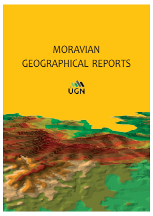

MORAVIAN GEOGRAPHICAL REPORTS

sciendo

The Czech Academy of Sciences, Institute of Geonics

journal homepage: http://www.geonika.cz/mgr.html

doi: https://doi.org/10.2478/mgr-2022-0016

The curse of coal or peripherality? Energy transitions and the socioeconomic transformation of Czech coal mining and post-mining regions

Bohumil FRANTÁL [a *], Jindřich FRAJER [b], Stanislav MARTINÁT [a,b], Lucia BRISUDOVÁ [b]

Abstract

New empirical evidence regarding theories of the resource curse and regional resilience in the context of energy transitions is presented in this article. Our analysis aimed to answer the questions of what the principal differences are between coal mining and other regions in the Czech Republic, and what are the determinants of population decline, unemployment and populism as some of the key indicators of socioeconomic transformation. Unlike most current European studies focusing on NUTS2 or NUTS3 regions, we deal with data for districts (LAU1). The analysis revealed that (in aggregate) coal mining and post-mining districts are worse off in terms of air quality, population vitality, labour market and social capital indicators. It would be problematic for policy implications to consider coal mining and post-mining districts as homogenous categories, however, since there are significant inter-group and intra-group differences in most indicators. Coal mining itself and its decline did not prove to be a direct determinant of population loss, unemployment, and support for populism. The factors significantly affecting these phenomena are geographical (peripherality, urbanisation, population density) and socioeconomic (education level, business activity). In this respect, a provocative question is offered: to what extent is it effective and sustainable to economically support coal mining regions in their existing industrial production structures and population scales, and whether the current processes of reterritorialisation and depopulation can be considered a natural process. The fact that coal mining districts are at the forefront in the implementation of wind energy may be seen as positive, but it raises questions about spatial concentration, and the environmental justice of renewable energy development.

Keywords: *coal mining; coal phase-out; resource curse; regional resilience; Czech Republic*

Article history: *Received 1 September 2022, Accepted 10 December 2022, Published 31 December 2022*

1. Introduction

"Ostrava city with the coal stands and falls"

Augustin Kliment
communist minister of heavy industry (1952)

The ongoing low-carbon energy transition poses particular challenges for regions that are still heavily dependent on the extraction of fossil fuels and related industries – so called coal and carbon-intensive regions (CCIR) (European Commission, 2017). Despite their centrality in energy provision chains during the 19th and 20th centuries, carbon-intensive regions are now regarded as peripheries synonymous with air pollution, land degradation, and health and social deprivation (see e.g. Zullig and Hebdryx, 2010; Frantál, 2016; Smeraldo Schell and Silva, 2020). The phasing out of coal mining and combustion and the decline of related industries have resulted in stagnating local economies, declining populations, an overall sense of loss of identity and prospects, and the rise of populism rhetoric with nostalgia and false political promises (Thorleifsson, 2016; Abreu and Jones, 2021; Mayer, 2022). On the other hand, the energy transition is considered as an opportunity for developing new lines of economy, rebranding identities, and for increasing the competitiveness of structurally depressed regions (Alves Dias et al., 2018; Oei et al., 2020a; Stognief et al., 2019).

In 2017, the European Commission established the "Initiative for Coal Regions in Transition", to promote knowledge-sharing and exchanges of experiences between

[a] Department of Environmental Geography, Institute of Geonics, The Czech Academy of Sciences, Brno, Czech Republic (*corresponding author: B. Frantál, e-mail: *bohumil.frantal@ugn.cas.cz*)

[b] Department of Geography, Faculty of Science, Palacký University Olomouc, Czech Republic

EU coal regions and supported several research projects within the H2020 R&I Framework. The partial programme "Social Sciences and Humanities Aspects of the Clean-Energy Transition" (European Commission, 2019) focused on principal challenges facing coal and carbon-intensive regions, stressing the following issues:

i. What are the principal differences between regions that are coping well with the transition and those that are not?;
ii. To what extent have carbon-intensive regions experienced outward migration and how has this affected their social and demographic composition?; and
iii. What effect have these changes had on the rise of populism and of anti-democratic attitudes?

Most recent comparative studies assessing the impacts of coal mining on the health and socioeconomic well-being of affected areas (i.e. the resource curse literature), and searching for factors affecting the resilience and adaptive capacity of regional economies to transform (i.e. the transition studies) have dealt with either NUTS2 or NUTS3 regions (Alves Dias et al., 2018; Schulz and Schwartzkopff, 2018; Stognief et al., 2019; Drobniak, 2020; Esposito and Abramson, 2021; Everingham et al., 2022) or even with countries (e.g. Svobodova et al., 2020). While these studies provide useful international comparisons, however, they present quite generalised results which often ignore the fact that coal mining regions are not uniform and homogenous entities. There are both inter-regional (depending on their location, scale, and structure, the type of mining technology and industrial organisation, etc.) and intra-regional differences (between districts, municipalities and localities within regions). If these differences are ignored and coal mining regions are considered only in the aggregate, the analyses can give biased and discrepant results, the policies based on aggregate data may perpetuate both disadvantages and advantages in many local areas (Nord and Luloff, 1993; Williams and Nikijuluw, 2020a) and the measures taken (e.g. energy transition funds or retrofit subsidies) may be inefficient or even regressive, reproducing existing inequalities between the centres and the peripheries and others (see e.g. Willand et al., 2020; Frantál and Dvořák, 2022). The studies analysing the impacts of coal mining dealing with lower spatial levels, such as counties, shires or cities have been carried out almost exclusively in Australia or the United States (see e.g. Nord and Luloff, 1993; Hajkowicz et al., 2011; Tonts et al., 2012; Fleming et al., 2015; Wolley et al., 2015; Williams and Nikijuluw, 2020a, 2020b).

This paper seeks to partially fill the existing research gap and demonstrate the importance of investigating the relationships between coal mining, socioeconomic well-being and resilience to transitions at lower spatial levels, using statistical data for districts (Local Administrative Units (LAU1)) in the Czech Republic. Using the analysis of variance (ANOVA) and regression modelling, we test the effect of a wide range of variables, including geographical and environmental indicators, population vital and health statistics, labour market and income data, renewable energy production data, and social capital and social cohesion indicators. The research questions that have driven our exploratory research were defined as follows:

- In which indicators do coal mining, post-mining and non-mining regions differ significantly?
- Do coal mining regions differ with respect to renewable energy development? and
- What are the main factors and barriers that have enabled or slowed down the socioeconomic transformation of coal mining regions?

The remainder of the paper is organised as follows. The next section reviews the literature dealing with the issues and concepts of the resource curse, regional adaptive capacity and resilience in the context of the energy transition and coal phase-out, and the so-called extractive populism. The next section is concerned with a description of the regional context of the case study, the sources of data and methods of their analysis and processing. Results are presented and discussed in the following sections, which are structured according to the above defined research questions, including comparisons to previous studies from other countries if eligible. The concluding section highlights the main findings and provides some policy implications.

2. Theoretical background: The resource curse, regional resilience, coal phase-out and extractive populism

The historical role of coal for industrialisation, the creation of new jobs and regional economic development is indisputable (e.g. Domenech, 2008; Latzko, 2011; Ivanova, 2014; Berbée et al., 2022). The economic benefits of coal mining for host regions and local communities have been, however, in a longer-term view, outweighed by negative environmental, health and social externalities and unintended consequences (Lockie et al., 2009; Riva et al., 2011; Petrova and Marinova, 2013; Li et al., 2018; Esposito and Abramson, 2021). In this respect, the coal mining has been often associated with the resource curse theory, stressing that regions whose development has been strongly dependent on the extraction of natural resources (specifically non-renewable resources like minerals and fossil fuels) are characterised by economic vulnerability, demographic instability, negative health and socioeconomic impacts, increasing geographic isolation, a decrease in educational attainments, and imbalances of scale and power with respect to extractive industries (Freudenburg and Gramling, 1992; Morrice and Colagiuri, 2013, Betz et al., 2015; Esposito and Abramson, 2021).

Understanding the links between resource dependence and socio-economic wellbeing has long been a subject of interest amongst social scientists, particularly in North America and Australia (Freudenburg and Wilson, 2002; Mancini and Sala, 2018; Williams and Nikijuluw, 2020a, 2020b). Existing empirical studies have nonetheless provided inconclusive and/or contradictory evidence of the resource curse hypothesis. For example, Petkova-Timmer et al. (2009) and Hajkowicz et al. (2011) proved positive impacts of coal mining at the regional level in Australia, including effects on employment, incomes, housing affordability, the improvement in infrastructure and services. Hajkowicz et al. (2011) however pointed out that the highly localised disadvantages and inequalities from coal mining (e.g. uneven income distribution) were not detected due to the chosen scale of analysis. The earlier studies from the US suggested that mining-dependent counties are characterised by levels of socioeconomic wellbeing above the national average but striking regional differences among mining-dependent counties were masked when such counties were considered as a single category (Nord and Luloff, 1993). Perdue and Pavela (2012), Oxley (2014) and Betz et al. (2015) examined the effect of coal mining on the Appalachian regions and found positive associations between coal mining, unemployment and poverty rates, and negative associations with entrepreneurial activity and population growth. The results of an international comparative study by Esposito and Abramson (2021) show that European former coal-mining regions are substantially poorer than comparable regions in the same country that did not mine coal, which can be explained by lower levels of human capital accumulation (particularly in men). They suggest that persistently lower levels of human capital in coal mining regions result from the crystallisation of negative attitudes towards education and lower future orientations (*cf*. Esposito and Abramson, 2021).

As Bebbington et al. (2008) pointed out, the contribution of mining to regional development is contentious and ambiguous at best. The effects of coal mining on regions and local communities differ between boom-and-bust periods and over the long run (Black et al., 2005; Shandro et al., 2011; Betz et al., 2015; Measham et al., 2019). Moreover, most of the socioeconomic impacts of the coal industry rely on its spillover effect, rather than direct effects (Williams and Nikijuluw, 2020a). The results and conclusions are dependent on the geographical context, the industrial organisation and social relations of production (e.g. differences between the "old coal" regions of the South, the "old coal and iron" regions of the Great Lakes, and the "new coal and petroleum" regions of the West in the US: see Nord and Luloff, 1993), the spatial level of analysis, the spectrum of used indicators, and the degree of data aggregation (Tonts et al., 2012; Betz et al., 2015; Williams and Nikilujuw, 2020b).

Furthermore, the coal mining industry has changed dramatically during the last two decades, including geographic shifts in production, technological changes that have reduced labour demand and led to relatively new mining practices (e.g. invasive mountain-top approaches), changed economic footprints, a shutdown of capacities or a complete end of mining in many regions (Betz et al., 2015). The decline or the end of mining can bring new or amplify already existing negative phenomena. For example, Scheuch (2020) reports that coal mining counties in the Appalachian region suffer from high rates of obesity, heart disease, diabetes, smoking, and drug abuse, leading them to have some of the lowest life expectancies in the country. Kratzer (2015) also shows that areas (in the Appalachian region) with high levels of coal mining experience have higher population loss. Abreu and Jones (2021) found that residents of former coal mining communities in the UK are highly politically disengaged, with low levels of trust and political efficacy, and low involvement in the political process.

The question "why, when faced with external transformative pressures, are some regional economies able to economically and socially renew themselves, whereas others remain locked in decline" is among the key issues in the regional studies literature (Campbell and Coenen, 2017). The ability of regions to cope with shocks or significant changes has been inflected in connection with the terms adaptive capacity and resilience (Robinson and Carson, 2016; Stognief et al., 2019; Everingham et al., 2022). Whether a region is resilient refers to the distinction between the short-term capacity to absorb shocks (i.e. to adjust) and its long-term capacity to develop new growth paths (i.e. to renew itself) (Martin and Sunley, 2015 as cited in Cambell and Coenen, 2017). A successful transition and renewal of mining regions and cities largely depended on timely economic diversification, developing new pathways of industrial development and innovation (Cambell and Coenen, 2017; Measham et al., 2019). Jonek-Kowalska and Turek (2022) document how the decommissioning of coal mines in cities of the Upper Silesian coal basin (Poland) had a negative impact on the balance of local budgets and the level of long-term debt. The impact was especially strong in cities where all mines were decommissioned and which did not replace the mining industry with economic alternatives, while cities with more diversified economic activity and sources of income were in a better economic condition.

The studies from Australia (as reviewed by Everingham et al., 2022) suggest that the adaptive capacity of coal mining regions is dependent on human and social capital (i.e. education level, community cohesion) as well as geographical location (remoteness) and the accessibility of infrastructure and services. The importance of combining not only policies addressing unemployment and the attraction of new energy corporations and investments, but also measures improving infrastructure, education, research facilities and soft location factors, has been highlighted also based on the experiences from the transition of German coal mining regions (Oei et al., 2020a, 2020b). Furthermore, Everingham et al. (2022) emphasise that transitions resulting from sectoral change are influenced by multidimensional patterns in surrounding contexts rather than coupled dynamics or single factors.

Oei et al. (2020) also point out that besides the economic reorientation, the change of regional identities is the most difficult aspect of the transition of coal mining regions. The place-based and class identities and social imaginaries linked to coal mining have recently become an important dynamic in an emerging political "extractive populism", not only in the United States (Kojola, 2019; Mayer, 2022) but also in Germany (Abraham, 2019), Poland (with an exemplary case of the Turow open pit mine conflict, see Żuk and Żuk, 2022) or the Czech Republic (Osička et al., 2020; Kuba et al., 2022). Kojola (2019) examines and describes how the support for coal mining among white, working-class, and rural residents in the US has been made meaningful through nostalgia for preserving mining as a way of life and anger at outsiders (and burdensome government regulations), disrupting their livelihoods and extractive moral economy (as exemplified in the rhetoric of Donald Trump's claims of ending the "war on coal").

Throughout modern history coal has played a key role in human development, it has transformed societies, expanded frontiers, and sparked social movements, redefined the role of workers, changed family structures, altered concepts of public health and private wealth and crystallised debates over national values (Freese, 2003), and it prevails as a symbol of broader cultural, geographic, and class divides to this day (Kojola, 2019).

3. Methods and data

3.1 Regional context of the study

The Czech Republic is a country with a significant coal mining tradition dating back to the Middle Ages. The industrial development of coal mining is associated with the construction of the railway network in the mid-19th century, which connected major industrial regions with the locations of coal deposits. The biggest mining boom, however, came in the second half of the 20th century. During the era of communism (1948–1989), coal was hailed as the "crown jewel of the land" and the "blood" of the metallurgical and energy-intensive heavy industries, which had been centrally supported as dominant sectors of the economy (Glassheim, 2007) (see Fig. 1). In that period, the production of brown coal as the main source of energy increased about five times and electricity generation about twenty times (CZSO, 2012). This planning orientation affected the overall national economy and resulted in the environmental devastation of several regions, particularly in the North Bohemian coal basin and Ostrava-Karvina coal basin (Říha et al., 2011; Frantál, 2017).

After the change of regime in 1989, the newly established Federal Ministry of Environment prepared programs to restore the environment of the most environmentally affected areas. As a result, all operational coal power plants were required to be desulphurised or shut down and the so-called territorial ecological limits for mining were established by the Government Decrees No. 331 and 444/1991 (Říha et al., 2011). By restricting exploration, coal mining and other mining-related activities beyond certain spatial limits, the Government established a balance between economic and ecological interests, but it also ignited a fierce political debate and conflicts of interest that persist to the present (Černoch et al., 2019; Sivek et al., 2017; Shriver et al., 2022). The transition to a market economy, economic changes accompanied by a strong recession of heavy industries, the pressure to improve the environment and, following global trends, caused a gradual reduction in coal mining and the subsequent shutdown of capacities or a complete end of mining in some regions or localities (see Fig. 2).

More than thirty years after the change of regime, despite general economic restructuring, the decline of coal mining and heavy industries, and investments in environmental restoration, the coal mining regions still seem to suffer from the resource curse characterised by long-term exploitation and the commodification of the landscape through coal mining and combustion. The results appear to be clear: draining profits from energy sales out of the affected regions, negative environmental, health and socioeconomic consequences, the absence of realistic alternatives for future diversified

Fig. 1: "Soviet energy – our model". Communist propaganda sign in a current desolate building of a coal-fired power plant in Oslavany town, Brno-countryside district. Photo: B. Frantál

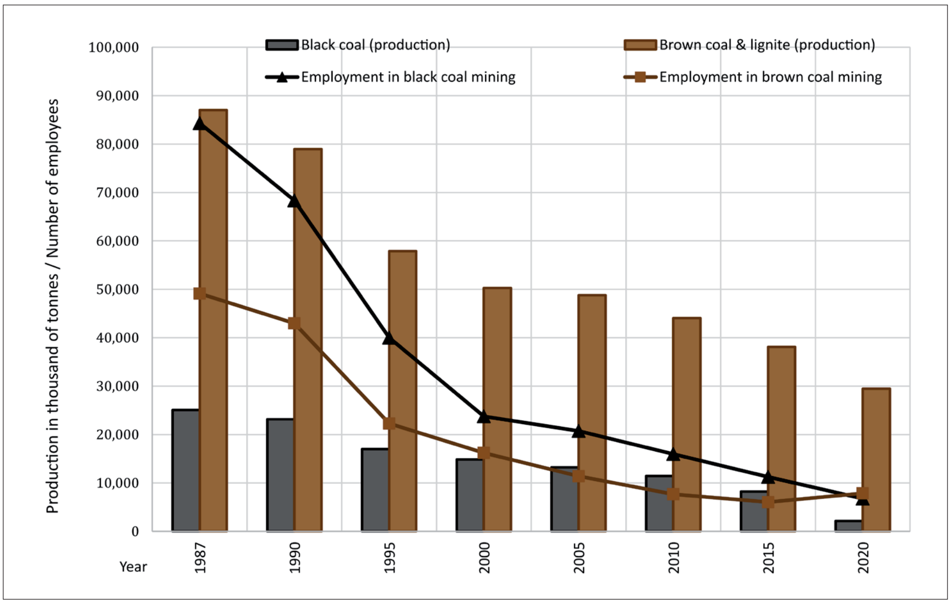

Fig. 2: The decline of the coal mining industry after change in the communist regime in 1989
Sources: Czech Statistical Office (2012): Historical yearbook of the energy statistics; Czech Mining Authority: Mining Yearbooks (1992–2015)

development, and persistent pressures from the industrial lobby to expand mining areas (Frantál, 2017; Shriver et al., 2022). The current Czech energy policy remains highly dependent on traditional resources, with overall electricity generation based predominantly on thermal or combined cycle power plants burning coal (40%), natural gas (8%), and other fuels (3%), nuclear power (36%), with renewable energy sources contributing less than 13% (ERU, 2022). While in 1990, coal mining took place in thirteen districts, currently mining is active in only five districts of the Czech Republic (see Fig. 3 and Tab. 1).

In relation to the future of coal mining and burning, the Czech public and its political representation are characterised by a high degree of ambiguity, fragmentation among decision-makers, stakeholders and opposition groups (related to their ideological cross-coalition membership and the heterogeneity of beliefs) (see Ocelík et al., 2019; Černoch et al., 2019) and the predominance of the aspects of employment, regional economic resilience and energy security over environmental and climate issues in the mass media (Lehotský et al., 2019; Osička et al., 2020). After years of hesitations and expert and political disputes, at the beginning of 2022 the new government announced in its programme statement to phase out coal by 2033. The plans assumed an increase in the share of nuclear power plants and renewables (particularly wind and solar installations) on electricity generation, with an increased importance of natural gas as a "transition fuel" to balance fluctuations in energy production and the decarbonisation of the heating industry (Government of the Czech Republic, 2022). These plans about coal-phase out have been, however, significantly questioned by the ongoing economic and energy crisis in connection with the war in Ukraine.

3.2 Data and statistical methods

As the spatial level of analysis, we have chosen districts (Local Administrative Unit – LAU1)[1] for which a relatively wide spectrum of data is available and, at the same time, they exhibit a high degree of variance in terms of the key socioeconomic indicators. We created a database of selected variables representing the geographical characteristics of districts, population statistics, local economy and labour market data, living standards and social capital indicators (see Appendix 1). To provide empirical evidence of the "curse of coal" hypothesis, a comparative analysis was made for selected variables for groups with active coal mining, post-mining, and non-mining districts. The statistical testing has been carried out using the analysis of variance (ANOVA) to analyse differences between group mean values, providing F-tests and Eta correlation coefficients. ANOVA has also been used for detecting significant differences between districts in the implementation of renewable energy technologies.

As dependent variables for a deeper analysis, we chose those indicators that are most often mentioned in the present literature as negative impacts of coal mining dependence (i.e. population decline, unemployment, and the rise of populism). To determine the relative strength of the effects of individual variables on the change in population during the last thirty years, the current unemployment rate, and the support of populist political parties, we carried out multiple regression analyses. For each of the three dependent variables, we created two regression models (one for the sample of all districts in the Czech Republic (N = 76), and the second for the sample of coal mining and post-mining districts (N = 13), including independent variables which proved to be significantly correlated with dependent variables and rationally considered as possible determinants affecting

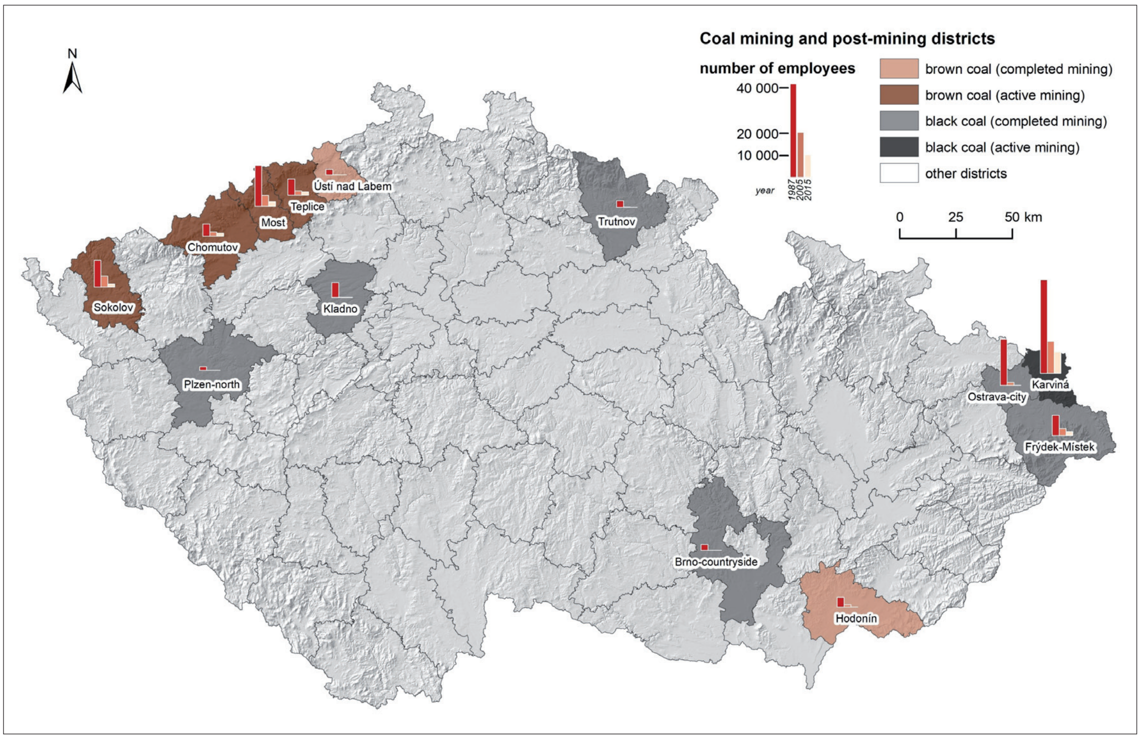

Fig. 3: Coal mining and post-mining districts in the Czech Republic
Source: authors' elaboration based on data from Czech Statistical Office and Czech Mining Authority (Mining Yearbooks, 1992–2015)

[1] There are 76 districts in the Czech Republic, the capital city of Prague does not belong to any of them and represents a specific unit. The areas of districts range between 230 and 1,946 km^2 (the mean value is 1,031 km^2).

District	Type of coal (mining)[1]	End of mining[2]	Number of employees in coal mining (% of productive population)		
			1987[3]	2005	2015
Brno-countryside	Black (UG)	1992	2,605 (2.3)	0	0
Ostrava	Black (UG)	1994	20,491 (9.1)	1,309 (0.6)	0
Trutnov	Black (UG/SF)	1994/2007	2,851 (3.4)	39 (0.05)	0
Plzeň-North	Black (UG)	1995	1,448 (2.8)	0	0
Ústí n/Labem	Brown (SF)	1997	2,446 (2.9)	0	0
Kladno	Black (UG)	2002	6,595 (6.2)	53 (0.05)	0
Hodonín	Lignite (UG)	2009	4,252 (3.8)	984 (0.9)	0
Frýdek-Místek	Black (UG)	2017	8,935 (5.6)	3,052 (1.9)	1,733 (1.2)
Karviná	Black (UG)	2023 (?)	41,392 (20.9)	14,086 (7.1)	9,522 (5.6)
Chomutov	Brown (SF)	2033 (?)	5,321 (5.9)	1,779 (1.9)	1,240 (1.5)
Most	Brown (SF)	2033 (?)	18,086 (21.6)	4,811 (5.7)	1,962 (2.6)
Sokolov	Brown (SF)	2033 (?)	11,884 (17.7)	4,888 (7.3)	1,403 (2.3)
Teplice	Brown (SF)	2033 (?)	7,133 (7.9)	1,863 (2.1)	1,441 (1.7)

Tab. 1: Basic characteristics of Czech coal-mining and post-mining districts (Notes: [1]In this paper we use a division of coal into types, which is usual in the Czech Republic, according to the carbon content and calorific value: lignite (30–50%, approx. 13 MJ/kg), brown coal (50–80%, 15–20 MJ/kg), black coal (80–90%, 18–30 MJ/kg), and anthracite (over 90%, 26–30 MJ/kg). The type of coal mining represents the dominant method of mining in the area: UG = underground, SF = surface; [2]In the district of Trutnov, the underground coal mining was terminated in 1994. After the end of underground mining, one mining area (Žacléř) was preserved, where localised surface mining began in 1998 and lasted until 2007. Production was very limited, and the number of employees included only a few dozen workers; [3]The number of employees is given based on the registered office of the mining company. Therefore, in 2005, for example, workers are registered in the district of Ostrava, although there was no active mining in that district at that time, but mining was done in neighbouring districts, and at the same time work related to closing the mines was underway.)
Source: authors' calculations based on data from Czech Statistical Office and Czech Mining Authority (Mining Yearbooks, 1992–2015)

the dependent variables. Thus, for example, the share of people with basic education, which strongly correlates with population decline, was not included in the regression model for population change, since it is more likely a consequence (outmigration of more educated people) rather than a cause of population change.

4. Results

4.1 Differences between coal mining, post-mining and non-mining districts

The coal mining districts show some geographical characteristics (see Tab. 2). They are mostly located in borderland areas, they have significantly smaller area, are more urbanised, and have a smaller share of agricultural land (which is logically related to the processes of industrialisation and urbanisation). On the other hand, the coal mining districts do not differ significantly in terms of the share of forests and landscape protected areas with respect to total area, not even in terms of the coefficient of ecological stability (the ratio of areas of stable and unstable landscape-forming elements), which is quite surprising considering the high level of urbanisation.

Coal mining and post-mining districts significantly exhibit much higher concentrations of emissions of the main air pollutants (i.e. of particulate matter and carbon monoxide, as well sulphur dioxide and nitrogen oxide which are not included in the table). From the long-term point of view, the district of Ostrava-city shows the highest concentrations of air pollutants among all areas in the Czech Republic. Air quality in this area is significantly affected by the location of the Liberty Steel factory (previously Arcellor Mittal), which is considered the largest polluter in the region. Although there has been a positive trend in decreasing emissions since the 1990s, the air quality in coal mining districts remains significantly worse compared to rest of the country (note that the latest air pollution data for districts was available only for 2015).

Czech coal mining districts do not differ significantly in terms of population density (although the analysis shows relatively large differences between categories in population density, they are not statistically significant), gender structure, the average age, and the index of aging. They do show significantly higher rates of abortions and infant mortality, and people living there have significantly lower life expectancy at birth (particularly men). These results are quite like data from Australia, where population and gender indicators show no significant differences between coal mining and non-mining areas (Williams and Nikijuluw, 2020b), but significant differences exist as regards life expectancy (Hajkowicz et al., 2011).

While the population in non-mining and post-mining districts has increased slightly on average compared to 1990, the population in districts with active mining has distinctly decreased (on average by 11% compared to 1990). Such differences between mean values of the categories of districts were not proved to be statistically significant, which indicates that there is a large variance in the change of population within groups (see Fig. 4). While some coal mining and post-mining districts (Karviná, Sokolov, Most, Hodonín, Frýdek-Místek) are among the Czech districts that have lost the larger part of their population, some other post-mining districts (Brno-countryside, Kladno, Plzen-north) show some of the largest relative population gains in the country.

It is necessary to mention that the significant relative increase of the population in the district Brno-countryside was also affected by the administrative change of borders (i.e. incorporation of 50 municipalities from neighbouring districts in 2005 and 2007). Among the highest ranking 15 districts with the largest relative population decline in the country are three mining districts, two post-mining districts and ten non-mining districts. Twelve of these fifteen districts with the largest decrease in population are located in borderland areas. A deeper analysis shows that coal mining has not been the primary factor affecting out-migration and the decline of population in these districts.

During the transformation of society and the economy after the change of political regime in 1989, there were significant changes in the indicators of the labour market and wealth. While in 1991 the coal mining districts showed a significantly higher share of people working in the industrial sector as a whole (by almost ten percent on average), just ten years later (2001) the districts with still active coal mining no longer differed in the share of workers in industry from post-mining and non-mining districts. While in 1991, Czech districts did not significantly differ

Indicators	Mean values for districts			Statistics	
	Non-mining	Post-mining	Active mining	F test	Eta[1]
Geography and environment					
Total area (km²)	1,075	962	596	4.188	0.321*
Share of districts located on country´s border (%)	40	50	100	–	0.292*
Urbanisation rate (%)	36.6	43.3	68.9	6.966	0.400**
Share of agricultural land on total area (%)	54.6	50.9	36.4	0.424	0.393**
Concentration of PM emissions (tons/km²) (1991)	3.5	–	35.6	24.077	0.498***
Concentration of CO emissions (tons/km²) (1991)	1.2	–	58.5	6.998	0.296*
Concentration of PM emissions (tons/km²) (2011)	0.3	0.8	0.9	10.668	0.476***
Concentration of CO emissions (tons/km²) (2011)	1.4	25.1	12.0	5.615	0.365*
Population and health					
Life expectancy at birth (males) (2006–2020)	75.8	75.4	73.5	14.045	0.527***
Abortions per 100 births (2018)	29.4	29.1	39.7	6.772	0.396**
Infant mortality (‰) (2018)	2.7	3.3	4.7	3.139	0.281*
Population density (inh./km²) (2021)	143	260	277	1.558	0.202
Population change between 1990 and 2021 (%)	+ 2.6	+ 4.1	− 11.1	1.007	0.165
Labour market and economy					
Share of employees in industry (%) (1991)	27.4	–	35.9	12.297	0.380***
Share of employees in industry (%) (2001)	17.9	17.9	17.9	0.000	0.002
Unemployment rate (%) (1991)	4.7	–	4.4	0.28	0.062
Unemployment rate (%) (2001)	8.3	10.6	13.5	7.47	0.412**
Unemployment rate (%) (2011)	9.0	10.3	12.4	4.957	0.346**
Unemployment rate (%) (2021)	3.2	4.1	5.9	16.521	0.558***
Job vacancy rate (2011)	1.0	1.7	2.5	8.039	0.425***
Business activity (2011)	237.0	223.1	193.3	5.225	0.354**
Average monthly wage (CZK) (1991)	3,718	–	4,146	45.75	0.621***
Average monthly wage (CZK) (2001)	13,114	13,720	13,772	1.818	0.218
Average price of flats (millions CZK) (2010)	1.305	1.211	0.555	9.112	0.447***
Social capital and social cohesion					
Share of people with basic or no formal education (%)	13.9	14.4	18.6	15.655	0.548***
Share of ethnic minorities (%) (2011)	0.18	0.26	0.55	17.453	0.569***
Crime rate (2018)	13.9	16.0	20.0	4.842	0.342*
Turnout in parliamentary elections (%) (2021)	65.7	63.9	54.4	23.658	0.627***
Support for populist parties (%) (2021)	38.4	40.0	51.3	13.399	0.518***

Tab. 2: Principal differences between categories of districts
*Note: [1]Measures of association (Eta) are significant at ***p < 0.001, **p < 0.01, *p < 0.05*
Source: authors' calculation (for sources of data see Appendix 1)

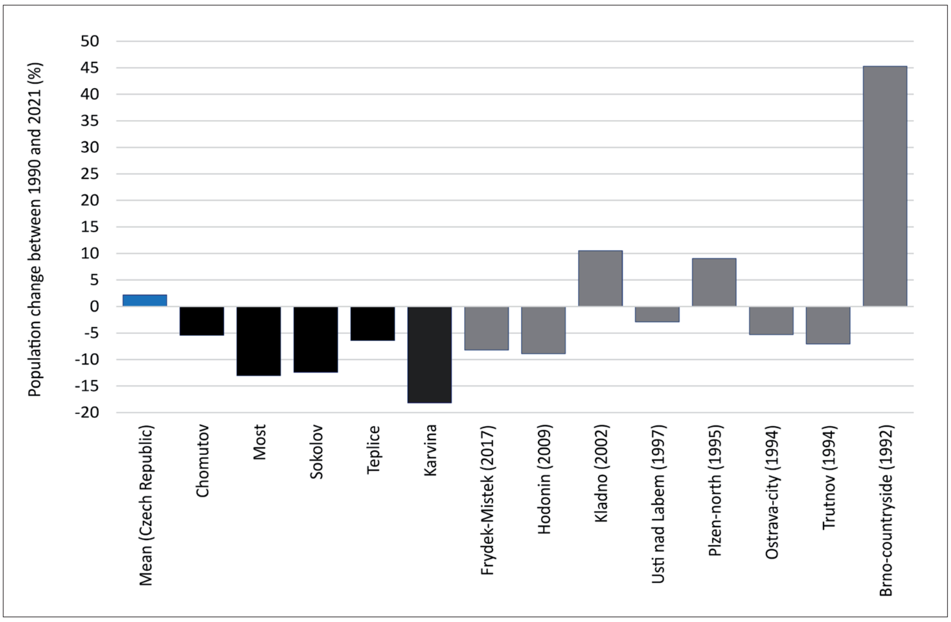

Fig. 4: Differences in population change in the period 1990–2021 between coal mining and post-mining districts
Notes: Grey colour indicates post-mining districts (the year of termination of coal mining in brackets), black colour indicates districts with active mining, and the blue column indicates the mean value for the entire Czech Republic
Source: authors' calculations

in the rate of unemployment, in the course of the following decades, statistically significant differences among districts became apparent, and they further deepened. The coal mining and post-mining districts have significantly higher unemployment rates (see Tab. 2), less job opportunities, and lower business activity than non-mining districts. In any case, there are again (as in the case of population change) significant differences between districts within the groups of both coal mining and post-mining districts, where some of them are below the national unemployment average, while most are well above the national average (see Fig. 5).

In 1991, the coal-mining districts showed significantly higher wages (the prevailing effect of above-average wages provided in coal mining and the industrial sector in general during the communist era), but already in 2001, the differences between categories disappeared. The latest available data about wages for districts is for 2005 and there were no significant differences between coal mining and non-mining district categories. Housing price data (by districts only available until 2010) shows a significant negative correlation between coal mining and housing prices, which probably indicates a generally lower standard of apartments (a large proportion of housing estates with prefabricated houses built during the 1970s–1980s – called "uniform socialist-realist cityscape" by Barton (2013)) and their worse marketability in the context of lower demand for living in districts characterised by a lower quality of life – evidence of which is also a significant loss of population during the last decades.

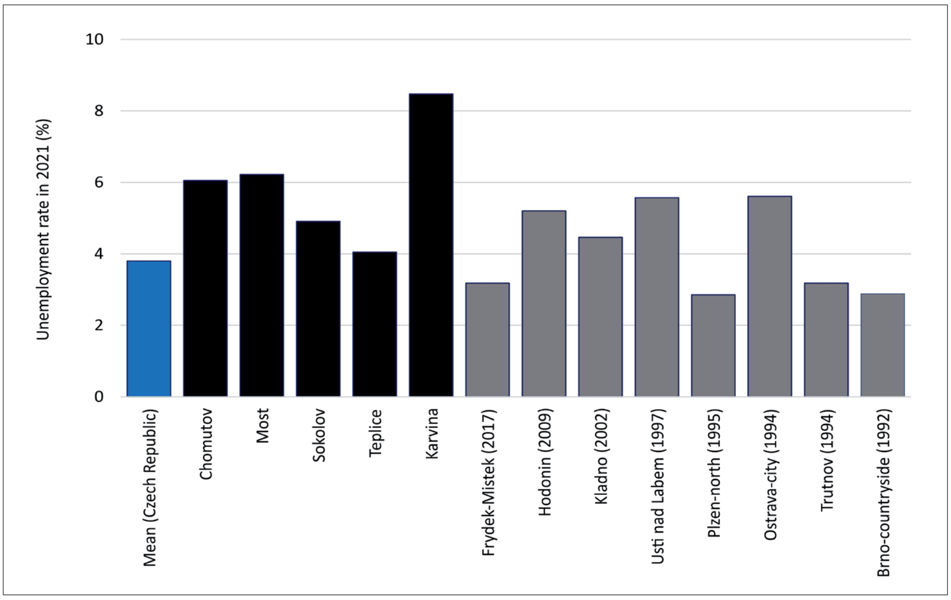

Fig. 5: Differences in the unemployment rate in 2021 between coal-mining and post-mining districts
Notes: Grey colour indicates post-mining districts (the year of termination of coal mining in brackets), black colour indicates districts with active mining, and the blue column indicates the mean value for the entire Czech Republic
Source: authors' calculations

Czech coal mining and post-mining districts are also characterised by worse indicators in terms of social capital and social cohesion. There is a larger share of people with incomplete or only basic education, a larger share of ethnic minorities (Roma people), and higher crime rates in the coal mining and post-mining districts. On the other hand, the categories of districts do not significantly differed in terms of the share of people with university education and the share of natives (people with permanent living at the place of their birth). The analysis revealed that in coal mining districts, there is a lower level of political engagement (participation in elections). Within the framework of the last parliamentary elections (autumn 2021), the trend of increasing support for populist political parties (the populist political parties are represented by the "Action of Dissatisfied Citizens" (ANO 2011) and "Freedom and Direct Democracy" (SPD) in our research) was also significantly manifested in all coal mining and most post-mining districts (see Fig. 6).

4.2 Energy transition in coal mining, post-mining and non-mining districts

Unsurprisingly, most coal-fired power plants have been located close to the coal mining areas. The mining and post-mining districts have about two thirds of the overall installed capacity of coal power in the country. Post-mining districts have five times larger and mining districts have twenty-five times larger installed capacity of coal power per area than non-mining districts (see Tab. 3). There are significant correlations between the installed capacity of coal power and population density, rate of urbanisation and industrialisation, concentration of air emissions and negative health and socioeconomic indicators. A detailed analysis of the relationships between the spatial distribution of coal-fired power plants and socioeconomic indicators has been published by Frantál and Nováková (2014).

The analysis of variance showed that coal mining and non-mining districts do not currently differ significantly in terms of the installed capacity of biogas plants and solar (photovoltaic) power plants. The correlation analysis, however, revealed some significant associations between the installed capacity of biogas and solar power and the geographical characteristics of districts. While biogas plants are more likely located in inland areas with larger shares of agricultural land and smaller shares of forests and landscape protected areas, the solar power plants (PVs) are more concentrated in more populated, urbanised, naturally less attractive areas with smaller shares of forests.

Wind energy is the only renewable energy sector for which data about the realisable potential of wind energy for districts is available (Hanslian et al., 2008). The realisable potential is the expert estimation how many wind turbines and what installed capacity can be potentially implemented in the district considering the technical wind potential and taking into account the limiting factors and exclusion of areas due to the nature and landscape protection, forestation, residential development, military purposes, and other restrictions. Our analysis revealed that while there are not statistically significant differences in the realisable wind energy potential between mining, post-mining and non-mining districts, there are significant differences in the installed capacity. While coal-mining districts have already implemented almost half of their overall realisable potential (48%), post-mining and non-mining districts have implemented only 13% and respectively 10% of their realisable potential.

The differences in the installed capacity of wind energy can be regarded as a good indicator of the social and political acceptance of renewables for the reason that while solar power plants and biogas plants have been constructed mostly on private land and their implementation has not been usually tied to the consent of the municipality and acceptance by the local community, so wind power projects are subject to the Environmental Impact Assessment (EIA) process and they required acceptance by local governments and local communities (see e.g. Frantál, 2015).

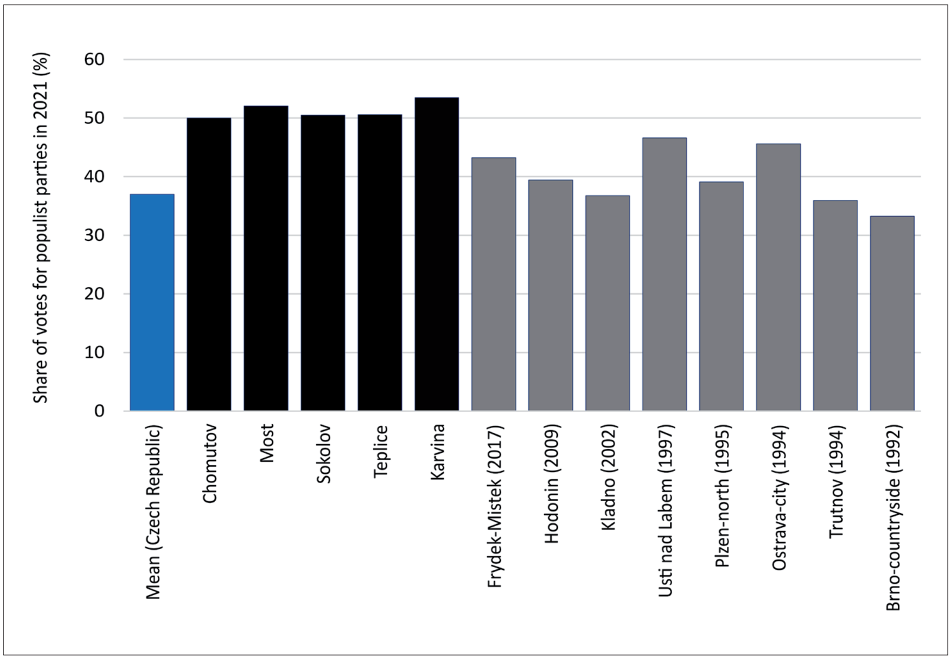

Fig. 6: Differences in the support of populist parties (2021) between coal-mining and post-mining districts
Notes: Grey colour indicates post-mining districts (the year of termination of coal mining in brackets), black colour indicates districts with active mining, and the blue column indicates the mean value for the entire Czech Republic
Source: authors' calculations

Indicators	Mean values for districts			Statistics	
	Non-mining	Post-mining	Active mining	F test	Eta[1]
Coal power plants					
Total installed capacity [MW]	3,363	1,222	4,823	–	–
Average installed capacity in a district [MW]	53.4	152.8	964.6	23.614	0.627*
Average installed capacity per area [kW/km^2]	61.4	303.7	1,535.8	44.262	0.740*
Biogas plants					
Total installed capacity [MW]	336	32	9	–	–
Average installed capacity in a district [MW]	5.3	4.0	1.8	1.868	0.221
Average installed capacity per area [kW/km2]	4.9	4.2	3.9	0.332	0.095
Solar (PV) power plants					
Total installed capacity [MW]	1,680	323	100	–	–
Average installed capacity in a district [MW]	26.7	40.3	20.0	1.343	0.188
Average installed capacity per area [kW/km^2]	27.4	38.4	32.6	0.669	0.134
Wind power plants					
Total realisable potential [MW]	2,139	151	246	–	–
Average realisable potential [MW]	33.9	18.9	49,2	1.033	0.166
Total installed capacity [MW]	204	20	118	–	–
Average installed capacity in a district [MW]	3.2	2.5	23.7	11.244	0.485*
Average installed capacity per area [kW/km^2]	2.8	3.4	32.8	25.033	0.638*
Utilisation of the realisable wind potential [%]	10%	13%	48%	–	–

Tab. 3: Differences in the installed capacity of coal power and renewable energy facilities
*Notes: [1]Measures of association (Eta) are significant at *p < 0.001.*
Sources of data: Czech Energy Regulatory Office (2021); Czech Wind Energy Association (2022); Hanslian et al. (2008); authors' calculations

4.3 Factors affecting the decline of population, unemployment and support of populism

For the sample of 76 districts, factors that have a significant effect on population decline are peripherality (location in borderland area), urbanisation rate, business activity, and average wage (in 1991, when coal mining regions showed significantly higher wages on average, but in the following years they started to decline). No significant correlation was found between population decline and variables indicating the intensity and type of coal mining (presence of active mining, type of mining, proportion of workers in mining in specific years, time that passed from the end of mining). Peripherality turned out to be the only significant variable affecting the differences in the change of population for the sample of coal mining and post-mining districts. In this respect, we can thus speak of a curse of peripherality rather than a curse of coal.

Predictors	Unstandardised Coefficients		Standardised Coefficients	t	Sig.
	B	S.E.	Beta		
(Constant)	– 171.541	34.709		– 4.942	< 0.001
Peripherality	**– 11.173**	**3.826**	**– 0.262**	**– 2.920**	**0.005**
Urbanisation rate	**– 0.419**	**0.134**	**– 0.401**	**– 3.134**	**0.003**
Share of employees in industry potential (MW)	– 0.448	0.261	– 0.180	– 1.717	0.091
Unemployment rate	– 3.638	2.639	– 0.218	– 1.379	0.173
Job vacancies rate	3.834	3.697	0.162	1.037	0.303
Business activity	**0.349**	**0.072**	**0.525**	**4.848**	**< 0.001**
Average wage	**0.036**	**0.008**	**0.439**	**4.295**	**< 0.001**
N (districts) = 76					
R^2 = 0.726; Sig. < 0.001					
Dependent variable: Change of population between 1990 and 2021 (%)					

Tab. 4: Regression model for the change in population (for the sample of all 76 districts)
Source: authors' calculations

Predictors	Unstandardised Coefficients		Standardised Coefficients	t	Sig.
	B	S.E.	Beta		
(Constant)	39.930	11.144		3.583	0.007
Peripherality	**– 18.423**	**6.889**	**– 0.545**	**– 2.674**	**0.028**
Urbanisation rate	– 0.046	0.142	– 0.083	– 0.324	0.754
Share of employees in industry potential (MW)	– 0.626	0.359	– 0.387	– 1.742	0.120
Job vacancies rate	– 2.017	2.694	– 0.165	– 0.749	0.476
N (districts) = 13					
R^2 = 0.870; Sig. = 0.014					
Dependent variable: Change of population between 1990 and 2021 (%)					

Tab. 5: Regression model for the change of population (for the sample of 13 coal mining districts)
Source: authors' calculations

Predictors	Unstandardised Coefficients		Standardised Coefficients	t	Sig.
	B	S.E.	Beta		
(Constant)	0.767	1.456		0.527	0.600
Peripherality	0.059	0.240	0.023	0.245	0.807
Population density	**0.002**	**0.001**	**0.307**	**2.665**	**0.010**
Urbanisation rate	**0.017**	**0.007**	**0.269**	**2.232**	**0.023**
Active coal mining	– 0.190	0.319	– 0.088	– 0.595	0.554
Share of employees in coal mining	0.063	0.049	0.210	1.291	0.201
Share of employees in industry	– 0.011	0.015	– 0.075	– 0.751	0.455
Business activity	**– 0.009**	**0.004**	**– 0.232**	**– 2.466**	**0.016**
Education level (basic)	**0.292**	**0.070**	**0.482**	**4.161**	**< 0.001**
N (districts) = 76					
R^2 = 0.800; Sig. < 0.001					
Dependent variable: Unemployment rate (2021)					

Tab. 6: Regression model for the unemployment rate (for the sample of all 76 districts)
Source: authors' calculations

Predictors	Unstandardised Coefficients		Standardised Coefficients	t	Sig.
	B	S.E.	Beta		
(Constant)	12.310	2.477		4.970	0.008
Peripherality	0.844	0.475	0.249	1.777	0.150
Population density	0.002	0.001	0.332	1.790	0.148
Urbanisation rate	0.023	0.010	0.404	2.204	0.092
Active coal mining	– 1.935	0.875	– 0.601	– 2.211	0.092
Years since the end of mining	**0.141**	**0.035**	**1.125**	**4.028**	**0.016**
Share of employees in coal mining	– 0.016	0.038	– 0.069	– 0.427	0.691
Business activity	**– 0.104**	**0.017**	**– 1.421**	**– 6.025**	**0.004**
Education level (basic)	**0.691**	**0.168**	**1.077**	**4.105**	**0.015**
N (districts) = 13					
R^2 = 0.986; Sig. = 0.007					
Dependent variable: Unemployment rate (2021)					

Tab. 7: Regression model for the unemployment rate (for the sample of 13 coal mining districts)
Source: authors' calculations

As for the unemployment rate, it is significantly determined primarily by the level of education (or the share of population with only basic or no formal education) and the level of entrepreneurial activity. These two variables proved to be significant factors in both the sample of all districts and of coal mining and post-mining districts. Within the sample of all districts, the unemployment rate is also significantly affected by the population density and rate of urbanisation: in other words, the greater the population density, concentrated mainly in larger cities, the higher the unemployment rate.

In the sample of mining and post-mining districts, the population density and urbanisation are not significant determinants of unemployment, but the rate of unemployment is significantly affected by the time which has passed since the end of coal mining. Like the case of population decline, coal mining itself has not proved to be a statistically significant determinant of unemployment either. These two models worked with unemployment data for the year 2021. However, as a check, we also performed the analysis for data from 2011, when the unemployment rate was more than three times higher than today. Nevertheless, regression models for the 2011 data give similar results.

The last two regression models focus on evaluating the significance of variables affecting the support for populist parties. A higher support of populist parties is in districts with a higher age index, a higher share of people with basic education, a lower level of business activity and higher rate of crime (see Tab. 8). The only two statistically significant variables that can explain differences in populism support in a split sample of coal mining and post-mining districts are peripherality and crime rate (see Tab. 9). The coal mining variables (i.e. active mining, share of employees in coal mining, the time since the end of mining) did not appear in the regression models as significant determinants of populism support.

Predictors	Unstandardised Coefficients		Standardised Coefficients	t	Sig.
	B	S.E.	Beta		
(Constant)	11.648	5.809		2.005	0.049
Peripherality	– 0.608	0.876	– 0.049	– 0.695	0.490
Urbanisation rate	0.049	0.031	0.160	1.560	0.124
Active coal mining	– 0.214	2.789	– 0.009	– 0.077	0.939
Share of employees in coal mining	– 0.053	0.162	– 0.036	– 0.323	0.748
Age index	**0.084**	**0.026**	**0.209**	**3.208**	**0.002**
Unemployment rate	0.003	0.431	0.001	0.008	0.994
Business activity	**– 0.062**	**0.015**	**– 0.320**	**– 4.084**	**< 0.001**
Education level (basic)	**1.755**	**0.278**	**0.598**	**6.311**	**< 0.001**
Crime rate	**0.314**	**0.146**	**0.238**	**2.153**	**0.035**
N (districts) = 76					
R^2 = 0.901; Sig. < 0.001					
Dependent variable: Support of populism (2021)					

Tab. 8: Regression model for the support of populism (for the sample of all 76 districts)
Source: authors' calculations

Predictors	Unstandardised Coefficients		Standardised Coefficients	t	Sig.
	B	S.E.	Beta		
(Constant)	44.687	12.668		3.527	0.017
Peripherality	**8.844**	**2.840**	**0.621**	**3.113**	**0.026**
Urbanisation rate	– 0.201	0.092	– 0.858	– 2.195	0.080
Active coal mining	– 1.247	4.579	– 0.092	– 0.272	0.796
Unemployment rate	0.322	0.875	0.077	0.368	0.728
Business activity	– 0.149	0.077	– 0.488	– 1.933	0.111
Education level (basic)	0.612	0.699	0.227	0.875	0.422
Crime rate	**1.421**	**0.403**	**1.270**	**3.530**	**0.017**
N (districts) =					
R^2 = 0.979; Sig. = 0.003					
Dependent variable: Support of populism (2021)					

Tab. 9: Regression model for the support of populism (for the sample of 13 coal mining districts)
Source: authors' calculations

5. Discussion

The results of our analyses are in line with the recent studies from Australia and the United States showing the spatially diverse and in-time changing effects (from positive to negative) of coal mining during periods of growth and decline (see e.g. Hajkowicz et al., 2011; Betz et al., 2015; Williams and Nikijuluw, 2020b; Scheuch, 2020). While the positive effect of coal industries on employment and wages was still reverberating in the early 1990s in the Czech Republic, the negative impacts of coal mining and burning on the environment (as indicated by air pollution) and population vitality (evidenced by higher rates of infant mortality and abortions, and lower life expectancy), and negative consequences of the economic transformation for labour market, business environment and the quality of life (manifested in significantly above average rates of unemployment, poverty, criminality, etc.) began to characterise coal mining regions over the following decades.

Our analysis showed relatively large differences between aggregate categories of districts in terms of population changes. While the population in 2021 increased slightly compared to 1990 in non-mining districts (by an average of 2.6%) and post-mining districts (by an average of 4.1%), it decreased significantly in districts with still active mining (by an average of 11.1%). The differences in mean values between categories, however, proved not to be statistically significant, indicating a high degree of variance in population changes both between and within categories. Significant determinants of the outmigration and population loss are both of geographic nature (peripherality, urbanisation) and economic nature (lower rate of entrepreneurial activity, less job opportunities, and wages). If we look separately only at the group of coal mining and post-mining districts, then the key determinant of the population decline is geographical peripherality (location at the border of the country). These results support the assumption that there is not a direct (causal) link between coal mining decline and population loss, and that migration patterns and population changes are determined by geographical conditions and affected by other factors and their cumulative effects. While Kratzer (2015) provides evidence that counties in the Appalachian region with high levels of coal mining experience have higher population loss, Mayer (2021) suggests (based on the data from Colorado) that the collapse of the coal industry will likely not lead to significant out-migration. In this respect, however, the problem of data aggregation and the existence of significant differences at the intra-regional level must be taken into account.

Although Czech non-mining districts show a long-term lower unemployment rate, on average, than post-mining districts, and those in turn lower rates than districts with active mining, regression analysis showed that coal-related variables are not significant determinants of the unemployment. The rate of unemployment proved to be dependent on the rate of urbanisation, population density, education level, and business activity in districts. The only exception is the time that has passed since the end of coal mining that is a significant variable explaining differences in the unemployment rate in the sample of mining and post-mining districts. These results are of course limited by the spectrum of analysed indicators, and there might be other variables which can have an influence on the unemployment and job offers at both regional and sub-regional level (Freudenburg and Wilson, 2002; Schulz and Schwartzkopff, 2018).

Our analysis shows that Czech coal mining districts have a higher proportion of people with only basic education and early school leavers and also a higher proportion of ethnic minorities (specifically Roma people). Such results might suggest that coal energy is socially unjust. This finding, however, does not confirm the theory of disproportionate siting, which suggests that polluting industries and toxic facilities (such as coal-fired power plants) are deliberately planned and localised in areas with higher concentrations of poor and minority populations (see e.g. Pastor et al., 2001). The coal mines and coal power plants have been located mostly in borderland regions (see Fig. 3). These border areas were characterised by distinct depopulation (caused by the displacement of the German population after World War II), and by the growing demand for labour for the massively expanding mining and metallurgical industries in the second half of the 20th century. As a result, less educated and minority populations migrated to extensively industrialised and urbanised areas with relatively affordable housing in new prefabricated housing estates (i.e. disproportionate minority move-in). Moreover, the migration of Roma population from rural areas to large cities in Northern Bohemia and Northern Moravia during 1970s and 1980s has usually had a form of forced resettlement (see e.g. Glassheim, 2006).

Our data about the differences in voter turnout (significantly lower in coal mining districts) are in line with the study of Abreu and Jones (2021), who found that residents of former coal mining communities in the UK have lower levels of political engagement, trust and political efficacy. As documented by a recent study of local anti-coal mining resistance in the Most region in the Czech Republic (Frantál, 2017), political efficacy is significantly determined by the level of education and place attachment (which are in the long term both negatively affected by coal mining and related processes of forced resettlement, uprooting, etc.).

The low level of social capital is considered as one of the main indicators of the resource curse and a barrier for economic renewal and sustainable development. Esposito and Abramson (2021) suggest that the problem of a low level of human capital accumulation in coal mining regions lies in the long-term negative attitudes towards education and lower future orientations (particularly among males). The low social capital and the reproduction of social inequalities through the education system have been often associated with the issue of low aspirations (towards economic prosperity) of children from working class families, particularly in heavily industrialised areas. However, Bright (2011, p. 63) suggests (based on an ethnographic study of teenagers growing up in former coal mining communities in the north of England) that working class teenagers "rather than suffering a failure of aspiration, often angrily and powerfully aspire – but for something contrary to the dominant model". He calls this phenomenon a resistant aspiration (cf. Bright, 2011).

The environmental degradation together with negative economic and social phenomena (unemployment, limited job opportunities, crime) are a breeding ground for populism and resistance to the central "establishment". Our analysis shows that there is significantly higher support for populist political parties in districts with active coal mining. However, the regression analysis revealed that coal mining related variables are not direct determinants of populist support, which is determined by the age index, education level, business activity, and crime rate in districts. In the sample of coal mining and post-mining districts, also peripherality proved to be significant determinant of populist support.

Dvořák et al. (2022) suggest that regional peripheralisation processes are a key contextual condition driving populist attitudes, especially in post-communist settings. The results of their analysis (based on data from the Czech Republic and Eastern Germany) indicate that while individual-level characteristics do not alone drive populist attitudes, living in peripheral areas (which are characterised by unfavourable economic conditions and demographic decline) increases the likelihood of having populist attitudes. Similar evidence on the relationship between peripheries and populism was provided by Lysek et al. (2021).

In the Czech Republic, coal mining is not among the (explicitly pointed out) key topics on the agenda of populist parties, as it was recently articulated by political leaders, for example, in the United States or Poland (Kojola, 2019; Żuk and Żuk, 2022). The issue of decarbonisation and its consequences, however, resonates within the anti-European and anti-elitist narrative: considering climate policy, the Green Deal and other initiatives and directives of the European Commission as a result of decisions made by transnational elites that go against national interests and socioeconomic wellbeing of "ordinary people". Havlík and Spáč (2022) suggest that the more one holds such anti-elitist populist positions, the more they are likely to support coal energy and be against green policy. They did not find, however, significant differences in populist attitudes between people living in districts with and without coal power plants. This finding is in line with our results. Martinát et al. (2014) and Frantál (2017) also document that employment in the coal industry, lower education, higher income, and lower place attachment are predictors of the support for coal mining expansion at the individual level.

As concerns the real implementation of energy transition, our analysis found that coal-mining and non-mining districts do not differ significantly in terms of the installed capacity of biogas and solar power plants, but they do differ significantly as regards the exploitation of wind energy. The confirmed relationship between the presence of coal industries and the number and installed capacity of wind farms may indicate several things. First, we can assume that in environmentally deprived areas, wind energy is being adopted more positively as an alternative source to fossil fuels. This is in line with the findings of Balta-Ozkan et al. (2015), who found that households in highly polluted areas in the UK are early adopters of solar installations. Van der Horst (2007) discusses other case studies showing that the existence of heavy industry and large stacks in the area appears to make residents more likely to support wind farms as an improvement of the image of the area. Furthermore, the higher rate of wind energy implementation in Czech coal mining districts may also indicate that the economic motivation (i.e. financial compensation for local communities from developers) can have greater effects on local acceptance (see Frantál and Kunc, 2010, Frantál and Nováková, 2019). Crowe and Li (2020) surveyed residents in Illinois, Texas, and Vermont (US) and found that residents of places with historical attachment to coal mining have positive attitudes toward coal, but at the same time they have even more positive attitudes toward renewable energy sources. On the other hand, Olson-Hazboun (2018) interviewed representatives of fossil fuels-dependent communities in Utah (US) and found prevailing overall negative views of renewable energy development, driven mainly by the perceived threat to the existing local economy, the feeling that renewable energy is incongruent with local identity, and anger about policy incentives favouring renewables. These incongruous findings suggest that even though renewable energy development may offer an economic boost to declining fossil fuels-based communities, it may still be rejected in these places for different reasons. Van der Horst (2007, p. 2709) also points out that the lack of organised opposition to wind farms does not directly mean that people are in favour of them and support them. The passive acceptance can be just an indicator of low political self-efficacy and resignation, which is a common occurrence in environmentally and socially deprived areas (see also Frantál, 2017).

Regarding energy policy and planning, these results suggest that the spatial targetting of new energy projects (not only wind farms but also other energy facilities) towards environmentally and economically depressed coal mining regions will be an easier way for developers to reduce the risk of vocal public opposition. The concentration of power plants and other polluting and risky facilities (such as refineries, incinerator plants or nuclear waste disposal sites) in the landscapes "sacrificed for national energy security", raises questions of environmental and energy injustice, and the uneven spatial and social distribution of benefits and costs of energy production (see e.g. Sovacool and Dworkin, 2015; Sovacool et al., 2017). It has been suggested that renewable energy with community-based distributed generation offers unique opportunities for addressing energy justice issues, such as access and energy security, with less environmental impact (Outka, 2012). It does seem, however, that new energy systems (which should replace fossil resources) as they are currently being implemented in many countries share some characteristics with their predecessors (such as spatial concentration, procedural injustice, lack of trust, etc.) and may reproduce existing patterns of environmental injustice (Ottinger, 2013; Frantál et al., 2023).

6. Conclusions

Our study has demonstrated the validity of the resource curse hypothesis in relation to coal mining in the Czech Republic, at least as it concerns selected environmental, health and socioeconomic indicators at a sub-regional level. When considered in aggregate, coal mining and post-mining districts have significantly worse air quality, lower life expectancy and higher rates of infant mortality and abortions than non-mining districts. While thirty years ago, there was still visible a positive effect of the coal industry on employment and wages, in the following decades coal-mining and post-mining districts regularly showed higher rates of unemployment, lower business activity, and less job opportunities. Both coal mining and post-mining districts show significantly lower levels of social capital and social cohesion (greater proportion of uneducated people and ethnic minorities, higher crime rates, lower political engagement, and higher support of populism). Coal mining districts (together with other peripheral districts) are also losing population significantly. It would be wrong and problematic regarding policy implications, however, to consider coal mining districts and regions as homogenous categories.

Naturally, there are significant differences among districts within all three categories (coal mining, post-mining and non-mining). While the post-mining districts, which are in the metropolitan areas of Prague, Brno and Pilsen, are among the highest developing and population-growing districts in the country, the others (located in borderland areas) are among the worst in the country in this respect. Coal mining itself did not turn out to be a significant determinant of the unemployment and population loss in the Czech districts.

The key factors affecting these phenomena proved to be both geographical (peripherality, urbanisation, population density) and socioeconomic (education level, business activity). In this respect, we can thus speak of a curse of peripherality rather than a curse of coal. Anyway, we are aware that our conclusions are limited by the selection of available indicators and the spatial level of analysis. Other (both "hard" and "soft") factors at the regional level can have an influence on the investigated phenomena and, in addition, as Williams and Nikijuluw (2020a) emphasised, most of the socioeconomic impacts of the coal industry rely on its spillover effect, rather than direct effects.

It turns out that coal mining districts are at the forefront in terms of renewable energy developments, specifically the implementation of wind energy potential. This can be perceived as a positive phenomenon and a manifestation of higher social and political acceptance, but there is a need to address issues of spatial concentration of new energy systems, and procedural and distributive justice in this context.

From a methodological point of view, this study confirms the importance of investigating the relationships between coal mining, socioeconomic well-being, and adaptive capacity at a sub-regional level. The problem with most recent EU projects and comparative studies is that they deal with regions (NUTS3) or so-called cohesion regions (NUTS2) and consequently their results and conclusions lack greater sensitivity. More detailed analyses can reveal that there are significant differences both within coal mining regions (where there are districts or cities that are relatively stable economically and demographically), and that within a generally prosperous regions there are districts or municipalities that show some of the worst economic indicators in the country (typically the peripheries, see also Jeřábek et al., 2021). These intra-regional differences must be considered when distributing money and subsidies (e.g. from the Just Transition Fund), so that existing spatial inequalities do not deepen, or new inequalities do not arise. In the context of a "just transition", it should also not be neglected that there are areas even outside of coal mining regions that require targeted economic support.

In this context, however, a provocative question is offered: to what extent is it effective and sustainable to economically support coal mining regions in their existing industrial production structures and population scales? Czech coal mining regions and their urban agglomerations experienced dominant development in the second half of the 20th century during the period of communism characterised by the processes of centralisation and concentration (of power, production, housing development, etc.). Then the current processes of reterritorialisation and depopulation in heavily industrialised and urbanised regions can be seen as a natural process and a return to a (maybe) sustainable state. The problem, of course, is the structural nature of population changes, when environmentally and poor regions are left more often by young and highly educated people, which further limits social capital and development potential of these regions.

The ongoing energy crisis with increasing prices of fossil fuels and electricity related to the post-Covid economic recovery and the war in Ukraine, have brought another dimension to the coal-phase out debate – and not only in the Czech Republic: it is no longer just a binary "jobs versus the environment" discourse, but issues of both national energy security and peoples' rights to affordable energy and heat that are being highlighted (Mayer, 2022, Żuk and Żuk, 2021). There are even efforts (supported by the industrial lobby and some regional politicians) to reverse the process of coal phase-out. Recently, a plan to dismantle the Keyenberg wind farm in the western state of North Rhine-Westphalia (Germany) to expand the area of surface coal mining has stirred up public opinion (Oltermann, 2022). This summer, the Czech Government decided to extend coal mining in the state-owned ČSM mine in the Karviná district, which was supposed to be completed in 2022, at least until the end of 2023. The politicians however, assume that coal mining will continue here even in the following years as long as it will be at least "economically neutral" (i.e. neither profitable nor unprofitable) (Czech Television, 2022). Such speculations can bring false hope to coal mining regions and delay more radical steps towards transformation. Even though not all experiences and solutions are transferable, the studies from Germany (Oei et al., 2020b; Hermville and Kiyar, 2022) show that preventing radical changes and protecting a declining industry for decades caused increased transition costs compared to an earlier phase-out.

Acknowledgements

The paper was elaborated in the scope of the project "Enabling Positive Tipping Points towards clean-energy transitions in Coal and Carbon Intensive Regions (TIPPING+)" (H2020 No. 884565), and the long term institutional support of the Institute of Geonics, Czech Academy of Sciences (RVO: 68145535). The authors thank Dr. Hana Doležalová and Assoc. Prof. Václav Toušek for assistance in obtaining and processing of statistical data on coal mining and mining companies.

References:

ABRAHAM, J. (2019): Just transitions in a dual labor market: Right wing populism and austerity in the German energiewende. Journal of Labor and Society, 22(3): 679–693.

ABREU, M., JONES, C. (2021): The shadow of the Pithead: understanding social and political attitudes in former coal mining communities in the UK. Applied Geography, 131: 102448.

ALVES DIAS, P., KANELLOPOULOS, K., MEDARAC, H., ... & TZIMAS, E. (2018): EU coal regions: opportunities and challenges ahead.: Petten, The Netherlands, European Commission, Joint Research Centre.

BALTA-OZKAN, N., YILDIRIM, J., CONNOR, P. M. (2015): Regional distribution of photovoltaic deployment in the UK and its determinants: A spatial econometric approach. Energy Economics, 51: 417–429.

BARTON, A. (2013): Environmental mining limits in the North Bohemian Lignite Region. Envigogika, 8(4): 1–7.

BEBBINGTON, A., HINOJOSA, L., BEBBINGTON, D. H., BURNEO, M. L., WARNAARS, X. (2008): Contention and ambiguity: Mining and the possibilities of development. Development and change, 39(6): 887–914.

BERBÉE, P., BRAUN, S. T., FRANKE, R. (2022): Reversing Fortunes of German Regions, 1926–2019: Boon and Bane of Early Industrialization? Working Paper. Kiel, Hambur, ZBW – Leibniz Information Centre for Economics.

BETZ, M. R., PARTRIDGE, M. D., FARREN, M., LOBAO, L. (2015): Coal mining, economic development, and the natural resources curse. Energy Economics, 50: 105–116.

BLACK, D., McKINNISH, T., SANDERS, S. (2005): The Economic Impact of the Coal Boom and Bust. The Economic Journal, 115(503): 449–476.

BRIGHT, N. G. (2011): 'Off The Model': resistant spaces, school disaffection and 'aspiration' in a former coal-mining community. Children's geographies, 9(1): 63–78.

CAMPBELL, S., COENEN, L. (2017): Transitioning beyond coal: Lessons from the structural renewal of Europe's old industrial regions, CCEP Working Paper 1709, Crawford School of Public Policy, Australian National University.

ČERNOCH, F., LEHOTSKÝ, L., OCELÍK, P., OSIČKA, J., VENCOUROVÁ, Ž. (2019): Anti-fossil frames: Examining narratives of the opposition to brown coal mining in the Czech Republic. Energy Research & Social Science, 54: 140–149.

CROWE, J. A., LI, R. (2020): Is the just transition socially accepted? Energy history, place, and support for coal and solar in Illinois, Texas, and Vermont. Energy Research & Social Science, 59: 101309.

Czech Statistical Office (CZSO) (2012): Historical energy statistic yearbook [online]. Available at: http://www.czso.cz/csu/czso/8113-12-n_2012-01

Czech Television (2022): Mining in OKD will continue after 2023, as long as it is not unprofitable, minister Stanjura assumes. [online]. Available at: https://ct24.ceskatelevize.cz/ekonomika/3526561-tezba-v-okd-bude-po-roce-2023-pokracovat-pokud-nebude-ztratova-predpoklada

DELLA BOSCA, H., GILLESPIE, J. (2018): The coal story: Generational coal mining communities and strategies of energy transition in Australia. Energy Policy, 120: 734–740.

DOMENECH, J. (2008): Mineral resource abundance and regional growth in Spain, 1860–2000. Journal of International Development, 20(8): 1122–1135.

DROBNIAK, A. (2020): Development in regions lagging behind–the case of coal and post-coal regions. Biblioteka Regionalisty, (20): 20–37.

DVOŘÁK, T., ZOUHAR, J., TREIB, O. (2022): Regional Peripheralization as Contextual Source of Populist Attitudes in Germany and Czech Republic. Political Studies, (online first): 00323217221091981.

ESPOSITO, E., ABRAMSON, S. F. (2021): The European coal curse. Journal of Economic Growth, 26(1): 77–112.

EUROPEAN COMMISSION (2017): Terms of reference: Initiative on coal and carbon-intensive regions [online]. Available at: https://ec.europa.eu/energy/topics/oil-gas-and-coal/EU-coal-regions/coal-regions-transition_en

EUROPEAN COMMISSION (2019): Social Sciences and Humanities (SSH) aspects of the Clean-Energy Transition [online]. Available at: https://cordis.europa.eu/programme/id/H2020_LC-SC3-CC-1-2018-2019-2020

EVERINGHAM, J. A., SVOBODOVA, K., LÈBRE, É., OWEN, J. R., WORDEN, S. (2022): Comparative capacity of global mining regions to transition to a post-mining future. The Extractive Industries and Society, 11: 101136.

FLEMING, D. A., MEASHAM, T. G., PAREDES, D. (2015): Understanding the resource curse (or blessing) across national and regional scales: Theory, empirical challenges and an application. Australian Journal of Agricultural and Resource Economics, 59(4): 624–639.

FRANTÁL, B. (2016): Living on coal: Mined-out identity, community displacement and forming of anti-coal resistance in the Most region, Czech Republic. Resources Policy, 49(9): 385–393.

FRANTÁL, B. (2017): Under the curse of coal: Mined-out identity, environmental injustice and alternative futures for coal energy landscapes. In: Bouzarovski, S., Pasqualetti, M. J. & Castán Broto, V. (eds.): The Routledge Research Companion to Energy Geographies, (pp. 200–216). New York, Routledge.

FRANTÁL, B., KUNC, J. (2010): Factors of the uneven regional development of wind energy projects (a case of the Czech Republic). Geografický Časopis/Geographical Journal (Slovak), 62(3): 183–201.

FRANTÁL, B., NOVÁKOVÁ, E. (2014): A Curse of Coal? Exploring Unintended Regional Consequences of Coal Energy in the Czech Republic. Moravian Geographical Report, 22(2): 55–65.

FRANTÁL, B., NOVÁKOVÁ, E. (2019): On the spatial differentiation of energy transitions: Exploring determinants of uneven wind energy developments in the Czech Republic. Moravian Geographical Reports, 27(2): 79–91.

FRANTÁL, B., DVOŘÁK, P. (2022): Reducing energy poverty in deprived regions or supporting new developments in metropolitan suburbs? Regional differences in the use of subsidies for home energy efficiency renovations. Energy Policy, 171: 113250

FRANTÁL, B., FROLOVA, M., LIÑÁN-CHACÓN, J. (2023): Conceptualizing the patterns of land use conflicts in wind energy development: Towards a typology and implications for practice. Energy Research and Social Science, 95: 102907.

FREESE, B. (2003): Coal: A Human History. Cambridge: Basic Books.

FREUDENBURG, W. R., GRAMLING, R. (1998): Linked to what? Economic linkages in an extractive economy. Society & Natural Resources, 11(6): 569–586.

FREUDENBURG, W. R., WILSON, L. J. (2002): Mining the data: Analyzing the economic implications of mining for nonmetropolitan regions. Sociological Inquiry, 72(4): 549–575.

GLASSHEIM, E. (2006): Ethnic Cleansing, Communism, and Environmental Devastation in Czechoslovakia's Borderlands, 1945–1989. The Journal of Modern History, 78(1): 65–92.

GLASSHEIM, E. (2007): Most, the Town that Moved: Coal, Communists and the 'Gypsy Question' in Post-War Czechoslovakia. Environment and History, 13(4): 447–476.

Government of the Czech Republic (2022): Programme Statement of the Government [online]. Available at: https://www.vlada.cz/cz/programove-prohlaseni-vlady-193547/

HAJKOWICZ, S. A., HEYENGA, S., MOFFAT, K. (2011): The relationship between mining and socio-economic well being in Australia's regions. Resources Policy, 36(1): 30–38.

HANSLIAN, D. et al. (2008): Odhad realizovatelného potenciálu větrné energie na území ČR. Praha, ÚFA AV ČR.

HAVLÍK, V., SPÁČ, P. (2022): Populism, elite cues and coal power plants: Public attitudes to fossil fuels reduction in Central Europe. Paper presented at the 7th Prague Populism Conference „Current Populism in Europe and Climate Change", Prague, 15–17 May, 2022.

HERMWILLE, L., KIYAR, D. (2022): Late and expensive: The political economy of coal phase-out in Germany. In The Political Economy of Coal (pp. 21–39). Routledge.

IVANOVA, G. (2014): The mining industry in Queensland, Australia: Some regional development issues. Resources Policy, 39: 101–114.

JEŘÁBEK, M., DOKOUPIL, J., FIEDOR, D., KREJČOVÁ, N., ŠIMÁČEK, P., WOKOUN, R., ZICH, F. (2021): Nové vymezení periferií Česka. Geografie, 126(4): 419–443.

JONEK-KOWALSKA, I., TUREK, M. (2022): The Economic Situation of Polish Cities in Post-Mining Regions. Long-Term Analysis on the Example of the Upper Silesian Coal Basin. Energies, 15(9): 3302.

KOJOLA, E. (2019). Bringing back the mines and a way of life: Populism and the politics of extraction. Annals of the American Association of Geographers, 109(2): 371–381.

KRATZER, N. W. (2015): Coal mining and population loss in Appalachia. Journal of Appalachian Studies, 21(2): 173–188.

KUBA, O., HUDEC, O., STEJSKAL, J. (2022): Economic Discontent and Anti-System Political Parties in the Czech Republic. Problems of Post-Communism, 1–12.

LATZKO, D. A. (2011): Coal Mining and Regional Economic Development in Pennsylvania, 1810–1980. Economies et Sociétés (Serie 'Histoire Economique Quantitative'), 44: 1627–1649.

LEHOTSKÝ, L., ČERNOCH, F., OSIČKA, J., OCELÍK, P. (2019): When climate change is missing: Media discourse on coal mining in the Czech Republic. Energy Policy, 129: 774–786.

LI, Q., STOECKL, N., KING, D., GYURIS, E. (2018): Using both objective and subjective indicators to investigate the impacts of coal mining on wellbeing of host communities: a case-study in Shanxi Province, China. Social Indicators Research, 137(3): 895–921.

LOCKIE, S., FRANETTOVICH, M., PETKOVA-TIMMER, V., ROLFE, J., IVANOVA, G. (2009): Coal mining and the resource community cycle: a longitudinal assessment of the social impacts of the Coppabella coal mine. Environmental Impact Assessment Review, 29(5): 330–339.

LYSEK, J., PÁNEK, J., LEBEDA, T. (2021): Who are the voters and where are they? Using spatial statistics to analyse voting patterns in the parliamentary elections of the Czech Republic. Journal of Maps, 17(1): 33–38.

MANCINI, L., SALA, S. (2018): Social impact assessment in the mining sector: Review and comparison of indicators frameworks. Resources Policy, 57: 98–111.

MARTIN, R., SUNLEY, P. (2015): On the Notion of Regional Economic Resilience: Conceptualization and Explanation. Journal of Economic Geography 15(1): 1–42.

MARTINÁT, S., NAVRÁTIL, J., DVOŘÁK, P., KLUSÁČEK, P., KULLA, M., KUNC, J., HAVLÍČEK, M. (2014): The expansion of coal mining in the depression areas - A way to development?. Human Geographies Journal of Studies & Research in Human Geography, 8(1): 5–15.

MAYER, A. (2021): Economic Change, the Death of the Coal Industry, and Migration Intentions in Rural Colorado, USA. Journal of Rural Social Sciences, 36(1): 4.

MAYER, A. (2022): More than just jobs: Understanding what drives support for a declining coal industry. The Extractive Industries and Society, 9: 101038.

MEASHAM, T. G., WALTON, A., GRAHAM, P., FLEMING-MUNOZ, D. A. (2019): Living with resource booms and busts: Employment scenarios and resilience to unconventional gas cyclical effects in Australia. Energy Research & Social Science, 56: 101221.

MORRICE, E., COLAGIURI, R. (2013): Coal mining, social injustice and health: A universal conflict of power and priorities. Health & Place, 19: 74–79.

NORD, M., LULOFF, A. E. (1993): Socioeconomic Heterogeneity of Mining-Dependent Counties 1. Rural Sociology, 58(3): 492–500.

OCELÍK, P., SVOBODOVÁ, K., HENDRYCHOVÁ, M., LEHOTSKÝ, L., ... & LECHNER, A. (2019): A contested transition toward a coal-free future: Advocacy coalitions and coal policy in the Czech Republic. Energy Research & Social Science, 58: 101283.

OEI, P. Y., HERMANN, H., HERPICH, P., HOLTEMÖLLER, O., LÜNENBÜRGER, B., SCHULT, C. (2020a): Coal phase-out in Germany–Implications and policies for affected regions. Energy, 196: 117004.

OEI, P. Y., BRAUERS, H., HERPICH, P. (2020b): Lessons from Germany's hard coal mining phase-out: policies and transition from 1950 to 2018. Climate Policy, 20(8): 963–979.

OLSON-HAZBOUN, S. K. (2018): "Why are we being punished and they are being rewarded?" views on renewable energy in fossil fuels-based communities of the US west. The Extractive Industries and Society, 5(3): 366–374.

OLTERMANN, P. (2022): Stop dismantling German windfarm to expand coalmine, say authorities. The Guardian, October 26, 2022 [online]. Available at: https://www.theguardian.com/world/2022/oct/26/german-windfarm-coalmine-keyenberg-turbines-climate

OSIČKA, J., KEMMERZELL, J., ZOLL, M., LEHOTSKÝ, L., ČERNOCH, F., KNODT, M. (2020). What's next for the European coal heartland? Exploring the future of coal as presented in German, Polish and Czech press. Energy Research & Social Science, 61: 101316.

OTTINGER, G. (2013): The winds of change: environmental justice in energy transitions. Science as Culture, 22(2): 222–229.

OUTKA, U. (2012): Environmental justice issues in sustainable development: Environmental justice in the renewable energy transition. Journal of Environmental and Sustainability Law, 19(1): 60.

OXLEY, L. (2014): The Socioeconomic Impact of Coal in the Appalachian Region of Kentucky. MPA/MPP Capstone Projects. Paper 17: 1–27.

PASTOR, M., SADD, J., HIPP, J. (2001): Which Came First? Toxic Facilities, Minority Move-in, and Environmental Justice. Journal of Urban Affairs, 23(1): 1–21.

PERDUE, R. T., PAVELA, G. (2012): Addictive Economies and Coal Dependency: Methods of Extraction and Socioeconomic Outcomes in West Virginia, 1997–2009. Organization & Environment, 25(4): 368–384.

PETKOVA-TIMMER, V., LOCKIE, S., ROLFE, J., IVANOVA, G. (2009): Mining developments and social impacts on communities: Bowen Basin case studies. Rural Society, 19(3): 211–228.

PETROVA, S., MARINOVA, D. (2013): Social impacts of mining: Changes within the local social landscape. Rural Society, 22(2): 153–165.

ŘÍHA, M., STOKLASA, J., LAFAROVÁ, M., DEJMAL, I., MAREK, J., PAKOSTA, P. (2011): Environmental Mining Limits in North Bohemian Lignite Region. Společnost pro krajinu, Praha, Czech Republic [online]. Available at: https://frontiers-of-solitude.org/sites/default/files/file-uploads/limitsreport.pdf

RIVA, M., TERASHIMA, M., CURTIS, S., SHUCKSMITH, J., CARLEBACH, S. (2011): Coalfield health effects: variation in health across former coalfield areas in England. Health and Place, 17(2): 588–597.

ROBINSON, G. M., CARSON, D. A. (2016): Resilient communities: transitions, pathways and resourcefulness. The Geographical Journal, 182(2): 114–122.

SCHEUCH, E. (2020): Life After Coal: The Decline and Rise of West Virginia Coal Country [online]. Available at: https://news.climate.columbia.edu/2020/08/07/coal-rise-decline-west-virginia/

SCHULZ, S., SCHWARTZKOPFF, J. (2018): European Lignite-Mining Regions in Transition Challenges in the Czech Republic and Germany. Prague, Heinrich-Böll-Stiftung and Deutsche Umwelthilfe in cooperation with EG3 and Glopolis.

SHANDRO, J. A., VEIGA, M. M., SHOVELLER, J., SCOBLE, M., KOEHOORN, M. (2011): Perspectives on community health issues and the mining boom–bust cycle. Resources Policy, 36(2): 178–186.

SHRIVER, T. E., ADAMS, A. E., LONGEST, L. (2022): "Cursed by Coal": Climate Change and the Battle over Mining Limits in the Czech Republic. Society & Natural Resources, 35(2): 111–128.

SIVEK, M., VLČEK, T., KAVINA, P., JIRÁSEK, J. (2017): Lifting lignite mining limits – correction of the Czech Republic energy policy. Energy Sources, Part B, 12(6): 519–525.

SMERALDO SCHELL, K., SILVA, J. M. (2020): Resisting despair: Narratives of disruption and transformation among white working-class women in a declining coal-mining community. Gender & Society, 34(5): 736–759.

SOVACOOL, B. K., DWORKIN, M. H. (2015): Energy justice: Conceptual insights and practical applications. Applied Energy, 142: 435–444.

SOVACOOL, B. K., BURKE, M., BAKER, L., KOTIKALAPUDI, C. K., WLOKAS, H. (2017): New frontiers and conceptual frameworks for energy justice. Energy Policy, 105: 677–691.

STOGNIEF, N., WALK, P., SCHÖTTKER, O., OEI, P. Y. (2019): Economic resilience of German lignite regions in transition. Sustainability, 11(21): 5991.

SVOBODOVA, K., OWEN, J. R., HARRIS, J., WORDEN, S. (2020): Complexities and contradictions in the global energy transition: A re-evaluation of country-level factors and dependencies. Applied energy, 265: 114778.

THORLEIFSSON, C. (2016): From coal to Ukip: the struggle over identity in post-industrial Doncaster. History and Anthropology, 27(5): 555–568.

TONTS, M., PLUMMER, P., LAWRIE, M. (2012): Socio-economic wellbeing in Australian mining towns: A comparative analysis. Journal of Rural Studies, 28(3): 288–301.

VAN DER HORST, D. (2007): NIMBY or not? Exploring the relevance of location and the politics of voiced opinions in renewable energy siting controversies. Energy policy, 35(5): 2705–2714.

WILLAND, N., MOORE, T., HORNE, R., ROBERTSON, S. (2020): Retrofit Poverty: Socioeconomic Spatial Disparities in Retrofit Subsidies Uptake. Buildings and Cities, 1(1): 14–35.

WILLIAMS, G., NIKIJULUW, R. (2020a): The economic and social benefit of coal mining: the case of regional Queensland. Australian Journal of Agricultural and Resource Economics, 64(4): 1113–1132.

WILLIAMS, G., NIKIJULUW, R. (2020b): Economic and social indicators between coal mining LGAs and non-coal mining LGAs in regional Queensland, Australia. Resources policy, 67: 101688.

WOOLLEY, S. M., MEACHAM, S. L., BALMERT, L. C., TALBOTT, E. O., BUCHANICH, J. M. (2015): Comparison of mortality disparities in central Appalachian coal-and non–coal-mining counties. Journal of Occupational and Environmental Medicine, 57(6): 687–694.

ŻUK, P., ŻUK, P., PLUCIŃSKI, P. (2021): Coal basin in Upper Silesia and energy transition in Poland in the context of pandemic: The socio-political diversity of preferences in energy and environmental policy. Resources Policy, 71: 101987.

ŻUK, P., ŻUK, P. (2022): The Turów Brown Coal Mine in the shadow of an international conflict: Surveying the actions of the European Union Court of Justice and the populist policies of the Polish government. The Extractive Industries and Society, 10: 101054.

ZULLIG, K. J., HENDRYX, M. (2010): A comparative analysis of health-related quality of life for residents of US counties with and without coal mining. Public Health Reports, 125(4): 548–555.

Please cite this article as:

FRANTÁL, B., FRAJER, J., MARTINÁT, S., BRISUDOVÁ, L. (2022): The curse of coal or peripherality? Energy transitions and the socioeconomic transformation of Czech coal mining and post-mining regions. Moravian Geographical Reports, 30(4): 237–256. doi: https://doi.org/10.2478/mgr-2022-0016

Appendices

Appendix 1: List of variables included in statistical analyses

Category[a] / Variable	Measure[Source of data]
Geography and environment	
Area	Total area (km^2)[1]
Peripheral location	District is located on the country´s border (yes/no)[1]
Agricultural land	Share of agricultural land on total area (%)[2]
Forests	Share of forests on total area (%)[3]
Landscape protected areas	Share of national parks & protected landscape areas on total area (%)[1]
Coefficient of ecological stability	Ratio of areas of stable and unstable landscape-forming elements[1]
Air pollution (PM)	Concentration of particulate matter (PM) emissions (tons/km^2)[1]
Air pollution (CO)	Concentration of carbon monoxide (CO) emissions (tons/km^2)[1]
Population & health	
Population density	Population per km^2
Urbanisation rate	Share of urban population on total population (%)[1]
Population change	Change (%) in the number of inhabitants between 1990 and 2021[2]
Average age	Average age of the population (years)[1]
Index of aging	Number of persons aged 65+ per 100 persons aged 0–14[1]
Coefficient of femininity	Share of females on total population (%)[1]
Life expectancy	Male life expectancy at birth (2016–2020)[1]
Infant mortality	Infant mortality (‰)[1]
Abortions	Number of abortions per 100 births[1]
Respiratory diseases	Deaths of respiratory diseases per 100,000 population[1]
Labour market and economy	
Employment in coal mining	Share of employees in coal mining on productive population (%)[4]
Employment in industry	Share of employees in industry on productive population (%)[1]
Unemployment rate	Unemployment rate (%)[1]
Job vacancy rate	Number of job applicants per one job vacancy[1]
Business activity	Total business units registered per 1,000 population1[2]
Average monthly wage	Average monthly wage (CZK)[1]
Property value	Average price of flats (millions CZK)[5]
Social capital & social cohesion	
Education level (basic)	Share of persons with basic or no formal education (%)[1]
Education level (university)	Share of persons with university education (%)[1]
Share of natives	People with permanent living at the place of their birth (%)[1]
Share of ethnic minorities	Share of Roma ethnic people on total population (‰)[1]
Crime rate	Ascertained offences per 1,000 population[1]
Voter turnout	Turnout in parliamentary elections 2021 (%)[1]
Support of populism	Share of people voting for populist parties (SPD+ANO)[b] (%)[1]
Energy production	
Coal power capacity	Installed capacity of coal-fired power plants (MW)[6]
Biogas capacity	Installed capacity of biogas/AD plants (MW)[7]
Solar power capacity	Installed capacity of solar/PV power plants (MW)[8]
Wind power potential	Realizable potential of wind power (MW)[9]
Wind power capacity	Installed capacity of wind power plants (MW)[10]

Notes:
[a] The categorisation of variables is only indicative as some variables may belong to several categories.
[b] The populist political parties are represented by the "Action of Dissatisfied Citizens" (ANO 2011) and "Freedom and Direct Democracy" (SPD) in our research.
Sources of data:
[1] Czech Statistical Office (2021): Census 2021; Districts of the Czech Republic, 2018; Census, 2011;
[2] Ministry of Agriculture (2021): Public Register of Land (pLPIS));
[3] State Administration of Land Surveying and Cadastre (2011): Share of forests in districts in the CR;
[4] Czech Mining Authority: Mining Yearbooks (1992–2015);
[5] Institute of Regional Information (IRI) (2010): Prices of flats in the districts of the Czech Republic
[6] Energy Regulatory Office of the Czech Republic (ERU) (2021): Yearly Report on the Operation of the Czech Electricity Grid for 2021. For the purpose of this analysis, we created a database of selected thermal and combined-cycle power plants which met the following conditions: (i) have a total installed capacity of at least 100 MW; and (ii) the major fuel is brown or black coal (altogether 28 power plants were included, with total installed capacity nearly 10,000 MW which is more than 80% of the overall installed capacity of thermal power plants in the country).
[7] Czech Biogas Association (2021): Map of biogas stations in the Czech Republic [online]. Available at: https://biom.cz/cz/produkty-a-sluzby/bioplynove-stanice
[8] Energy Regulatory Office of the Czech Republic (ERU) (2015): Database of the photovoltaic power plants connected to the grid.
[9] Hanslian, D., Hošek, J., Štekl, J. (2008): Estimation of the realizable potential of wind energy in the Czech Republic. Praha, ÚFA AV ČR.
[10] Czech Wind Energy Association (2021): Wind energy in the Czech Republic: Statistics [online]. Available at: https://csve.cz/en/clanky/statistika/281