

Rapid coal transition & labour markets

Downscaling pathways in China and India

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Coal under Paris compliant pathways

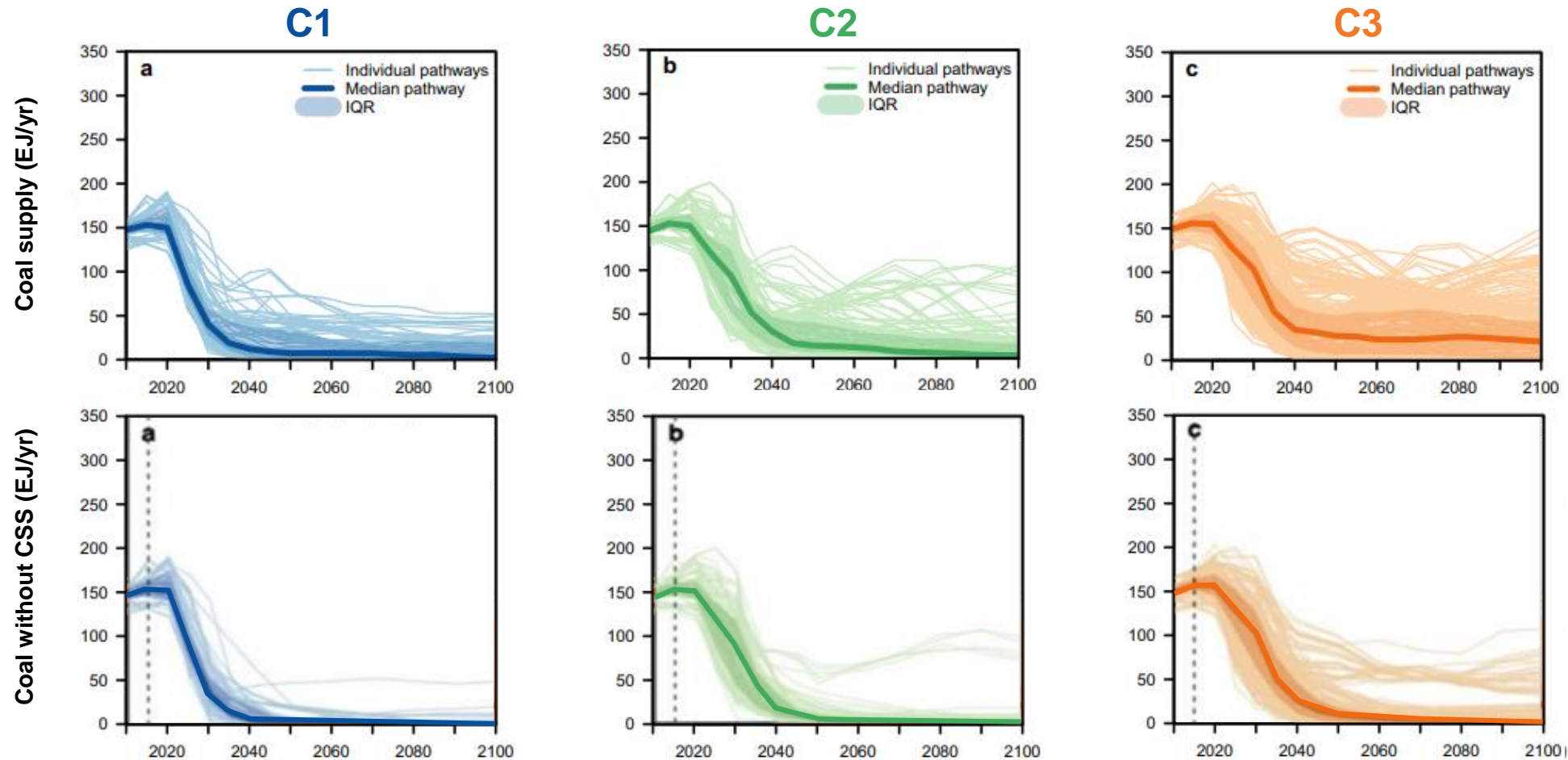


Figure 1: Coal pathways consistent with different climate mitigation objectives (from Achakulwisut et al, 2023)

Historical transitions

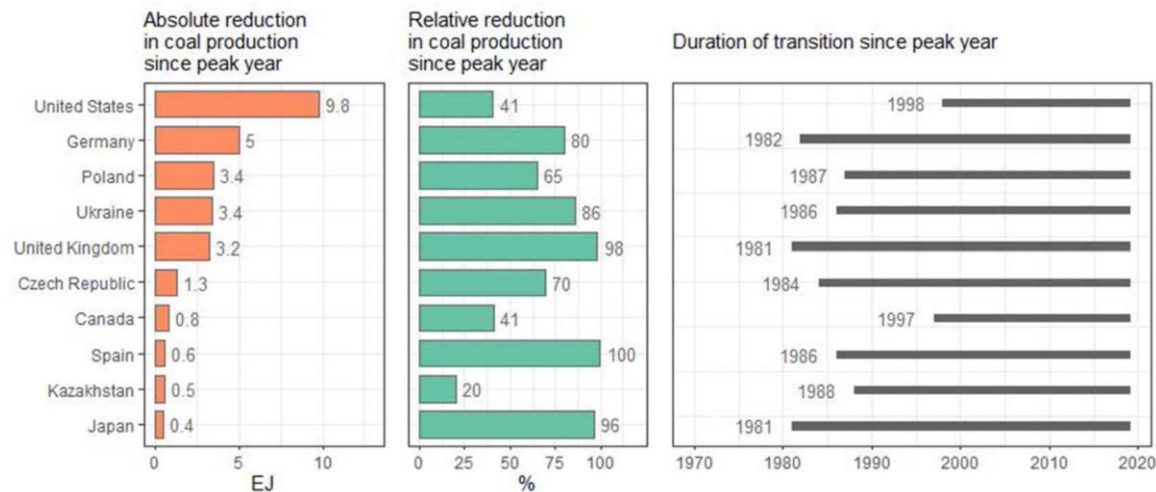


Figure 3: Coal transition indicators in the ten countries that have seen the largest absolute decline in coal production. (from Diluiso et al, 2021)

- Multiple example of coal production and consumption phase-outs
- Local economic reliance hinders transition (Diluiso et al, 2021)
- Inconsistent with the speed required for 1.5°C (Vinichenko et al, 2021)
- Localised regional impacts (Caldecott et al, 2017)
- Generate unemployment (Caldecott et al, 2017)
- Affect workers' and regions' identity (Oei et al, 2020)

Review of the literature

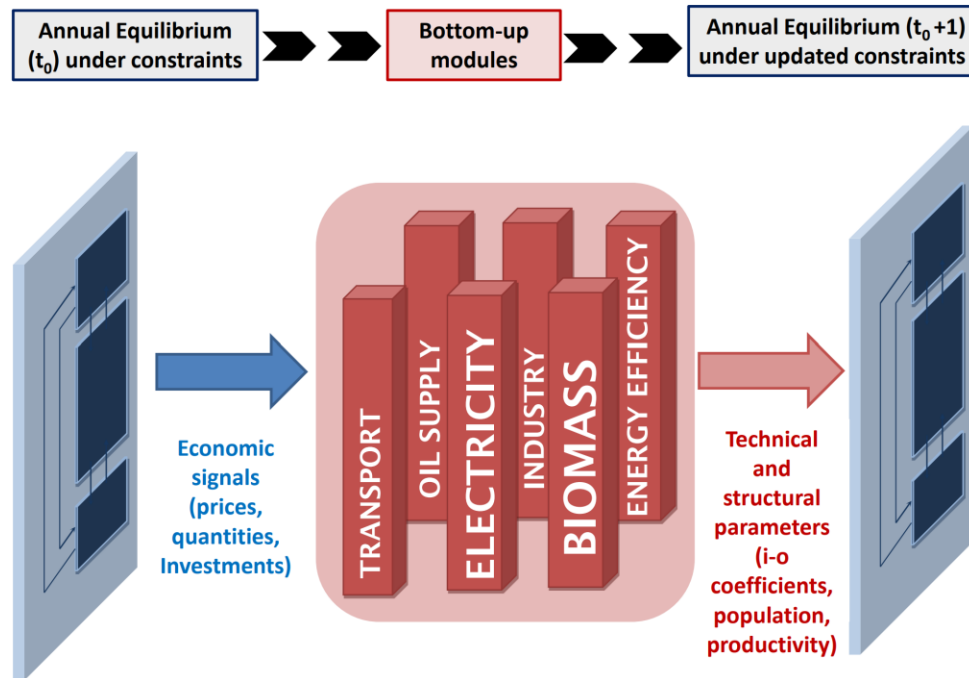
Study	Region	Scenarios	Model	Method	Labour market friction
Barker et al. (2016)	Global	Baseline, 6 climate scenarios with policies such as removing fossil fuel subsidies or methane emissions, and investment in energy-efficiency	E3MG	Econometric based IAM where employment is a production factor	Possibility of involuntary unemployment
Pollit et al. (2015)	European Union	Baseline and 2 scenarios to reduce European 2030 emissions by 40-45% compared to 1990. One of which focuses on high energy-efficiency.	E3ME and PRIMES	Macro-econometric model coupled to energy model	Possibility of involuntary unemployment
Garrett-Peltier (2017)	US	Shifting \$1 million investment in fossil fuels to 1) energy efficiency or 2) renewable energy		IO table and synthetic industries	None
Chateau et al (2018)	World	Central and mixed policy scenarios		Static CGE model Each occupational category is equally substituable to other and other production factors	- Imobility across 5 labour categories - Labour mobility across sectors is costly
Perrier and Quirion (2018)	France	Shifting €1 billion to 1) Solar or 2) Weatherization		Comparison between IO and CGE models	CGE model differentiates between high and low skill labour
Jacobson et al (2019)	World	100% wind, water solar energy by 2050	Jobs and Economic Development Impact (JEDI) models	Employment factors throughout the value chain of different energy technologies	None
Baran et al (2020)	Poland		- mathematical model - MEMO CGE		- Wage difference between coal and other sectors
Hartono et al (2020)	Indonesia	1 GW investment in hydro, geothermal, solar, wind or coal power		General equilibrium model	None
Ram et al (2020)	World	Best Policy Scenario (99.6% renewable in 2050)	LUT energy system transition modelling	Employment factors throughout the value chain of different energy technologies	None
Pai et al (2021)	World	Reference and well below 2°C	WITCH	Dataset of workers throughout value chain Coupling IAM analysis and employment factors	No
Clark and Zhang (2022)	China	"No transition", "Baseline", "Low-cost renewables", "50% lower emissions than 2015" and "80% lower emissions"		Bottom-up representation of individual mines and powerplants	None
Koasidis et al (2022)	Europe	Baseline and 800 Covid recovery subsidies scenarios	GCAM	GCAM results are coupled with employment results Scenarios are compared with multi-objective optimisation algorithm	None
Sun et al (2022)	China	- Fast transition (2055 fossil phaseout) - Slow transition (2060 coal phaseout)	- IO model	Employment factors for different energies No increase of labour productivity	None
Zhang et al (2022)	China	Reference (new coal fired power generation), orderly net-zero 2050 (linear decrease of emissions), Disorderly net-zero 2050 (new coal capacity in 2030 but same budget as orderly scenario)	SWITCH-China JIMC bottom-up accounting models	Employment factors throughout the value chain of different energy technologies Installed capacities from power system model	5 occupational skill levels (expost)
Mayfield et al (2023)	US	high electrification with or without renewable deployment constraints or with 100% renewables Moderate electrification without renewables deployment constraints	Decarbonization Employment and Energy Systems	Exogeneous technological trajectories Job factors and labour productivity increase	Spatial downscaling Wages, experience and occupational profile (expost)

Table 1: A review of recent studies modelling the effect of the energy transition on employment

Research questions

- What are the labour impacts that we can anticipate from global coal trajectories?
- Do these impact affect the most vulnerable regions?
- Which factors affect the re-employability of laid-off workers?

The IMACLIM-R model



Model strength

Hybrid architecture

Coal sector representation

Unemployment representation

Necessary improvements

Coal investments driver

Spatial disaggregation

Labour employability representation

Figure 4: IMACLIM-R modular architecture (from Bibas et al, 2015)

The coal labour nexus

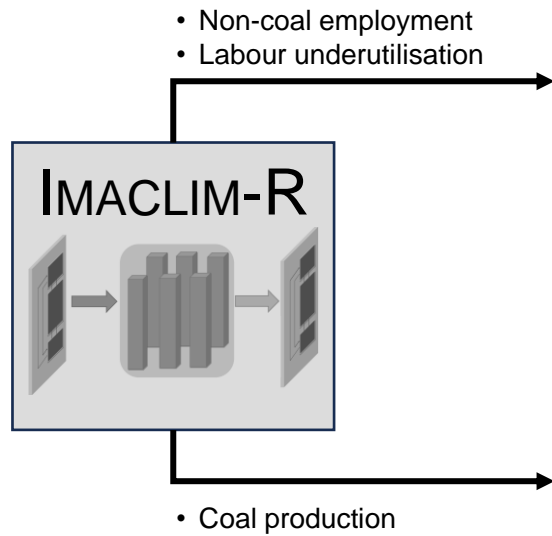


Figure 5: Modelling approach of the coal labour nexus

The coal labour nexus

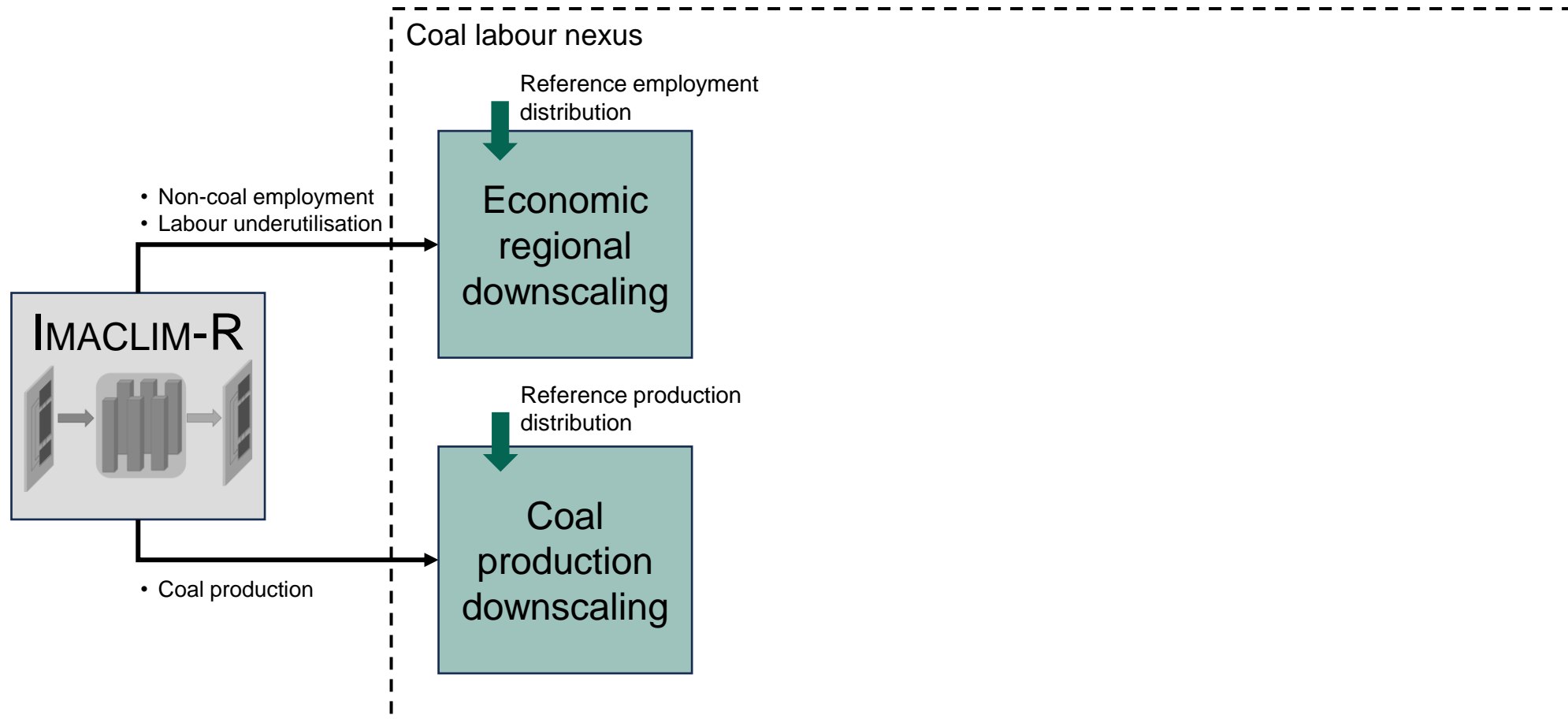


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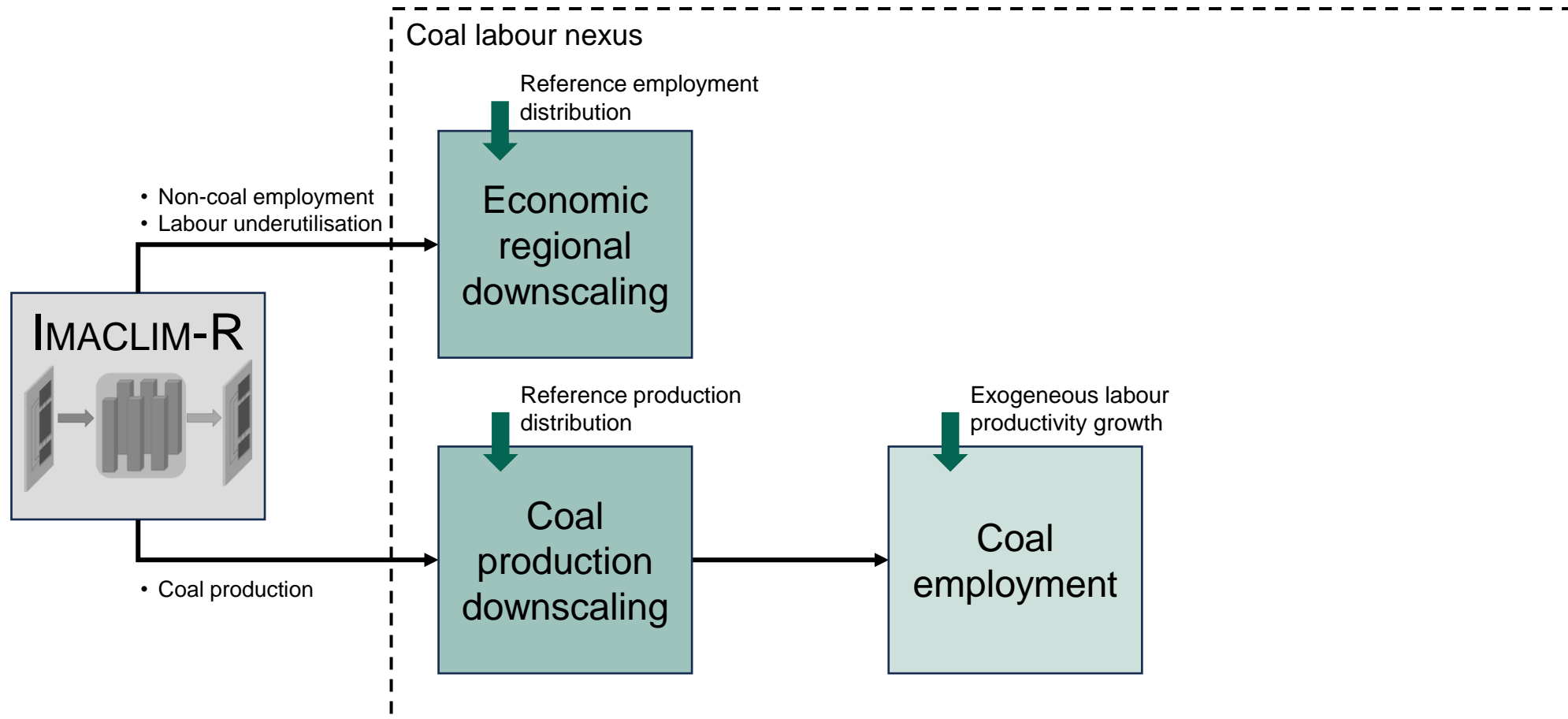


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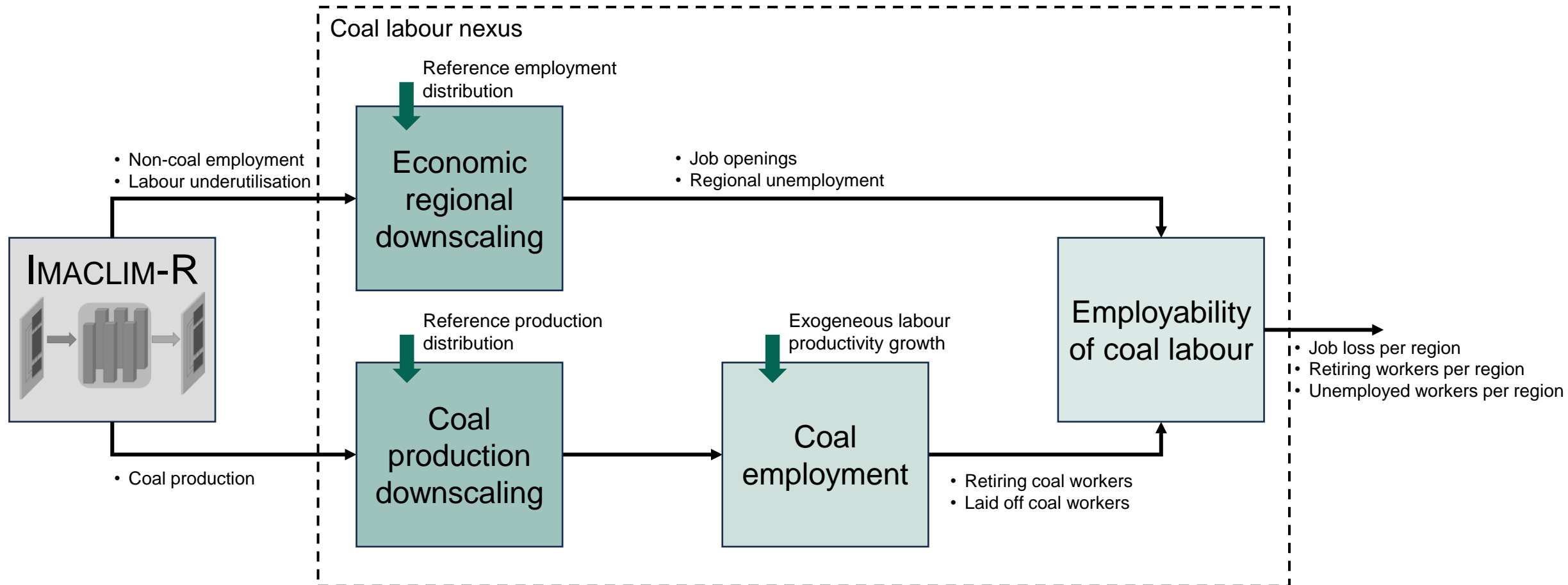


Figure 5: Modelling approach of the coal labour nexus

Assessing employability of coal labour

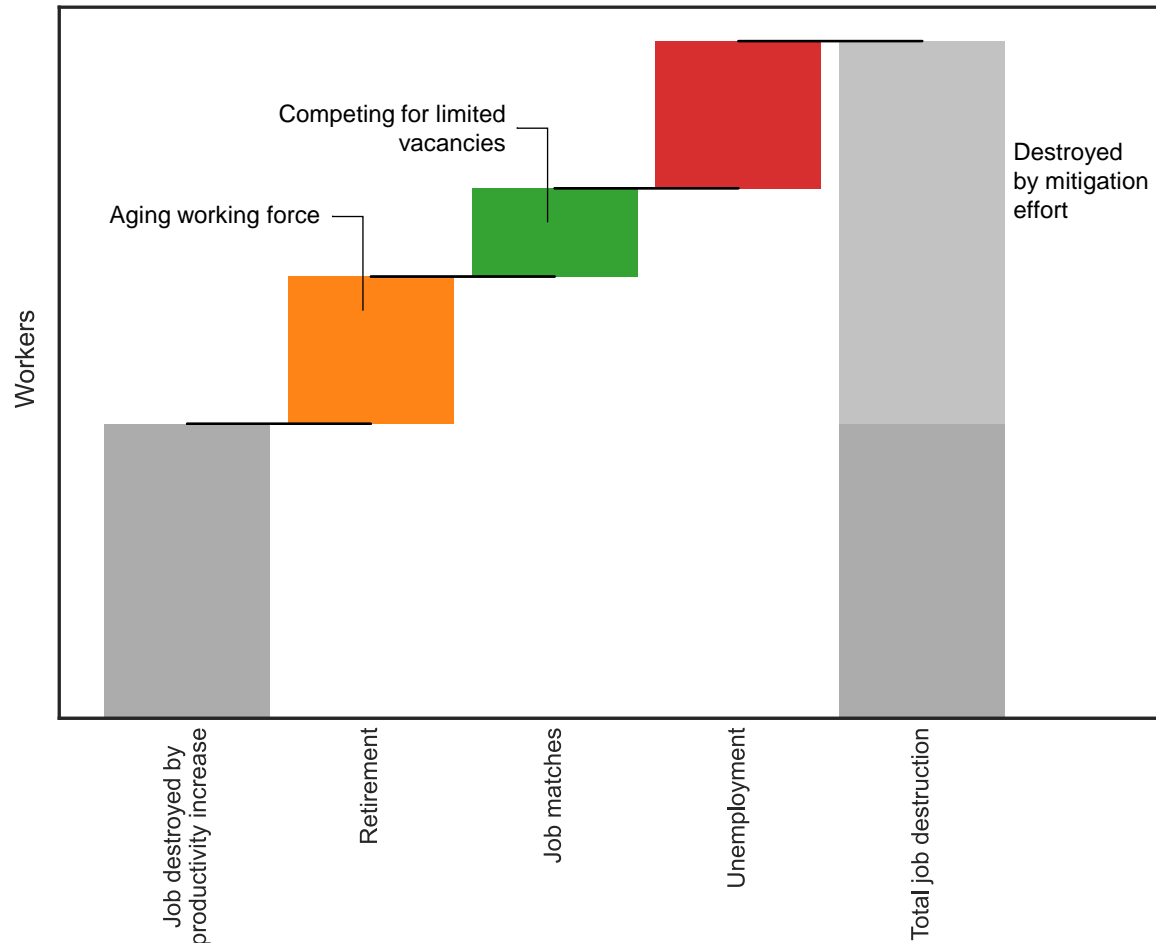


Figure 6: Schematic of coal worker destination and employability

Matches M in region m :

$$M_m = (V_m + L_m^{60}) \cdot \frac{S_m}{S_m + z_m L_m + L_m^{18}} \quad (1)$$

Where:

- S is the number of job seeking ex-coal workers
- $z_m L_m$ the share of the labour force without jobs
- V the number of vacancies
- L^{18} and L^{60} the labour force participants aged 18 and 60 respectively

Scenarios

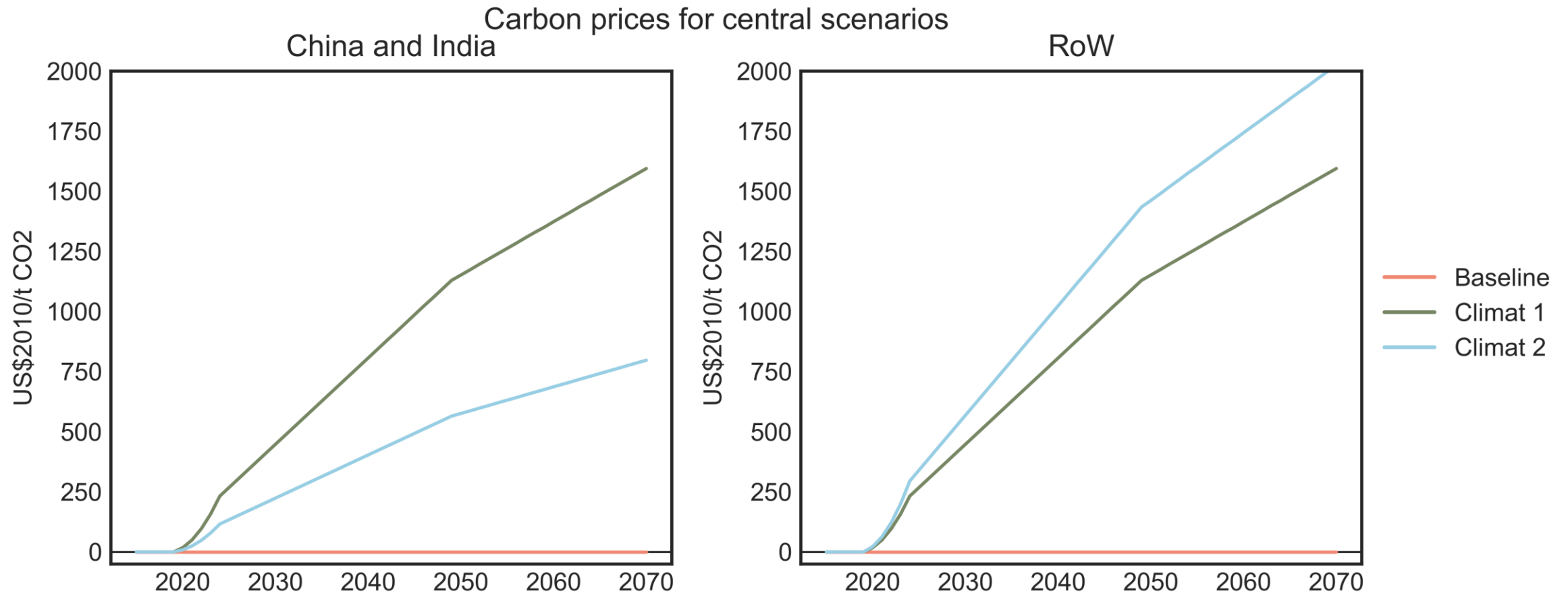


Figure 7: Carbon price in the central scenarios. All scenarios are based on SSP2 and are differentiated on the basis of carbon prices

Coal pathways

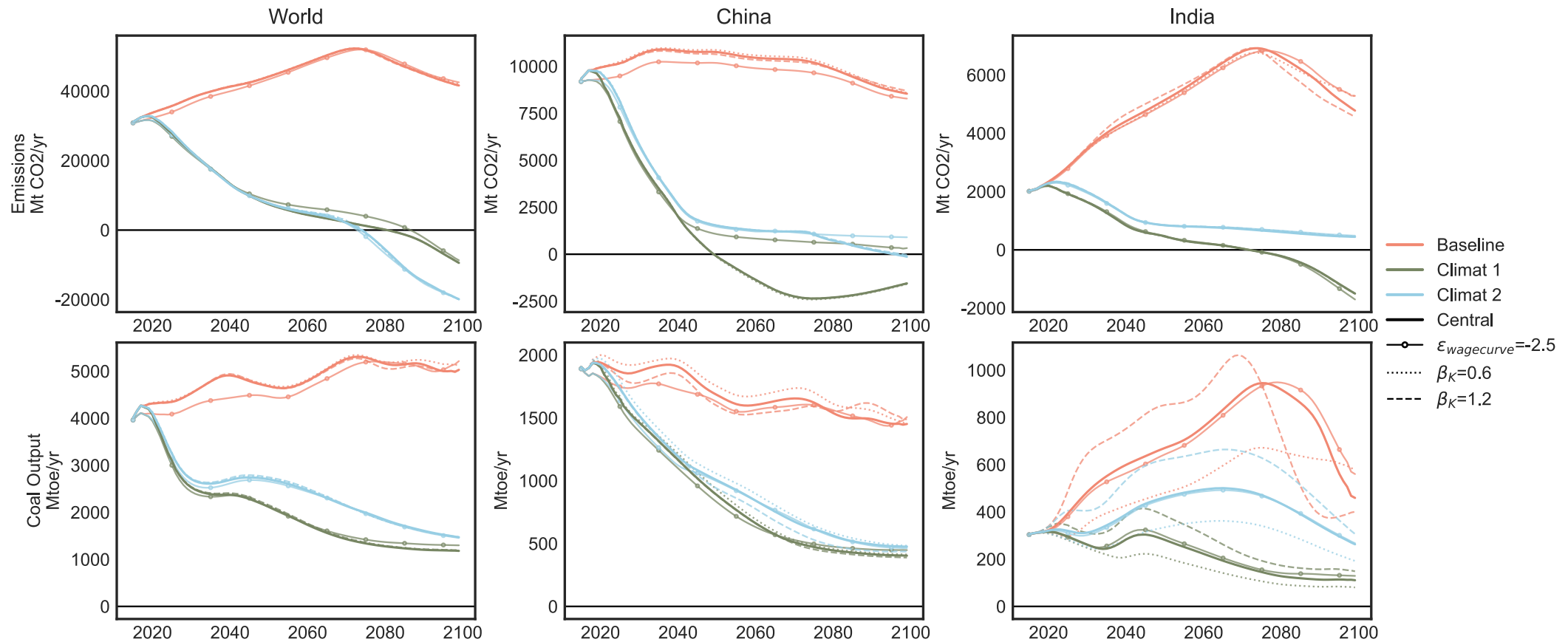


Figure 8: Main indicators for analysed scenarios.

Coal employment pathway

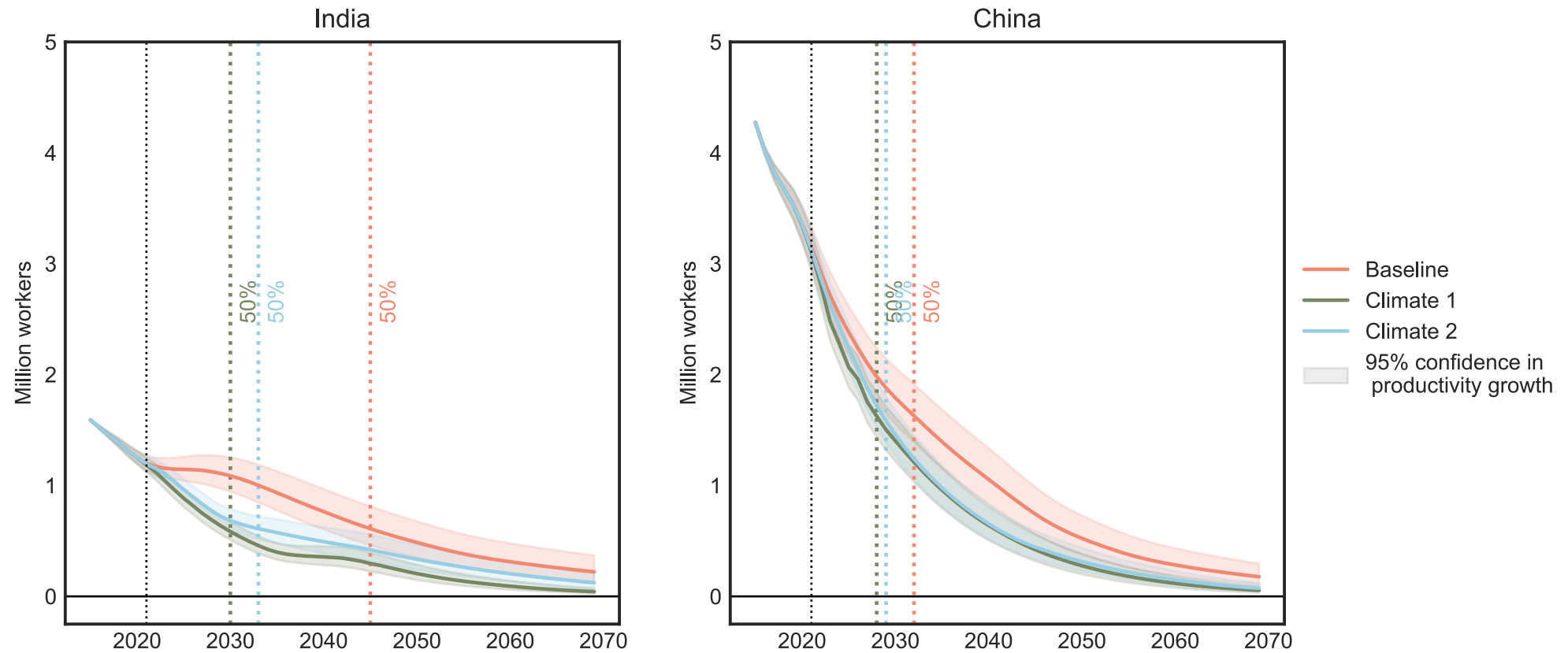
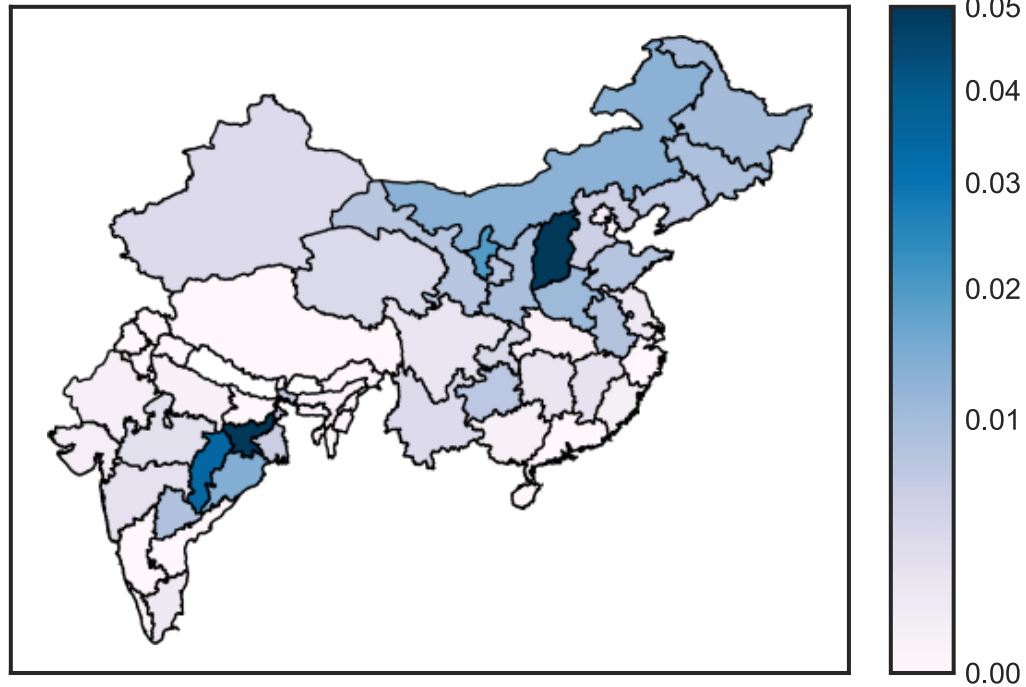


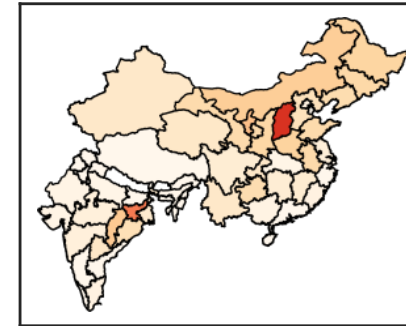
Figure 9: Coal employment for the analysed scenarios. Central estimates assume a constant 5.8% annual increase of the labour productivity of the coal sector. This corresponds to the 2004-2021 trend in China.

Regional exposition

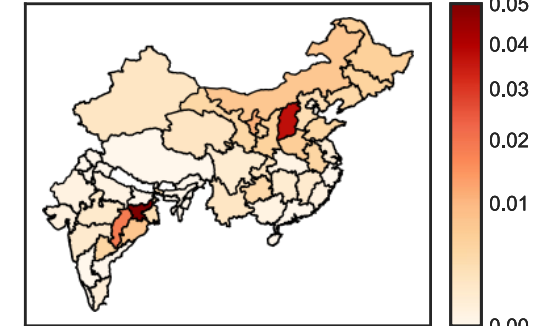
a) 2015 work force



b) Base - 2020-2035 coal job decrease



c) Climat 1 - 2020-2035 coal job decrease



d) Climat 2 - 2020-2035 coal job decrease

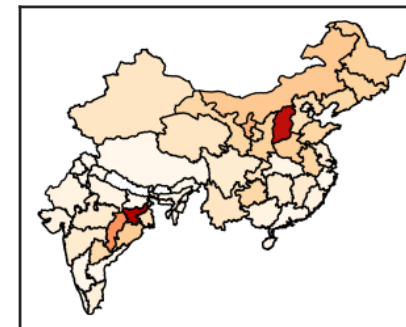


Figure 10: Number of coal workers exposed to the coal transition as a share of 2015 regional labour force. Note the nonlinearity in the colour scale.

Regional vulnerability

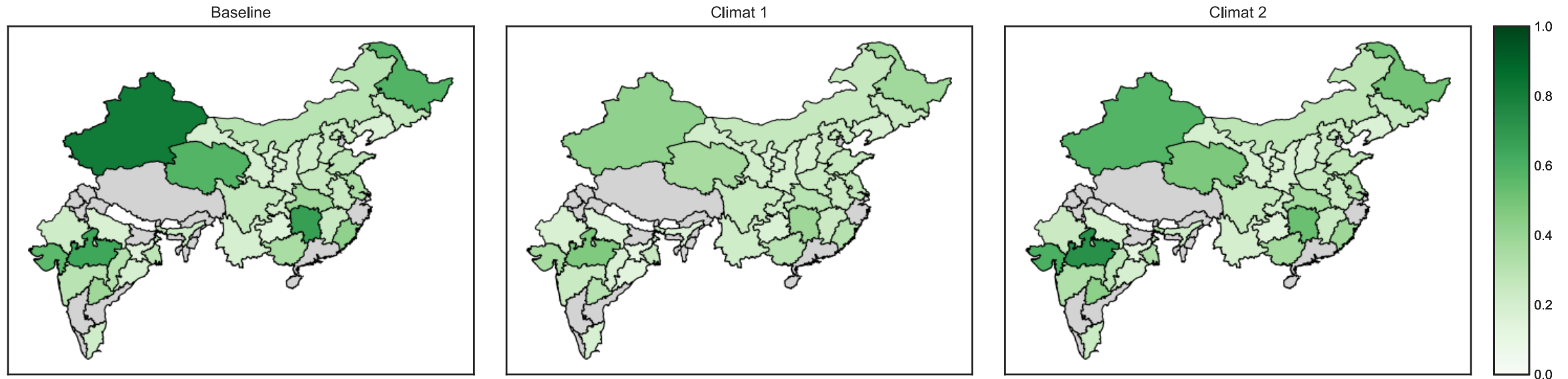


Figure 11: Share of laid-off workers that can find new employment. The number of available job openings depends on the macroeconomic and demographic context under the present scenario. Competition from other unemployed people and labour market entrants additionally depends on initial unemployment level.

Mobility of laid-off coal workers

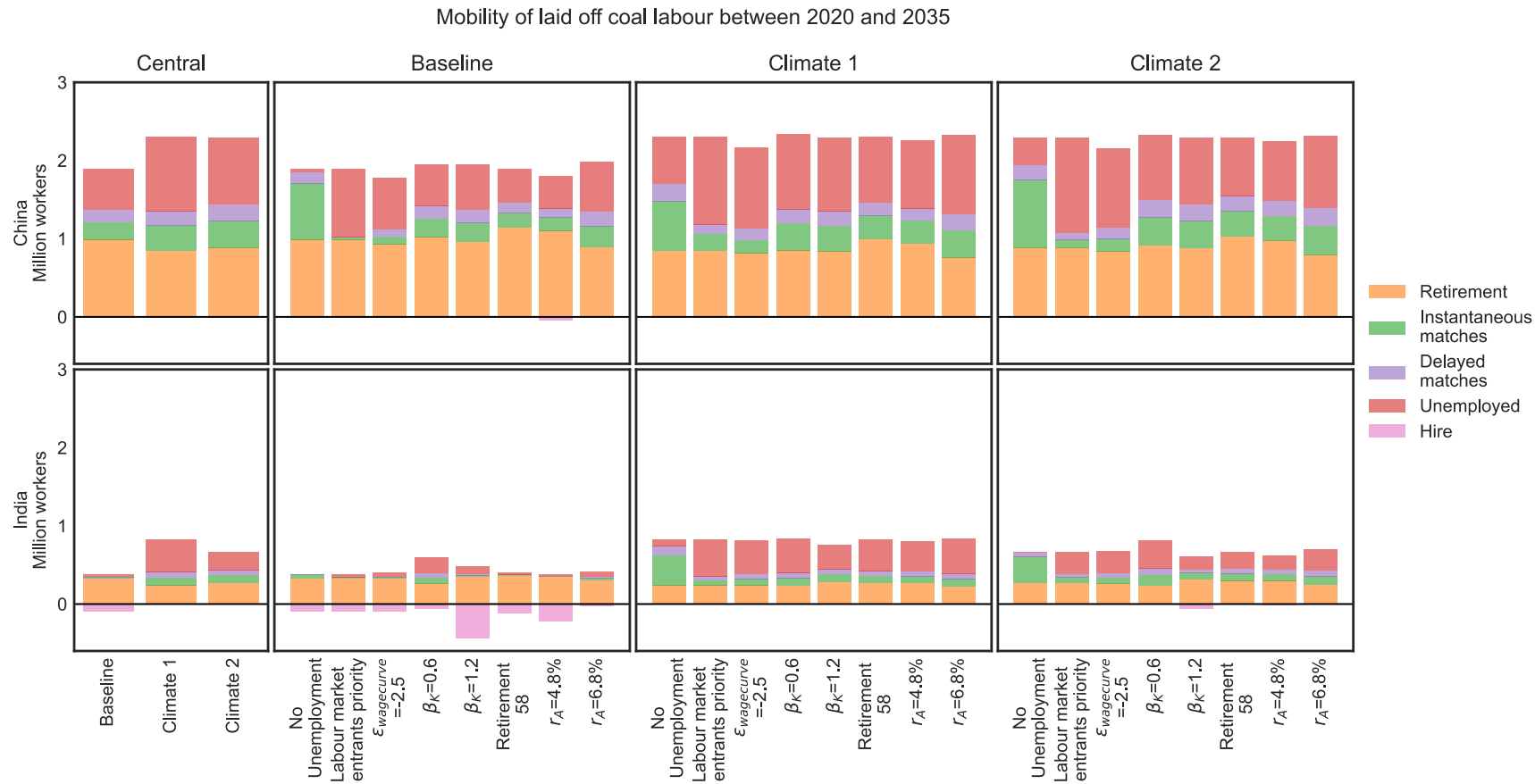


Figure 13: Mobility of laid-off workers between 2020 and 2035. Central scenarios refer to those depending on default parameters. Other scenarios are sensitivity analysis. Indirect matches refer to those happening within a year of the worker losing their job.

Conclusion

- Coal producing regions are particularly vulnerable to job destruction
- Under a constant productivity growth assumption, transition simply accelerates job destruction by a few years
- Such an acceleration means that less workers can find new employment
- Lower economic activity in vulnerable regions is a threat to laid-off workers
- Further research is necessary to endogenize labour productivity

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Additional indicators

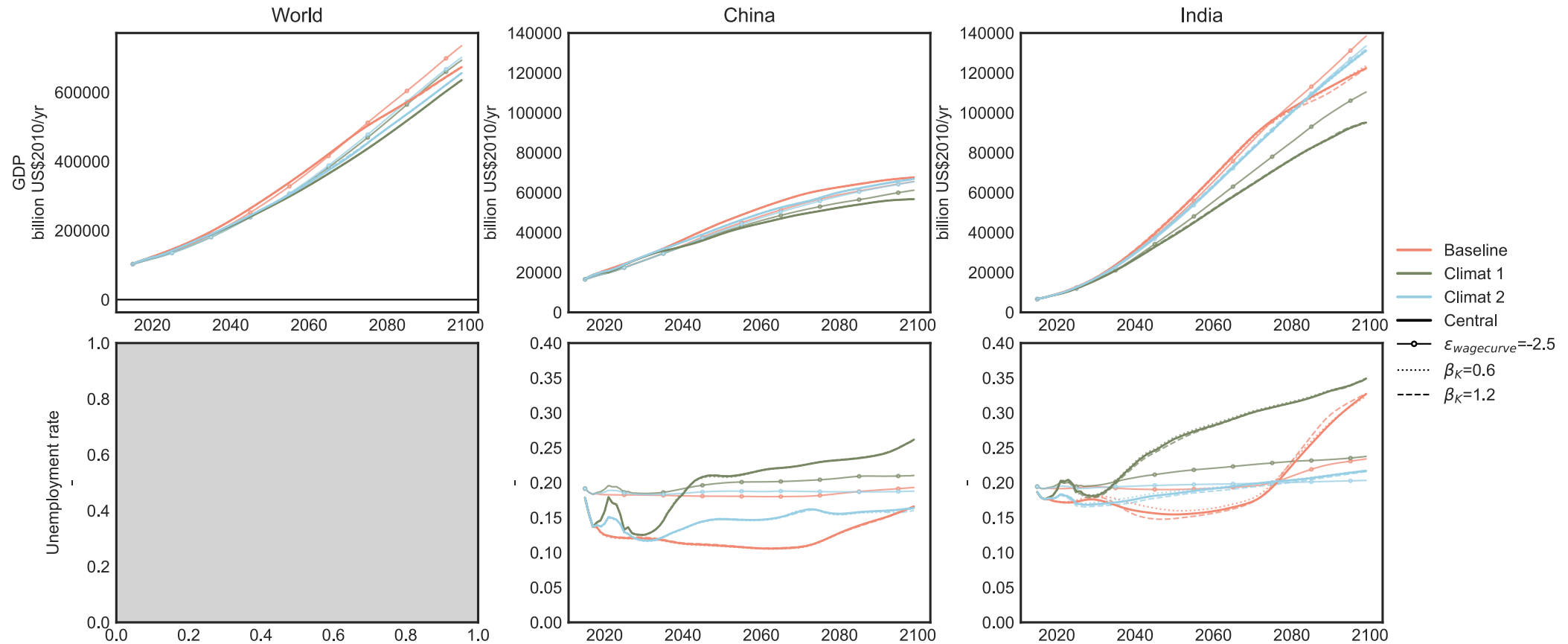


Figure A.1: Secondary indicators for analysed scenarios.

Trade-offs of heterogeneous climate price

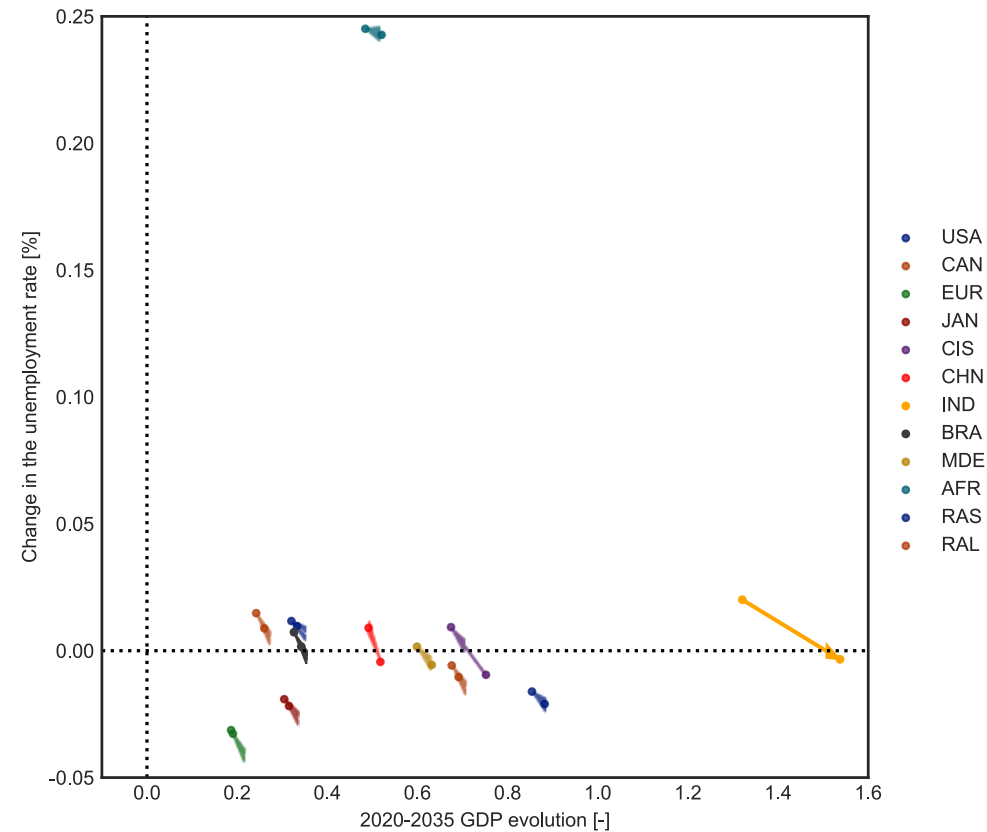


Figure A.2: Evolution of GDP (in purchase power parity) and labour under-utilisation across model regions between the two climate scenarios. Arrows point from Climate 1 to Climate 2 scenario

Trade-offs of heterogeneous climate price

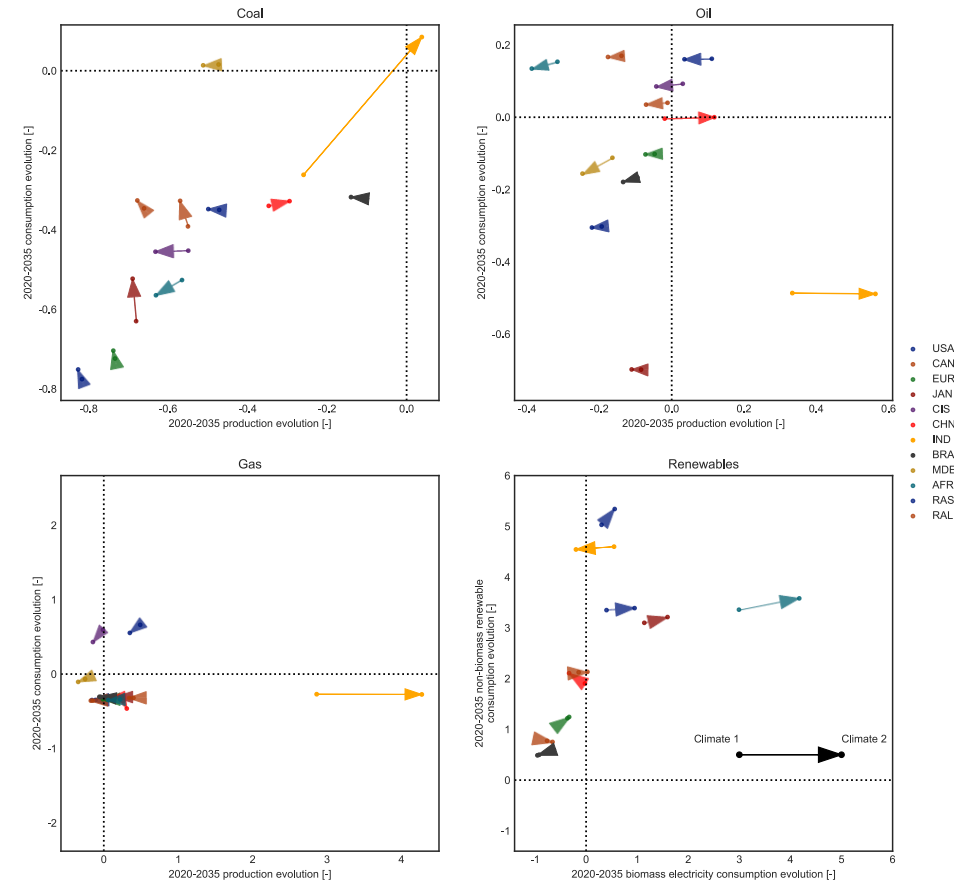


Figure A.3: Evolution of energy demand and supply across model regions between the two climate scenarios. Arrows point from Climate 1 to Climate 2 scenario.

Coal labour productivity

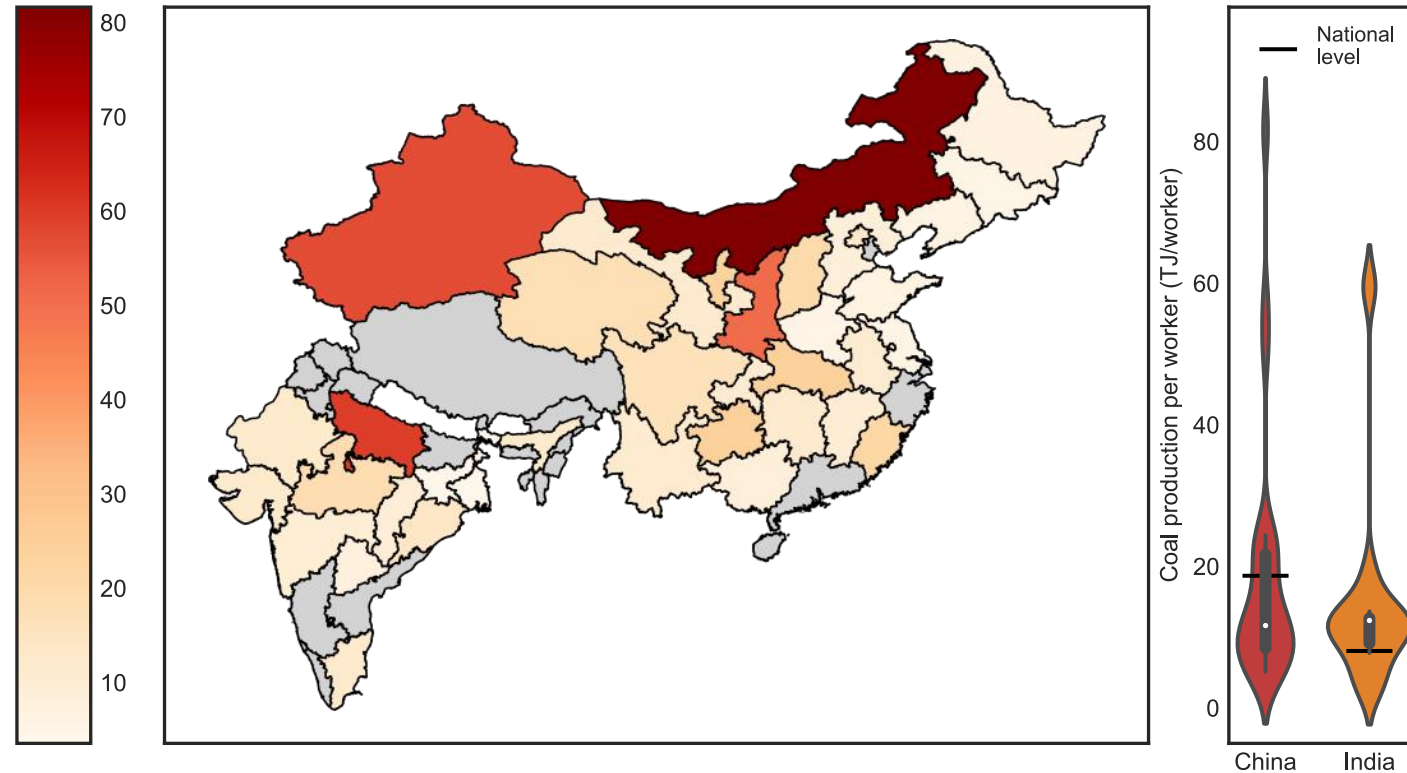


Figure A.4: Map of coal labour productivity (in TJ/workers) across subnational regions of China and India.

Labour productivity growth calibration

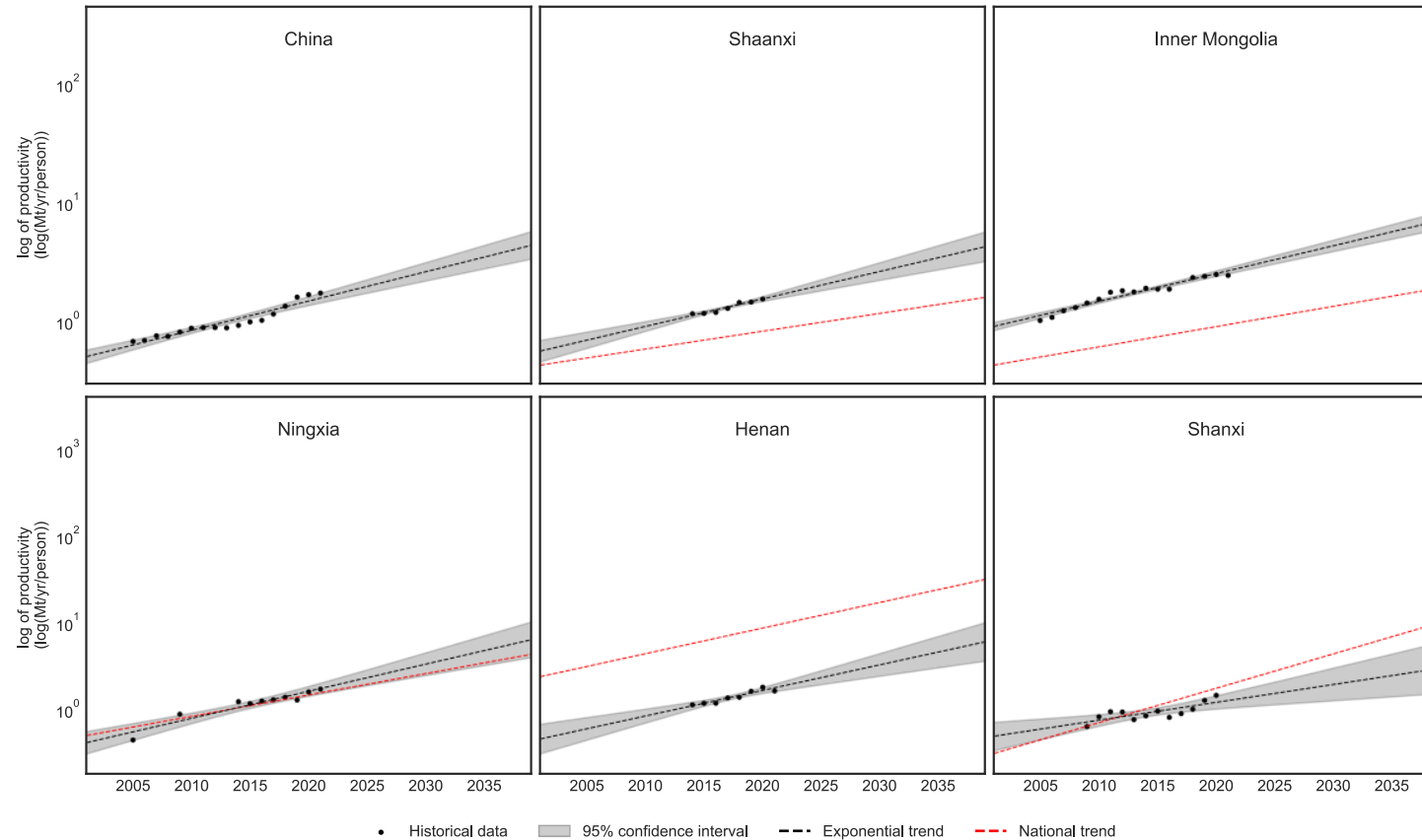


Figure A.5: Linear regression of the log of coal labour productivity with respect to time in China at the national level and in selected province. Productivity is constructed from production and employment data from yearly provincial yearbooks by NBSC (2016, 2022)