which we define as having a coal share of employment equal to at least 4 percent in 2007. We include lagged population size "$P_{t-1,i}$" to account for agglomeration effects, and include province "α_v" and year "π_t" fixed effects to control for potential structural variations across the different time periods and provinces. $U_{t,i}$ is the error term. Therefore, β_1 is the elasticity of the number of jobs in the non-coal sector to the number of jobs in the coal sector, and β_2 captures the difference in employment in the non-coal sector between the treatment districts and non-treatment districts. We run this for non-coal sectors aggregated together, and subsequently for each non-coal sector separately.

We follow Black et al. (2005) and Moritz et al. (2017) by restricting our sample to districts within coal provinces because they share similar institutional and geographic characteristics, which reduces confounding factors. The sample includes only coal provinces South Kalimantan and East and North Kalimantan, and within these, excludes districts that have zero or negligible coal employment (i.e., less than 0.5 percent). For robustness, we test on a wider sample of coal provinces (namely by adding South Sumatera and Banten) and find similar results.

Annex 2 Table 1

Net job creation in Indonesia

ALL PROVINCES	Employment level 2007	Employment level 2012	Employment level 2018	Net job creation 2007 to 2012 # of jobs	Net job creation 2007 to 2012 o/w % male	Net job creation 2007 to 2012 Annual job growth rate	Net job creation 2012 to 2018 # of jobs	Net job creation 2012 to 2018 o/w % male	Net job creation 2012 to 2018 Annual job growth rate
Agriculture	38,540,867	36,844,412	32,885,651	(1,696,455)	63%	-1%	(3,958,761)	56%	-2%
Coal	90,075	260,162	240,041	170,087	96%	24%	(20,121)	105%	-1%
Other Mining & Quarrying	894,193	1,324,460	1,187,376	430,267	97%	8%	(137,084)	83%	-2%
Manufacturing & Utilities	12,321,481	15,571,799	18,679,363	3,250,318	63%	5%	3,107,564	51%	3%
Construction	5,220,599	6,802,997	8,173,464	1,582,398	98%	5%	1,370,467	99%	3%
Wholesale & Retail & Restaurants	19,970,919	22,879,060	30,282,118	2,908,141	44%	3%	7,403,058	45%	5%
Transportation and Communications	5,901,586	4,992,125	6,258,773	(909,461)	91%	-3%	1,266,648	77%	4%
Finance & Business Services	1,382,738	2,660,271	3,834,138	1,277,533	71%	14%	1,173,867	71%	6%
Community and Personal Services*	11,821,820	17,069,477	18,361,441	5,247,657	43%	8%	1,291,964	-5%	1%
Total	**96,144,278**	**108,404,763**	**119,902,365**	**12,260,485**	**55%**	**2%**	**11,497,602**	**49%**	**2%**

SOUTH KALIMANTAN AND EAST AND NORTH KALIMANTAN	Employment level 2007	Employment level 2012	Employment level 2018	Net job creation 2007 to 2012 # of jobs	Net job creation 2007 to 2012 o/w % male	Net job creation 2007 to 2012 Annual job growth rate	Net job creation 2012 to 2018 # of jobs	Net job creation 2012 to 2018 o/w % male	Net job creation 2012 to 2018 Annual job growth rate
Agriculture	1,062,615	1,174,134	1,062,381	111,519	70%	2%	(111,753)	39%	-2%
Coal	69,678	179,196	166,575	109,518	96%	21%	(12,621)	85%	-1%
Other Mining & Quarrying	48,931	67,325	66,922	18,394	98%	7%	(403)	-447%	0%
Manufacturing & Utilities	216,642	234,292	349,240	17,650	169%	2%	114,948	54%	7%
Construction	126,121	201,080	192,749	74,959	99%	10%	(8,331)	114%	-1%
Wholesale & Retail & Restaurants	557,201	722,767	1,026,035	165,566	50%	5%	303,268	44%	6%
Transportation and Communications	151,662	139,903	209,905	(11,759)	73%	-2%	70,002	76%	7%
Finance & Business Services	40,149	94,869	128,650	54,720	87%	19%	33,781	53%	5%
Community and Personal Services*	369,703	555,510	701,220	185,807	45%	8%	145,710	39%	4%
Total	**2,642,702**	**3,369,076**	**3,903,677**	**726,374**	**70%**	**5%**	**534,601**	**49%**	**2%**

*Note: * Includes public administration.*

Source: Sakernas data 2007–2018.

Annex 2 Table 2

OLS regressions on the correlates of real hourly wages (2018; all provinces)

VARIABLES	(1)	(2)	(3)	(4)
Age	0.0372*** (0.0012)	0.0384*** (0.0009)	0.0377*** (0.0009)	0.0395*** (0.0009)
Age squared	-0.000352*** (1.55e-05)	-0.000367*** (1.13e-05)	-0.000368*** (1.13e-05)	-0.000372*** (1.13e-05)
Complete Primary	0.136*** (0.0076)	0.113*** (0.0073)	0.106*** (0.0072)	0.111*** (0.0073)
Incomplete or Complete Secondary	0.400*** (0.0075)	0.382*** (0.0073)	0.339*** (0.0073)	0.369*** (0.0074)
Post-Secondary	0.956*** (0.0103)	0.933*** (0.0099)	0.755*** (0.0111)	0.906*** (0.0100)
Male	0.291*** (0.0052)	0.271*** (0.0050)	0.279*** (0.0049)	0.265*** (0.0050)
Urban	0.189*** (0.0046)	0.112*** (0.0045)	0.111*** (0.0045)	0.104*** (0.0046)
Coal sector	0.542*** (0.0238)	0.457*** (0.0248)		0.409*** (0.0248)
Other mining	0.191*** (0.0175)	0.178*** (0.0172)		0.157*** (0.0171)
Manufacturing	0.125*** (0.0076)	0.123*** (0.0076)		0.0873*** (0.0078)
Electricity, gas, water	0.106*** (0.0245)	0.106*** (0.0240)		0.0734*** (0.0238)
Construction	0.0441*** (0.0075)	0.0737*** (0.0074)		0.0656*** (0.0074)
Wholesale & retail, restaurants	-0.00769 (0.0072)	-0.0132* (0.0071)		-0.0219*** (0.0071)
Transportation & communications	0.0302*** (0.0102)	0.00793 (0.0099)		0.00166 (0.0098)
Finance & business services	0.294*** (0.0135)	0.267*** (0.0131)		0.231*** (0.0135)
Community & personal	-0.0109 (0.0083)	-0.00219 (0.0081)		-0.0417*** (0.0085)
Administrative & Managerial			0.426*** (0.0215)	
Clerical			0.0843*** (0.0107)	
Sales			-0.162*** (0.0117)	
Services workers			-0.249*** (0.0134)	
Skilled agricultural			-0.194*** (0.0118)	
Production & Machine operators			-0.147*** (0.0109)	
Others			-0.0850*** (0.0162)	
Permanent wage employees				0.0909*** (0.0053)
Constant	7.046*** (0.0237)	7.220*** (0.0229)	7.463*** (0.0251)	7.168*** (0.0232)
Observations	193,977	193,977	193,977	193,977
R-squared	0.197	0.24	0.244	0.242

*Notes: Table reports results for Ordinary Least Squares regressions estimating the correlation of individual characteristics with log real hourly labor earnings of wage employees using data from Indonesia's Sakernas 2018 dataset. Real wages are expressed in constant 2007 rupiahs. Reference categories are: less than primary complete education, agriculture sector, and professional or technical occupations. Columns 2, 3 and 4 include province controls. Standard errors are reported in parentheses where ***, **, and * indicate significance at 1, 5, and 10 percent respectively. Province controls are included in columns 2, 3 and 4.*

Source: Authors' estimates.

Annex 2 Table 3

OLS regressions on the correlates of real hourly wages in South Kalimantan and East and North Kalimantan provinces (2018)

VARIABLES	(1)	(2)	(3)	(4)
Age	0.0546*** (0.00462)	0.0540*** (0.00461)	0.0571*** (0.00459)	0.0564*** (0.00463)
Age squared	-0.000536*** (593e-05)	-0.000530*** (593e-05)	-0.000582*** (589e-05)	-0.000550*** (592e-05)
Complete Primary	0.130*** (0.0304)	0.124*** (0.0304)	0.116*** (0.0304)	0.126*** (0.0303)
Incomplete or Complete Secondary	0.393*** (0.0292)	0.374*** (0.0292)	0.343*** (0.0293)	0.362*** (0.0292)
Post-Secondary	0.852*** (0.0371)	0.835*** (0.0371)	0.662*** (0.0415)	0.808*** (0.0372)
Male	0.273*** (0.0198)	0.270*** (0.0197)	0.313*** (0.0199)	0.262*** (0.0196)
Urban	0.0263 (0.0180)	0.0098 (0.0181)	0.0006 (0.0179)	0.0056 (0.0181)
Coal sector	0.385*** (0.0312)	0.380*** (0.0313)		0.335*** (0.0321)
Other mining	0.0720 (0.0578)	0.0688 (0.0571)		0.0424 (0.0571)
Manufacturing	-0.109*** (0.0342)	-0.0961*** (0.0343)		-0.115*** (0.0345)
Electricity, gas, water	0.172* (0.1010)	0.184* (0.0994)		0.1540 (0.0974)
Construction	0.0120 (0.0315)	0.0206 (0.0315)		(0.0000) (0.0315)
Wholesale & retail, restaurants	-0.0705*** (0.0269)	-0.0600** (0.0270)		-0.0584** (0.0269)
Transportation & communications	(0.0316) (0.0405)	(0.0192) (0.0404)		(0.0277) (0.0404)
Finance & business services	0.134*** (0.0452)	0.137*** (0.0449)		0.106** (0.0452)
Community & personal	-0.0587** (0.0294)	-0.0515* (0.0294)		-0.0863*** (0.0303)
Administrative & Managerial			0.365*** (0.0686)	
Clerical			(0.0172) (0.0372)	
Sales			-0.180*** (0.0412)	
Services workers			-0.357*** (0.0501)	
Skilled agricultural			-0.182*** (0.0409)	
Production & Machine operators			-0.169*** (0.0383)	
Others			-0.172*** (0.0516)	
Permanent wage employees				0.102*** (0.0221)
Constant	6.963*** (0.0896)	7.040*** (0.0899)	7.167*** (0.0958)	6.945*** (0.0927)
Observations	10,023	10,023	10,023	10,023
R-squared	0.193	0.197	0.194	0.199

*Notes: Table reports results for Ordinary Least Squares regressions estimating the correlation of individual characteristics with log real hourly labor earnings of wage employees using data from Indonesia's Sakernas 2018 dataset. Real wages are expressed in constant 2007 rupiahs. Reference categories are: less than primary complete education, agriculture sector, and professional or technical occupations. Columns 2, 3 and 4 include province controls. Standard errors are reported in parentheses where ***, **, and * indicate significance at 1, 5, and 10 percent respectively. Province controls are included in columns 2, 3 and 4.*

Source: Author's estimates.

Annex 2 Table 4

OLS regressions comparing non-coal real wage growth in coal-intensive and non-coal intensive districts in South Kalimantan and East and North Kalimantan provinces, 2007 to 2012

	Non-Coal employment		Agriculture		Manufacturing		Construction		Services	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Coal-intensive district	0.228*** (0.0233)	0.157*** (0.0267)	0.0318 (0.0409)	-0.0227 (0.0482)	0.477*** (0.0683)	0.432*** (0.0748)	0.322*** (0.0530)	0.293*** (0.0619)	0.263*** (0.0368)	0.190*** (0.0406)
2012	-0.00273 (0.0224)	-0.0071 (0.0223)	-0.024 (0.0388)	-0.0281 (0.0388)	-0.0108 (0.0586)	-0.0109 (0.0586)	-0.0896* (0.0543)	-0.0884 (0.0538)	0.0277 (0.0340)	0.0213 (0.0340)
2012* Coal-intensive district	-0.234*** (0.0409)	-0.229*** (0.0409)	-0.178** (0.0705)	-0.172** (0.0705)	-0.560*** (0.1520)	-0.559*** (0.1520)	-0.291*** (0.0919)	-0.292*** (0.0914)	-0.185*** (0.0647)	-0.178*** (0.0648)
Age	0.0816*** (0.0213)	0.0799*** (0.0212)	0.0458 (0.0360)	0.044 (0.0360)	-0.0246 (0.0570)	-0.0211 (0.0577)	0.0777 (0.0521)	0.0762 (0.0523)	0.111*** (0.0326)	0.109*** (0.0323)
Age squared	-0.000910*** (0.0003)	-0.000889*** (0.0003)	-0.000573 (0.0005)	-0.000553 (0.0005)	0.000709 (0.0008)	0.000654 (0.0008)	-0.000947 (0.0008)	-0.000929 (0.0008)	-0.00126*** (0.0005)	-0.00124*** (0.0005)
Complete Primary	0.0871** (0.0365)	0.0884** (0.0364)	0.107** (0.0540)	0.108** (0.0538)	-0.00248 (0.1280)	0.00717 (0.1310)	-0.0451 (0.0977)	-0.0443 (0.0982)	0.115* (0.0693)	0.116* (0.0684)
Incomplete or Complete Secondary	0.240*** (0.0348)	0.227*** (0.0350)	0.196*** (0.0536)	0.194*** (0.0535)	0.346*** (0.1170)	0.338*** (0.1200)	0.0944 (0.1010)	0.0865 (0.1020)	0.240*** (0.0627)	0.220*** (0.0620)
Post-Secondary	0.852*** (0.0482)	0.837*** (0.0481)	0.745*** (0.1420)	0.740*** (0.1400)	1.440*** (0.1990)	1.442*** (0.1990)	0.594*** (0.1730)	0.579*** (0.1760)	0.801*** (0.0699)	0.778*** (0.0690)
Urban	-0.160*** (0.0199)	-0.174*** (0.0201)	-0.163*** (0.0579)	-0.182*** (0.0562)	-0.230*** (0.0670)	-0.236*** (0.0671)	-0.188*** (0.0437)	-0.195*** (0.0462)	-0.197*** (0.0330)	-0.205*** (0.0330)
South Kalimantan		-0.121*** (0.0245)		-0.0824** (0.0397)		-0.0906 (0.0625)		-0.0558 (0.0642)		-0.136*** (0.0367)
Constant	6.781*** (0.3640)	6.897*** (0.3620)	7.661*** (0.6080)	7.755*** (0.6060)	8.432*** (0.9480)	8.431*** (0.9520)	7.116*** (0.8690)	7.181*** (0.8750)	6.224*** (0.5660)	6.338*** (0.5600)
Observations	6,990	6,990	1,969	1,969	643	643	773	773	3,325	3,325
R-squared			0.052	0.054	0.353	0.357	0.144	0.146	0.155	0.161

*Notes: Table reports results building on Black et al. (2005) methodology estimating the change in real hourly wages in non-coal sectors between 2007 and 2012 by regressing log wages in sector i on dummies for coal-intensive district, end year, and the interaction term. District is coal-intensive if coal employment share is at least 4%. The sample is restricted to males aged 25-45 to reduce bias due to changing composition of the workforce. Reference category is less than primary complete education. A negative coefficient value on the interaction variable 2012*coal-intensive district indicates slower wage growth in coal-intensive districts. Data from Indonesia's Sakernas 2007 and 2012. Standard errors are reported in parentheses where ***, ** and * indicate significance at 1, 5 and 10 percent respectively.*

Source: Author's estimates.

Annex 2 Table 5

OLS regressions comparing real wage growth in coal-intensive and non-coal intensive districts in South Kalimantan and East and North Kalimantan provinces, 2012 to 2018

	Non-Coal employment		Agriculture		Manufacturing		Construction		Services	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Coal district intensity	0.0039 (0.0335)	(0.0101) (0.0354)	-0.144** (0.0571)	-0.118* (0.0641)	(0.0802) (0.1350)	(0.0565) (0.1370)	0.0590 (0.0761)	0.1100 (0.0762)	0.0954* (0.0536)	0.0607 (0.0553)
2018	0.194*** (0.0251)	0.193*** (0.0250)	0.164*** (0.0461)	0.162*** (0.0461)	0.268*** (0.0677)	0.270*** (0.0669)	0.365*** (0.0549)	0.376*** (0.0528)	0.162*** (0.0376)	0.160*** (0.0374)
2018*Coal district intensity	0.0160 (0.0474)	0.0174 (0.0474)	0.158** (0.0786)	0.159** (0.0787)	0.1870 (0.2020)	0.1870 (0.2020)	(0.1440) (0.1240)	(0.1570) (0.1230)	(0.0872) (0.0736)	(0.0844) (0.0735)
Age	0.100*** (0.0240)	0.101*** (0.0240)	0.0725* (0.0416)	0.0747* (0.0417)	(0.1010) (0.0774)	(0.1060) (0.0780)	0.0789 (0.0540)	0.0770 (0.0536)	0.123*** (0.0355)	0.124*** (0.0354)
Age square	-0.00117*** (0.0003)	-0.00117*** (0.0003)	(0.0010) (0.0006)	-0.000980* (0.0006)	0.0016 (0.0011)	0.0017 (0.0011)	(0.0009) (0.0008)	(0.0009) (0.0008)	-0.00141*** (0.0005)	-0.00143*** (0.0005)
Complete Primary	0.0676* (0.0382)	0.0678* (0.0382)	0.0565 (0.0587)	0.0531 (0.0586)	(0.1300) (0.1360)	(0.1230) (0.1370)	(0.0208) (0.0781)	(0.0209) (0.0781)	0.129* (0.0735)	0.128* (0.0736)
Incomplete | Complete Secondary	0.233*** (0.0362)	0.230*** (0.0365)	0.257*** (0.0590)	0.258*** (0.0589)	0.1720 (0.1200)	0.1840 (0.1220)	0.0586 (0.0787)	0.0674 (0.0804)	0.245*** (0.0651)	0.232*** (0.0654)
Post-Secondary	0.700*** (0.0473)	0.697*** (0.0474)	0.697*** (0.1890)	0.701*** (0.1910)	0.893*** (0.2070)	0.891*** (0.2070)	0.346** (0.1430)	0.371*** (0.1420)	0.704*** (0.0707)	0.691*** (0.0707)
Urban	-0.0946*** (0.0215)	-0.0982*** (0.0217)	-0.157*** (0.0529)	-0.149*** (0.0522)	(0.1310) (0.0796)	(0.1220) (0.0790)	(0.0574) (0.0456)	(0.0398) (0.0478)	-0.0858** (0.0356)	-0.0931*** (0.0356)
South Kalimantan		(0.0255) (0.0257)		0.0449 (0.0465)		0.0508 (0.0705)		0.0883 (0.0591)		-0.0710* (0.0380)
Constant	6.434*** (0.4130)	6.447*** (0.4130)	7.176*** (0.7250)	7.108*** (0.7290)	10.02*** (1.3200)	10.07*** (1.3280)	6.894*** (0.9340)	6.858*** (0.9260)	5.925*** (0.6110)	5.955*** (0.6090)
Observations	4,992	4,992	1,313	1,313	430	430	540	540	2,516	2,516
R-squared	0.13	0.13	0.087	0.088	0.212	0.213	0.154	0.159	0.14	0.141

*Notes: Table reports results building on Black et al. (2005) methodology estimating the change in real hourly wages in non-coal sectors between 2012 and 2018 by regressing log wages in sector i on dummies for coal-intensive district, end year, and the interaction term. District is coal-intensive if coal employment share is at least 4%. The sample is restricted to males aged 25-45 to reduce bias due to changing composition of the workforce. Reference category is less than primary complete education. A negative coefficient value on the interaction variable 2018*coal-intensive district indicates slower wage growth in coal-intensive districts. Data from Indonesia's Sakernas 2012 and 2018. Standard errors are reported in parentheses where ***, ** and * indicate significance at 1, 5 and 10 percent respectively.*

Source: Author's estimates.

Annex 2 Table 6

OLS regressions estimating coal to non-coal employment elasticities

	Non-Coal employment		Agriculture		Manufacturing		Construction		Services	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Coal employment	0.408*** (0.0408)	0.387*** (0.0367)	0.545*** (0.106)	0.514*** (0.103)	0.591*** (0.0978)	0.565*** (0.0956)	0.363*** (0.0704)	0.355*** (0.0705)	0.414*** (0.0522)	0.399*** (0.0510)
Coal-intensive district	-0.726*** (0.0786)	-0.580*** (0.0737)	-0.686*** (0.203)	-0.469** (0.206)	-1.198*** (0.188)	-1.014*** (0.192)	-0.537*** (0.135)	-0.482*** (0.141)	-0.735*** (0.101)	-0.634*** (0.102)
lag total pop	2.63e-06*** (2.62e-07)	2.80e-06*** (2.36e-07)	-1.78e-06*** (6.77e-07)	-1.52e-06** (6.60e-07)	3.98e-06*** (6.27e-07)	4.19e-06*** (6.15e-07)	3.89e-06*** (4.51e-07)	3.95e-06*** (4.53e-07)	3.78e-06*** (3.35e-07)	3.89e-06*** (3.28e-07)
2008.year	0.0507 (0.116)	0.0641 (0.104)	0.173 (0.299)	0.193 (0.290)	-0.233 (0.277)	-0.216 (0.270)	0.108 (0.200)	0.113 (0.199)	-0.00566 (0.148)	0.00364 (0.144)
2009.year	-0.0758 (0.115)	-0.0547 (0.104)	0.156 (0.298)	0.187 (0.289)	-0.552** (0.276)	-0.525* (0.270)	-0.0505 (0.199)	-0.0425 (0.199)	-0.147 (0.148)	-0.132 (0.144)
2010.year	0.0525 (0.113)	0.0340 (0.101)	0.0572 (0.293)	0.0298 (0.284)	-0.136 (0.271)	-0.160 (0.264)	0.0588 (0.195)	0.0518 (0.195)	0.115 (0.145)	0.102 (0.141)
2011.year	0.0133 (0.111)	0.00775 (0.0996)	0.0607 (0.287)	0.0525 (0.278)	-0.444* (0.266)	-0.451* (0.259)	0.149 (0.191)	0.146 (0.191)	0.0652 (0.142)	0.0613 (0.138)
2012.year	-0.0176 (0.110)	-0.0210 (0.0989)	0.0210 (0.285)	0.0159 (0.276)	-0.331 (0.264)	-0.336 (0.257)	0.221 (0.190)	0.220 (0.190)	0.0377 (0.141)	0.0353 (0.137)
2014.year	0.0184 (0.109)	0.00494 (0.0981)	0.0670 (0.283)	0.0470 (0.274)	-0.273 (0.262)	-0.290 (0.255)	0.0913 (0.189)	0.0862 (0.188)	0.0900 (0.140)	0.0806 (0.136)
2015.year	0.132 (0.116)	0.0970 (0.105)	0.104 (0.301)	0.0516 (0.292)	-0.155 (0.279)	-0.199 (0.272)	0.376* (0.201)	0.363* (0.201)	0.270* (0.149)	0.246* (0.145)
2018.year	0.200* (0.119)	0.134 (0.107)	0.179 (0.307)	0.0818 (0.298)	0.325 (0.284)	0.243 (0.278)	0.164 (0.205)	0.139 (0.205)	0.359** (0.152)	0.314** (0.148)
East & North Kalimantan		-0.333*** (0.0493)		-0.494*** (0.138)		-0.419*** (0.128)		-0.126 (0.0947)		-0.231*** (0.0685)
Constant	7.945*** (0.280) 0.408***	8.198*** (0.253) 0.387***	6.495*** (0.723) 0.545***	6.870*** (0.708) 0.514***	3.580*** (0.670) 0.591***	3.898*** (0.660) 0.565***	4.845*** (0.482) 0.363***	4.941*** (0.487) 0.355***	6.743*** (0.358) 0.414***	6.919*** (0.352) 0.399***
Observations	194	194	194	194	194	194	194	194	194	194
R-squared	0.799	0.839	0.142	0.199	0.624	0.645	0.652	0.656	0.791	0.803

*Notes: Table reports regression results based on Black et al. (2015) methodology to estimate the correlation between log coal employment and log non-coal employment in coal provinces and whether the degree of coal-intensity matters. Province and year fixed effects. The coefficient on "coal employment" is the elasticity of the number of jobs in the non-coal sector to the number of jobs in the coal sector. The coefficient on "coal-intensive district" – a dummy variable equal to 1 for districts with a coal employment share of at least 4% – captures the difference in employment between coal-intensive districts and non-coal-intensive districts; a negative coefficient value indicates lower non-coal employment in coal-intensive districts. Sample restricted to districts in South Kalimantan and East and North Kalimantan and excludes districts that have zero or negligible coal employment (i.e., less than 0.5 percent). Data from Indonesia's Sakernas 2007-2018. Standard errors are reported in parentheses where ***, **, and * indicate significance at 1, 5, and 10 percent respectively.*

Source: Author's estimates.

ANNEX 3

Technical Results for South Africa

Methodology for estimating coal employment spill-overs in South Africa

Building on Black et al. (2005), we estimate the impact of coal sector jobs on non-coal employment within Mpumalanga province, and test the impact during periods of rapid coal sector expansion ("coal boom") and contraction ("coal bust") to detect any differential effects. We estimate the following equation:

$$Ln(Y_{s,t})=\beta_0 + \beta_1 Ln\,(X_t) + \beta_2 P + \beta_3 M_t + U_{t,i}$$

where $Y_{s,t}$ is the number of jobs in non-coal sector s at time t; X_t is the number of jobs in the coal sector at time t; P is a dummy variable representing the coal bust period between year 2015 and 2017 and M_t controls for other mining and quarrying activities at time t. $U_{t,i}$ is the error term. Therefore, β_1 is the elasticity of the number of jobs in the non-coal sector to the number of jobs in the coal sector, and β_2 captures the difference in employment in the non-coal sector between the boom period and the bust period. We run our equation for non-coal sectors aggregated together, and subsequently for each non-coal sector separately. For robustness, we test by excluding other mining and quarrying activity control and find similar results. We follow Black et al. (2005) and Moritz et al. (2017) by restricting our sample to districts within coal provinces because they share similar institutional and geographic characteristics, which reduces confounding factors. The sample includes only coal provinces South Kalimantan and East and North Kalimantan, and within these, excludes districts that have zero or negligible coal employment (i.e., less than 0.5 percent). For robustness, we test on a wider sample of coal provinces (namely by adding South Sumatera and Banten) and find similar results.

Annex 3 Table 1

Probit regressions on labor market outcomes (likelihood of being employed)

	Employed/Unemployed	
	2019 (1)	2008 (2)
Age	0.0934*** (0.00643)	0.0992*** (0.00613)
Age square	-0.000775*** (8.20e-05)	-0.000890*** (8.10e-05)
Married	0.332*** (0.0252)	0.312*** (0.0247)
Urban	0.0879*** (0.0271)	0.0344 (0.0254)
Female	-0.136*** (0.0209)	-0.229*** (0.0215)
Colored/mixed race	0.158*** (0.0533)	0.150*** (0.0496)
Asian	0.462*** (0.107)	0.361*** (0.0942)
White	0.673*** (0.0882)	0.823*** (0.0808)
Female* Colored/mixed race	0.0966 (0.0697)	0.249*** (0.0597)
Female * Asia	-0.222 (0.168)	0.102 (0.137)
Female * White	0.0114 (0.123)	0.136 (0.108)
Primary complete	-0.0143 (0.0617)	-0.0732 (0.0487)
Secondary incomplete	-0.131*** (0.0396)	-0.0288 (0.0314)
Secondary complete	0.124*** (0.0406)	0.0369 (0.0346)
Post-secondary	0.674*** (0.0626)	0.778*** (0.0808)
Constant	-2.003*** (0.126)	-1.563*** (0.113)
Observations	24,710	31,598

*Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.*

*Notes: Table reports results for probit regressions estimating the probabilistic correlation of individual characteristics with labor market outcomes (labor market outcome is a binary variable were 1 is being employed and 0 is being unemployed) using data from South Africa QLF 3rd quarter, 2019 and 2008 dataset. Reference categories are less than primary complete education, male, and Black South African. The results include province controls. Standard errors are reported in parentheses where ***, **, and * indicate significance at 1, 5, and 10 percent respectively.*

Source: Authors' estimates.

Annex 3 Table 2

OLS regressions on the correlates of real hourly wages (All provinces, 2019)

VARIABLES	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS
Age	0.0459*** (0.00612)	0.0432*** (0.00608)	0.0493*** (0.00595)	0.0436*** (0.00582)	0.0331*** (0.00610)
Age square	-0.000388*** (7.45e-05)	-0.000357*** (7.40e-05)	-0.000415*** (7.26e-05)	-0.000361*** (7.10e-05)	-0.000259*** (7.46e-05)
Female	-0.182*** (0.0204)	-0.168*** (0.0201)	-0.178*** (0.0200)	-0.176*** (0.0196)	-0.180*** (0.0186)
Urban	0.284*** (0.0216)	0.216*** (0.0237)	0.234*** (0.0233)	0.247*** (0.0228)	0.204*** (0.0219)
Colored /Mix	0.142*** (0.0304)	0.152*** (0.0361)	0.117*** (0.0346)	0.0885** (0.0343)	0.148*** (0.0356)
Asian	0.226** (0.108)	0.252** (0.107)	0.139 (0.0967)	0.114 (0.0923)	0.277*** (0.102)
White	0.783*** (0.0593)	0.762*** (0.0578)	0.535*** (0.0577)	0.525*** (0.0570)	0.864*** (0.0586)
Primary complete	0.0401 (0.0448)	0.0339 (0.0441)	0.0411 (0.0446)	0.0371 (0.0447)	0.0315 (0.0438)
Secondary incomplete	0.192*** (0.0306)	0.176*** (0.0303)	0.190*** (0.0307)	0.143*** (0.0305)	0.154*** (0.0296)
Secondary complete	0.515*** (0.0350)	0.487*** (0.0348)	0.464*** (0.0354)	0.357*** (0.0349)	0.407*** (0.0336)
Post-secondary	1.488*** (0.0478)	1.446*** (0.0475)	1.124*** (0.0500)	1.008*** (0.0494)	1.298*** (0.0459)
Other education	0.275** (0.137)	0.206 (0.138)	0.114 (0.132)	0.0938 (0.137)	0.251* (0.145)
Formal sector worker				0.338*** (0.0225)	
Union member					0.633*** (0.0249)
Coal	1.008*** (0.133)	0.993*** (0.134)			
Other Mining & quarrying	0.889*** (0.0617)	0.882*** (0.0616)			
Manufacturing	0.177*** (0.0415)	0.181*** (0.0411)			
Electricity, gas & water	0.540*** (0.0904)	0.564*** (0.0915)			
Construction	0.0793* (0.0428)	0.108** (0.0429)			

Annex 3 Table 2 — OLS regressions on the correlates of real hourly wages (All province, 2019) **(continued)**

VARIABLES	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS
Trade, catering & accommodation	-0.0424 (0.0366)	-0.0289 (0.0357)			
Transport, storage & communication	0.0172 (0.0523)	0.0254 (0.0518)			
Finance and business services	0.174*** (0.0398)	0.170*** (0.0393)			
General government services	0.734*** (0.0625)	0.756*** (0.0622)			
Personal Service	0.0509 (0.0373)	0.0752** (0.0370)			
Other Services	-0.00847 (0.0377)	0.000315 (0.0370)			
Technicians			-0.329*** (0.0641)	-0.336*** (0.0633)	
Clerks			-0.556*** (0.0636)	-0.564*** (0.0629)	
Service & sales			-0.956*** (0.0586)	-0.896*** (0.0582)	
Skilled agricultural			-0.955*** (0.0634)	-0.876*** (0.0630)	
Production, Craft workers, laborers			-0.740*** (0.0609)	-0.710*** (0.0603)	
Machine operators			-0.715*** (0.0638)	-0.678*** (0.0622)	
Constant	1.175*** (0.126)	1.326*** (0.128)	2.132*** (0.140)	2.047*** (0.137)	1.550*** (0.126)
Observations	7,288	7,288	7,288	7,288	7,213
R-squared	0.434	0.446	0.453	0.474	0.474

*Notes: Table reports results for Ordinary Least Squares regressions estimating the correlation of individual characteristics with log real hourly labor earnings of wage employees using data from South Africa QLFS 3rd quarter 2019 dataset. Reference categories are male workers, urban location, less than primary completed education, agriculture sector, and professional or technical occupations. Standard errors are reported in parentheses where ***, **, and * indicate significance at 1, 5, and 10 percent respectively. Columns 2, 3, 4 and 5 include province controls.*

Source: Authors' estimates

Annex 3 Table 3

OLS regressions on the correlates between coal employment and non-coal employment (Mpumalanga only, 2019)

VARIABLES	Non-Mining (1) OLS	Agriculture (2) OLS	Manufacturing (3) OLS	Electricity (4) OLS	Construction (5) OLS	Services (6) OLS
Coal employment	0.274*** (0.0699)	0.0929 (0.105)	0.235** (0.114)	0.481 (0.322)	0.221 (0.145)	0.302*** (0.0662)
2015-2017	0.0683*** (0.0151)	0.0513** (0.0226)	0.0536** (0.0246)	0.183** (0.0695)	0.109*** (0.0313)	0.0629*** (0.0143)
Other mining and quarrying	-0.0175 (0.0248)	0.0317 (0.0371)	-0.0223 (0.0404)	-0.108 (0.114)	0.00511 (0.0515)	-0.0241 (0.0235)
Constant	10.99*** (0.818)	10.06*** (1.225)	9.072*** (1.333)	5.802 (3.769)	8.942*** (1.699)	10.39*** (0.775)
Observations	48	48	48	48	48	48
R-squared	0.488	0.112	0.202	0.276	0.292	0.514

*Notes: Table reports regression results building on Black et al. (2005) to estimate the correlation between log coal employment and log non-coal employment in Mpumalanga and the direct impacts of the coal bust period. The coefficient on "coal employment" is the elasticity of the number of jobs in the non-coal sector to the number of jobs in the coal sector. The coefficient on "coal bust period" – a dummy variable equal to 1 during the period when coal employment declined between 2015 and 2017 – captures the difference in employment between bust and boom periods; a positive coefficient value indicates higher non-coal employment in the bust period. Sample restricted to Mpumalanga province. Data from South Africa QLFS 2008-2019. Standard errors are reported in parentheses where ***, **, and * indicate significance at 1, 5, and 10 percent respectively.*

Source: Authors' estimates

ANNEX 4

Technical Results for India

Annex 4 Table 1

OLS regressions on the correlates of real weekly wages (all states, 2017)

VARIABLES	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS
Age	0.0416*** (0.00227)	0.0388*** (0.00215)	0.0379*** (0.00212)	0.0352*** (0.00250)	0.0393*** (0.00264)
Age square	-0.000406*** (2.95e-05)	-0.000370*** (2.81e-05)	-0.000368*** (2.77e-05)	-0.000320*** (3.31e-05)	-0.000360*** (3.49e-05)
Female	-0.452*** (0.0108)	-0.459*** (0.0107)	-0.503*** (0.0103)	-0.507*** (0.0122)	-0.449*** (0.0129)
Urban	0.214*** (0.00899)	0.202*** (0.00876)	0.230*** (0.00790)	0.182*** (0.00822)	0.212*** (0.00887)
Formal				0.420*** (0.0124)	0.375*** (0.0128)
Primary education	0.0700*** (0.0136)	0.0931*** (0.0130)	0.0887*** (0.0126)	0.105*** (0.0146)	0.107*** (0.0160)
Secondary incomplete	0.200*** (0.0110)	0.198*** (0.0105)	0.183*** (0.0102)	0.184*** (0.0118)	0.244*** (0.0127)
Secondary complete	0.436*** (0.0153)	0.424*** (0.0148)	0.350*** (0.0148)	0.336*** (0.0156)	0.470*** (0.0164)
Post-secondary	0.951*** (0.0152)	0.944*** (0.0149)	0.716*** (0.0165)	0.650*** (0.0168)	0.922*** (0.0157)
Others Unspecified	0.138* (0.0783)	0.0945 (0.0673)	0.122* (0.0717)	0.177*** (0.0502)	0.196*** (0.0670)
Coal	1.249*** (0.0893)	1.356*** (0.0991)			0.999*** (0.0839)
Other mining and Quarrying	0.414*** (0.0379)	0.391*** (0.0382)			0.356*** (0.0523)
Manufacturing	0.364*** (0.0142)	0.349*** (0.0136)			0.301*** (0.0354)
Public Utilities	0.622*** (0.0354)	0.604*** (0.0337)			0.419*** (0.0479)
Construction	0.207*** (0.0123)	0.208*** (0.0117)			0.220*** (0.0349)
Wholesale & Retailing	0.222*** (0.0176)	0.197*** (0.0165)			0.178*** (0.0361)
Transport & Communications	0.534*** (0.0178)	0.510*** (0.0171)			0.457*** (0.0365)
Financial & Business Services	0.517*** (0.0208)	0.486*** (0.0206)			0.401*** (0.0380)
Public Administration	0.816*** (0.0232)	0.783*** (0.0227)			0.569*** (0.0401)
Others, unspecified	0.372*** (0.0162)	0.352*** (0.0159)			0.236*** (0.0362)
Professionals			-0.0482* (0.0282)	-0.135*** (0.0251)	
Technicians			-0.176*** (0.0294)	-0.298*** (0.0265)	

Annex 4 Table 1 — OLS regressions on the correlates of real weekly wages (all states, 2017) **(continued)**

VARIABLES	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS
Clerks			-0.179*** (0.0285)	-0.308*** (0.0265)	
Service & market sales workers			-0.498*** (0.0276)	-0.538*** (0.0249)	
Skilled agricultural			-0.720*** (0.0358)	-0.500*** (0.0566)	
Craft workers			-0.517*** (0.0276)	-0.506*** (0.0248)	
Machine operators			-0.350*** (0.0280)	-0.383*** (0.0254)	
Elementary occupations			-0.693*** (0.0278)	-0.612*** (0.0250)	
Constant	6.037*** (0.0433)	5.940*** (0.0480)	6.903*** (0.0543)	6.871*** (0.0588)	5.601*** (0.0607)
Observations	69,794	69,794	69,795	55,218	55,218
R-squared	0.474	0.509	0.507	0.519	0.471

*Notes: Table reports results for Mincer-type ordinary least squares regressions estimating the correlation of individual characteristics with log real weekly labor earnings of wage employees using data from India PLFS 2017-18 dataset. Reference categories are male workers, rural location, less than primary completed education, agriculture sector, and senior officials, Standard errors are reported in parentheses where ***, **, and * indicate significance at 1, 5, and 10 percent respectively. Column 2, 3 4, 5 includes state controls.*

Source: Authors' estimates

Annex 4 Table 2

OLS regressions on the correlates of real weekly wages (coal states, 2017)

VARIABLES	(1)	(2)	(3)	(4)	(5)
Age	0.0454*** (0.00411)	0.0430*** (0.00397)	0.0424*** (0.00391)	0.0378*** (0.00487)	0.0427*** (0.00501)
Age square	-0.000471*** (5.32e-05)	-0.000436*** (5.11e-05)	-0.000436*** (5.07e-05)	-0.000358*** (6.44e-05)	-0.000412*** (6.60e-05)
Female	-0.384*** (0.0185)	-0.426*** (0.0181)	-0.460*** (0.0173)	-0.524*** (0.0223)	-0.445*** (0.0249)
Urban	0.236*** (0.0168)	0.202*** (0.0160)	0.224*** (0.0141)	0.185*** (0.0153)	0.221*** (0.0171)
Formal				0.553*** (0.0207)	0.480*** (0.0223)
Primary education	0.0662*** (0.0230)	0.122*** (0.0222)	0.115*** (0.0211)	0.111*** (0.0273)	0.0726** (0.0299)
Secondary incomplete	0.197*** (0.0197)	0.218*** (0.0188)	0.181*** (0.0183)	0.185*** (0.0220)	0.216*** (0.0235)
Secondary complete	0.451*** (0.0279)	0.470*** (0.0267)	0.382*** (0.0262)	0.325*** (0.0294)	0.431*** (0.0307)
Post-secondary	1.038*** (0.0262)	1.028*** (0.0254)	0.767*** (0.0285)	0.653*** (0.0318)	0.918*** (0.0291)
Others Unspecified	-0.118 (0.170)	-0.0690 (0.166)	-0.110 (0.181)	0.0488 (0.0912)	0.00788 (0.0900)
Coal	1.402*** (0.0655)	1.452*** (0.0686)			1.186*** (0.0843)
Other mining and Quarrying	0.306*** (0.0693)	0.334*** (0.0735)			0.292*** (0.0882)
Manufacturing	0.198*** (0.0259)	0.233*** (0.0252)			0.240*** (0.0621)
Public Utilities	0.428*** (0.0657)	0.454*** (0.0645)			0.263*** (0.0859)
Construction	0.107*** (0.0205)	0.136*** (0.0198)			0.232*** (0.0601)
Wholesale & Retailing	0.0977*** (0.0282)	0.108*** (0.0262)			0.167*** (0.0630)
Transport & Communications	0.474*** (0.0328)	0.458*** (0.0315)			0.479*** (0.0635)
Financial & Business Services	0.344*** (0.0415)	0.368*** (0.0411)			0.272*** (0.0688)
Public Administration	0.637*** (0.0443)	0.670*** (0.0432)			0.421*** (0.0719)

Annex 4 Table 2 — OLS regressions on the correlates of real weekly wages (coal states, 2017) **(continued)**

VARIABLES	(1)	(2)	(3)	(4)	(5)
Others, unspecified	0.186*** (0.0271)	0.225*** (0.0259)			0.153** (0.0627)
Professionals			-0.0548 (0.0573)	-0.0198 (0.0580)	
Technicians			-0.215*** (0.0544)	-0.218*** (0.0575)	
Clerks			-0.143** (0.0569)	-0.185*** (0.0592)	
Services & market sales workers			-0.529*** (0.0530)	-0.391*** (0.0574)	
Skilled agricultural			-0.727*** (0.0634)	-0.343*** (0.102)	
Craft workers			-0.487*** (0.0525)	-0.293*** (0.0570)	
Machine operators			-0.291*** (0.0537)	-0.155*** (0.0581)	
Elementary occupations			-0.680*** (0.0521)	-0.443*** (0.0575)	
Constant	5.943*** (0.0787)	5.933*** (0.0809)	6.813*** (0.0934)	6.656*** (0.112)	
Observations	18,649	18,649	18,649	13,447	13,447
R-squared	0.459	0.496	0.495	0.554	0.513

*Notes: Table reports results for Mincer-type ordinary least squares regressions estimating the correlation of individual characteristics with log real weekly labor earnings of wage employees using data from India PLFS 2017-18 dataset. Reference categories are male workers, Rural location, less than primary completed education, agriculture sector, and senior officials, Standard errors are reported in parentheses where ***, **, and * indicate significance at 1, 5, and 10 percent respectively. Column 2, 3 4, 5 includes coal state controls.*

Source: Authors' estimates

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