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WAŁBRZYCH MEANT COAL: THE CLOSURE OF THE WAŁBRZYCH MINES IN THE CONTEXT OF THE SOCIO-TECHNICAL CARBON LOCK-IN

WAŁBRZYCH OZNACZAŁ WĘGIEL: LIKWIDACJA WAŁBRZYSKICH KOPALŃ W UJĘCIU SOCJOTECHNICZNEJ BLOKADY WĘGLOWEJ

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Abstract: During the transition of the Polish economy to a free market system in the 1990s, the coal mines in Wałbrzych were closed after nearly five centuries of extraction, which triggered over 20 years of deep socio-economic crisis in the city. This paper aimed to discuss this closure in the long-term perspective, leveraging the framework of path dependence, and in particular the socio-technical carbon lock-in. It claims that after WWII, a socio-technical lock-in occurred in Wałbrzych and the rapid closure of the mines was a consequence of its breakup resulting from the exogenous factor in the form of shock therapy. The discussion of the case of Wałbrzych contributes to the current debate on the phasing out of Poland's coal sector slowed down by the coal lock-in.

Keywords: Wałbrzych, coal phase-out, socio-technical, carbon lock-in, path dependency.

Streszczenie: Po niemal 500 latach działalności wałbrzyskie kopalnie zostały zamknięte w latach 90. ubiegłego wieku w ramach polskiej transformacji systemowej, co zapoczątkowało trwający ponad 20 lat głęboki kryzys społeczno-ekonomiczny w mieście. Niniejszy artykuł ma na celu omówienie ich

likwidacji w długiej perspektywie czasowej przy wykorzystaniu koncepcji trajektorii rozwoju (*path dependence*), a w szczególności pojęcia socjotechnicznej blokady węglowej (*socio-technical carbon lock-in*). Artykuł dowodzi, że po II wojnie światowej w Wałbrzychu wytworzyła się wyżej wspomniana blokada, a szybkie zamknięcie kopalń było konsekwencją jej przerwania pod wpływem zewnętrznego czynnika w postaci terapii szokowej. Przykład Wałbrzycha wpisuje się w obecną dyskusję na temat wygaszania sektora węglowego w Polsce, opóźnianego przez blokadę węglową (*carbon lock-in*).

Słowa kluczowe: Wałbrzych, likwidacja przemysłu węglowego, socjotechniczny, blokada węglowa, trajektoria rozwoju.

1. Introduction

In 1989, after the collapse of PRL (the Polish People's Republic), the economy of Poland started its transition from a centrally planned to a free market system. As part of that transformation, coal mining in Wałbrzych – a city located in southwest Poland – was abandoned after nearly five centuries of continuous extraction. This process started in 1990, when four collieries operating in Wałbrzych made up around 20% of the city's total employment; the complete coal phase-out took eight years. It marked the beginning of a long socio-economic crisis in the city with the unemployment rate as high as 30%, heavily affecting young people. While Wałbrzych was recognized as an example of the negative consequences of Poland's shock therapy's, members of the local community – often pushed into poverty and having lost their high social status associated with mining in the former political system – naturally raised the question which still echoes until today: why were the local mines closed?

The above question is discussed in literature predominantly from a technical point of view (i.e. Piątek, Czocher, Kowalski). Alternatively, some papers focus on the socio-economic or geological outcomes of the closure, only briefly touching upon underlying reasons (i.e. Kosmaty, Kowalski). This paper contributes to the discussion with a long-term economic perspective, leveraging the concept of a socio--technical carbon lock-in. It aimed to explain the mechanisms which led to the city's dependence on coal mining well until the late 20th century, and which subsequently allowed for their rapid closure.

This paper claims that the carbon phase-out in Wałbrzych was a consequence of lock-in disruption stemming from exogenous shock in the form of the political and economic transformation in Poland, showing that since the 19th century coal extraction in Wałbrzych was continued despite the validity of a phase-out. The technological, environmental as well as economic hurdles were recognized, however a sequence of historical and political events determined the further operation of collieries. After 1946, carbon lock-in occurred in Wałbrzych with its three strongest factors being protection from market competition, the socio-technical imagery around coal in Poland, and the micro-economic risks in the case of the mines' closure. Those levers were easily eliminated in the new economic system which allowed for the rapid closure of all the mines in the city.

The first section of this paper, based on desk research, introduces the framework of path dependence, and in particular the socio-technical carbon lock-in proposed by Trencher, Rinschield, Duygan, Truong and Asuka (2020). The lock-in approach is highly relevant to the subject of this paper given that despite the acknowledged validity of the phase-out, collieries in Wałbrzych remained operational until the 1990s. The second section outlines the history of coal mining in Wałbrzych, highlighting the turning points which determined the city's dependence on coal, as well as the factors driving the emergence of the lock-in. This part is based on the desk research and analysis of archive data from the Statistical Bureau in Wałbrzych and the State Archives branch in Kamieniec Ząbkowicki. The third part discusses the sources of the lock-in in Wałbrzych within the socio-technical carbon lock-in framework and briefly describes its disruption along with the ensuing consequences. The last section outlines the key findings and conclusions, linking it with the current debate on the coal phase-out in Poland.

2. Socio-technical carbon lock-in − the special case of path dependence

2.1. Path dependence

The concept of path dependence was initially defined to explain the dominance of one, inferior (efficiency, cost or otherwise) technology over another; emblematic cases are QWERTY and VHS described by David. Since it gained momentum in the 1990s (Henning, Stam, & Wenting, 2012), path dependence has been applied in a wide range of research fields outside economics such as history, political science, and management (Martin & Sunley, 2006). Contrary to classical economics which focused on efficiency, it centered the argument around historical events, triggering self-reinforcement processes[1] eventually leading to the lock-in. Henning et al. (2012) point to common aspects of the two 'classical' path dependence models introduced by David and Arthur. Firstly, small and unpredictable historical events affect economic structures in the long run (inflexibility and non-ergodicity (Arthur, 1989)). Secondly, new opportunities created by those small events are reinforced which leads to the lock-in. Lastly, the lock-in can be disrupted by external shocks.

Liebowitz and Margolis proposed a classification of path dependence into three categories depending on the outcome's efficiency and availability of alternative choices. Efficiency is understood as *path-efficiency,* which holds true if an implementation of the existing alternative technology would not have paid off better than of the one currently in place (Arthur, 1989). First-degree path dependence exists

[1] David discusses positive network externalities: technical interrelatedness, economies of scale, the quasi-irreversibility of investments. Arthur discusses increasing returns: large fixed initial set-up costs, dynamic learning effects, co-ordination effects, self-reinforcing expectations (Martin & Sunley, 2006).

when the outcome is effective. Second-degree path dependence occurs when the outcome is not fully satisfying but was the most efficient with the given state of knowledge. Finally, third-degree path dependence shows an inefficient outcome, while feasible alternatives not only exist but are also known to the agents (Liebowitz & Margolis, 1995).

2.2. Socio-technical carbon lock-in

A carbon lock-in is a specific case of a lock-in, which at the same time is a particular type of path dependence (Seto et al., 2016), and can be defined as an outcome of a non-ergodic sequence of events, gradually decreasing the flexibility of the economy (Arthur, 1989). Carbon industries deserve separate discussion due to the "large capital costs, long infrastructure lifetimes and interrelationships between the socioeconomic and technical systems involved" (Seto et al., 2016). A carbon lock-in was conceptualized by Urnuh, who discussed the techno-institutional complex (TIC) model built around the interdependency of large technological systems, infrastructure and institutions (private and public) in the context of carbon-dependent industries (Unruh, 2000). In later studies the additional lever of behavioural factor was added to the framework (Seto et al., 2016).

Trencher, Rinschield, Duygan, Truong and Asuka (2020) proposed a new framework of socio-technical carbon lock-in in their recent paper, combining factors from multiple academic fields. They classified lock-in sources into four categories: material, human, non-material and exogenous.

Material factors are split into three levers: infrastructure, assets and technology, which build up a lock-in since coal-related infrastructure and assets are most often of a singular purpose and characterized by high capital cost thus limiting their utility outside the coal context.

The second category – human actors – is related to the composition and balance of the power controlling the industry.

Non-material sources comprise the formal and informal institutions, knowledge and micro-economic factors. While formal institutions are codified, with explicit rules and behaviour driving the actions of the actors by obliging them to act in accordance certain assumptions, the informal ones are cognitive schemes, non--codified rules, routines and narratives shaping their expectations and responses to potential changes.

The facet of knowledge and competences reflects individual and organizational knowledge and skills within the specific technology. When accumulated, they could pose a barrier to absorbing new competences (both on individual and firm level) and block innovation.

Finally, exogenous factors are all the broader, macro-level conditions, which impact on (reinforce or constrain) the abovementioned lock-in sources. These may include, among others, environmental conditions, geographical features or societal and political aspects.

3. Development of coal mining in Wałbrzych

3.1. Emergence of coal mining in Wałbrzych (pre-1913)

The earliest record of collieries in Wałbrzych dates back to 1536 (Piątek & Piątek, 1999), however the leading position of coal mining in the city started to emerge only in the second half of the 18th century, resulting from the increase in demand and infrastructure advancement. Due to deforestation, coal gained attractiveness as a burning fuel. Demand was additionally stimulated by the growth of industry in Silesia (mainly food, brewery, distillery, confectionery, and mineral processing) and the opening of the first coke plant in Wałbrzych in 1776 (Czaja, 2017). The development of coal trails eased the removal and transportation of coal (Piątek & Piątek, 1999).

In the first half of the 19th century, the above-mentioned mechanisms were reinforced by the inflow of workforce from the declining weaving industry[2] and the new external markets (i.e. Saxony, Moravia, Pomerania), which opened thanks to the construction of the railway between Wałbrzych and Wrocław in 1853 (Jeżowski, 1961). Local coal mining experienced rapid growth, both in output and rate of employment (Piątek & Piątek, 1999).

The railway infrastructure expanding in the late 19th century, opened up further markets for local coal, while also being its significant consumer (Jeżowski, 1961). Moreover, a network of interrelated entities developed in Wałbrzych – four new coke plants enabled the establishment of a gas plant and subsequently the ceramics industry (Czaja, 2017). The Lower Silesia region, including the closest neighbourhood of Wałbrzych, was developing mainly towards light industry – clothing, food, glass, mineral – in contrast to the Upper Silesia, the Ruhr and Saar regions which were dominated by heavy industry. Compared to those major industrial areas, Wałbrzych collieries offered low salaries: in 1910, a local miner's wage averaged 88% of that in Upper Silesia and only 64% of the one in the Ruhr (Retecki, 2010). Low earnings combined with high employee demand in rapidly growing west German industrial areas resulted in the massive emigration of qualified industrial workers from Lower Silesia at the end of the 19th century (Jeżowski, 1961; Róg, 2014).

3.2. Marginalization of Wałbrzych as an industrial area (1918-1939)

After WWI, the position of Wałbrzych coal mining was gradually being marginalised. Structural differences in comparison to the leading industrial regions of Germany

[2] Weaving was a major industry in Lower Silesia (with Wałbrzych being an important hub) since the 18th century, reaching far-flung international markets (Western Europe, America). It collapsed mainly due to the introduction of the Continental Blockade in 1809, cutting off Lower Silesia from up to 80% of the markets, which left an estimated 50,000 textile workers unemployed (Czaja, 2017; Jeżowski, 1961).

intensified – the war stimulated the growth of heavy industry, while Wałbrzych which was dominated by light industry saw no major investments (Jeżowski, 1961). Local coal started to lose its external markets to cheaper alternatives from heavily invested areas such as the Ruhr, Saar and Upper Silesia (Jeżowski, 1961; Róg, 2014).

The price ineffectiveness of local mines discouraged investors. Underinvestment entailed low technical condition which, in turn, resulted in low efficiency (Róg, 2014), intensified by challenging geological conditions (narrow deposits, high concentration of methane). This provoked debate on the coal phase-out in Wałbrzych, which was put off due to the outbreak of WWII (Czaja, 2017).

3.3. Incorporation of Wałbrzych into Poland (1946-1949)

Due to the change of borders after WWII, Wałbrzych became part of Poland. At that time the local collieries were only at 50-60% of their pre-war capacity due to extensive war exploitation: decentralized extraction, neglected preparatory work and losses in production assets. Additionally, the mines were barely mechanized – the only mechanical device in use underground was the jackhammer (Retecki, 2010).

Despite technical hurdles, Poland's pressing need for coal caused by post-war reconstruction (as a fuel and export product generating major state income) determined the continuation of mines' operation. The economic plan for 1946--1949 assumed coal extraction in Poland at the maximum possible capacity. While the target was exceeded by 4 p.p. at national level, Wałbrzych missed it by 33 p.p. (Skiba, 1979). As demonstrated in Table 1, the growth of output was slow and not steady.

Table 1. Hard coal output, indexed (1946=100)

	1946	1947	1948	1949
Poland (excluding Wałbrzych)	100	125	149	157
Wałbrzych	100	107	115	110

Source: own elaboration according to "Statystyka przemysłu węglowego w Polsce 1947-1975" as cited in (Skiba, 1979).

The technical issues deepened due to the shortage of specialist spare parts which no longer could be sourced from central Germany (Skiba, 1979). On top of that, collieries struggled with a deficit of qualified workforce and high labour fluctuation. The latter was entailed by overpopulation[3] and the demanding working environment stemming from the tough geological and technical conditions.

[3] Overpopulation resulted from the settlement of Poles and the resettlement of German population enforced by the change of borders. The latter was delayed by the local authorities since it implied loss of local mining know-how, which then resulted in the city's overpopulation causing housing and food supply shortages (Czaja, 2017; Skiba, 1979).

After the war, the collieries played an extensive role in building Wałbrzych's social base. Facing housing and supply shortages, they took over the distribution of everyday-necessity goods, provided accommodation and childcare facilities (Jarocka, Jaworski, & Panfil, 1978). The miners sports club "Górnik" (Eng. 'miner') founded in 1949 was a strong integration factor for local society. In the same year, a mining vocational school was established.

3.4. Operation of Wałbrzych mines under a centrally planned economy (1950-1989)

Following the 'coal-absorbent' country reconstruction phase, the 1950s marked the start of the intense industrialization in Poland. This further drove internal coal up – both as a fuel and export product (Jaros, 1975). Meeting such a high demand required a notable effort from the mining industry – with its limited investment capacity, the workforce needed to be motivated. Already in late 1949, the authorities passed an act on special privileges for miners with regard to their remuneration, social facilities and healthcare protection, retirement and leisure (40). The war--like the slogans used by authorities (i.e. "the battle for coal", "the great battle for coal"), presented coal extraction not only as hard work but also a patriotic duty and a source of the country's survival. The narrative of "Poland standing on coal" was employed by Communist leaders throughout the existence of PRL (Kuchler, 2018). The second wave of legal privileges for miners was introduced in 1980s. It involved, for example, triple salary for weekend work and stores open exclusively to miners, offering otherwise unavailable goods (e.g. TVs, automatic washing machines, etc.) (Piątek & Piątek, 1999).

Throughout the 1950s and 60s, output growth in the Wałbrzych mines was slow and unstable. Excluding 1950-1955, it did not exceed the 1946 level by more than 20% (Skiba, 1979). No major capital investments were undertaken[4] therefore output increases were achieved predominantly by employment expansion (Czocher, Kawczak, & Pisanecka, 1978). Wałbrzych mines received funds for modernization in the early 70s which was reflected in the slight output increase (12% over the period 1970-1975). Despite that, the technological debt was still exceptionally high. In 1975, the decapitalization of fixed assets, machines and technical tools was as high as 79% (Archiwum Państwowe we Wrocławiu [ApWro]. (c). n.d.) and numerous assets were already classified as historical monuments. The spatial structure of mines was outdated (deconcentrated, with a high number of levels and shafts) which exacerbated the cost of excavations maintenance and underground transportation (Skiba, 1979). In order to address the above-mentioned issues, a decision on the

[4] The main investment area of polish mining in 60s was Upper Silesian ROW (Rybnicki Okręg Węglowy) with 12 new collieries opened and 5 in construction until late 70s (Piątek & Piątek, 1999). Growing extraction of coke coal in ROW was systematically diminishing significance of Wałbrzych mines (Skiba, 1979).

construction of the central extractive and processing plant "Kopernik" was taken in the mid-70s. Since then, only non-essential investments were carried out in the existing infrastructure. The construction of "Kopernik" aimed to modernize the local mining and centralize extraction, however the investment stopped in 90s (Piątek & Piątek, 1999).

The network of coal-related entities in Wałbrzych did not change significantly after the 19th century. It included coking and energy plants, a repair facility (producing and maintaining mining equipment) and an entity specializing in complex projects improving the extraction processes. Documents from 1993 list mining, coking, energy, ceramics/glass and clothing as key local industries which proves Wałbrzych was not a mining monoculture region (Michalkiewicz, 1993).

The collieries continued to play an important social role in Wałbrzych. They financed a major artistic ensemble, numerous sport clubs (37 in 1970) and tourism associations (13 in 1970), and furthermore invested in schooling, healthcare, housing, childcare and leisure (ApWro (a), n.d.). In the 1970s, mining represented 70% of the total Wałbrzyskie voivodeship social fund spend on sport, around 70% of expenditure on vocational schools and housing, and approximately 50% on healthcare (Główny Urząd Statystyczny [GUS], 1976).

Coal mining posed a serious ecological and thus health threat to Wałbrzych. In the 1990s the city was listed among the top 27 areas of environmental risk in Poland due to its serious water deficit, pollution of water bodies and air as well as terrain damage. Before 1989, two coking plants ("Thorez" and "Mieszko") had already closed down due to ecological reasons, and health reasons forced the closure of coal power plants located in the city centre (Michalkiewicz, 1993; APWro (b), n.d.). Moreover, the high concentration of methane resulted in high accident risk in collieries, the biggest being the 1985 methane explosion with 18 fatalities.

4. Socio-technical carbon lock-in in Wałbrzych

4.1. Emergence of lock-in

As outlined in the previous section, the continued coal extraction in Wałbrzych until 1998 despite the acknowledged technological, environmental and economic hurdles as well as the hazardous working conditions was determined by a sequence of historical events: the outbreak of WWII, the incorporation of Wałbrzych into Poland combined with high coal demand in post-war reconstruction, and finally the intense industrialization of Poland started in the 1950s. This section shows that during the times of PRL, a socio-technical carbon lock-in developed in Wałbrzych.

Following the socio-technical carbon framework (Trencher et al., 2020), the sources of lock-in were classified into three dimensions: material, non-material and exogenous. Due to the limitations of desk research, the human actors involvement

Table 2. Sources of the socio-technical carbon lock-in in Wałbrzych

Source	Category	Theme
Material	Infrastructure	"Kopernik" pit investment
		Existing mining infrastructure
	Assets	Vast non-operational assets portfolio of mines
Non--material	Formal institutions	Versatile social infrastructure
	Non-formal institutions	Collective identification with being a mining state
		Mining traditions
		Common expectation of continued extraction due to anthracite deposits
	Knowledge and competences	Practical know-how developed over the years
		Pool of qualified workforce (mining vocational schools)
		Low environmental awareness
	Micro-economic aspects	Unemployment in the event of mines closure
		Lack of suppliers and customers for coal-related entities in the event of mines' closure
		Impoverishment of society in the event of mines' closure
Exogenous	Economic	Protection from market competition (centrally planned economy)
	Societal	Nation-wide socio-technical imagery around coal – the community belief in coal as the backbone of the Polish economy
	Geographical	Natural coal resource base and geological conditions

Source: own elaboration.

was not included. Table 2 lists each dimension ("Source type" column) and further breaks it down into relevant categories. The "Theme" column identifies specific levers perpetuating Wałbrzych's dependence on coal.

4.2. Material sources of lock-in

Along with the vast mining infrastructure, part of which was already treated as monuments, the major infrastructural factor hampering the coal phase-out in Wałbrzych in the 1980s was the investment in "Kopernik". It was burdened with huge sunk costs in the event of collieries closure, and was a promise of the significant modernization of the local mines infrastructure.

Additional material challenge was the vast portfolio of the mines' non-operational assets. According to the evidence from 1989 (APWro (a), n.d.), the local mines were in charge of facilities in housing, education, art, culture, healthcare and social provisions, as well as sports and tourism (including resorts outside Wałbrzych, such as the Polish seaside). The potential handover of such a broad range of assets and ensuring their operational continuity posed a serious challenge.

4.3. Non-material sources of lock-in

The versatile social infrastructure of the coal mines in Wałbrzych was a lock-in factor in the category of formal (official) institutions. It was deeply embedded in the lives of the mining community. They benefited from housing, childcare, healthcare as well as tourism financed by collieries. The cultivation of mining traditions such as Miner's Day bonded the community even further. In the 1990s, there were already families of multiple generations involved in mining – such of those of repatriated skilled workers from Borysław area in Ukraine and from France who settled in Wałbrzych in the 1950s (Michalkiewicz, 1993; Róg, 2014). Huge sports events such as football matches and cultural activities like playing in artistic ensembles were building a local community centred around the mines. In this way, Wałbrzych developed its collective identity with the mining state lock-in lever of informal institution.

In the late 1980s and 90s, the widely discussed quality of local anthracite induced the community's expectation of the continued extraction, another informal institution perpetuating the dependence on coal. Although the huge technical debt and other hurdles were recognized, the identification of high-quality anthracite created the expectation of potential competitive advantage, additionally reinforced by the commenced investment in the "Kopernik" pit.

Mining vocational schools built a pool of qualified workforce, strengthened by know-how accumulated by multiple generations of miners. This posed a significant lock-in facet in the knowledge category. Skills specific to mining could not be easily translated into other industries. This posed a major issue given the location of Wałbrzych far from other heavy industry areas – a shutdown of the mines would require the retraining and/or relocation of their employees. A separate knowledge source of lock-in was the lack of broad environmental awareness in the community. Mining posed a serious ecological and health threat to the city which was a valid, however not widely discussed, argument for the mines shutdown.

The threat of high unemployment was a major micro-economic lock-in source. In 1989, the mines accounted for around 20% of the total workforce in Wałbrzych. Considering the struggles of coal-dependent establishments due to the loss of either supplier or customer, the potential unemployment was even higher. Another micro--economic element, potentially causing a domino effect in the local economy, was the impoverishment of the local community in the event of the mines closure. Wages in mining belonged to the highest in the local industrial sector – in 1980 the average monthly net salary in the mines was 68% higher than in the centrally planned industry of Wałbrzych Voivodeship (GUS, 1976). Combined with the additional benefits, it made mining state a significant consumer, stimulating local economy. Job reductions in mines posed the threat of a collapse in the local demand.

4.4. Exogenous sources of lock-in

The natural resources base was a primary factor shaping the development of Wałbrzych, in close relation to mining. The wealth of coal resources drove the initially scalable extraction, yet once the easily available resources were exhausted, specific geological conditions turned into a lock-in factor. Coal deposits were difficult to access which prevented their mechanization and led to decentralized extraction. On the other hand, vast deposits of high-quality coal were reinforcing the expectation of continued extraction.

The centrally planned economy protected the mines from market competitiveness which allowed for their operation regardless of their cost inefficiency and technical debt. This contributed to the long-term functioning of the Wałbrzych mines and their vast non-production operation despite their cost ineffectiveness.

Finally, the national socio-technical imagery around coal (Kuchler, 2018) was another exogenous factor. Coal was considered the backbone of the Polish economy and a guarantee of energy security. Such a narrative strengthened the miners' sense of job security and the inseparability of the Polish economy from coal mining. Along with the official privileges, it also built up the high social status of miners, reinforced by the considerable financial advantages perpetuating the strength of the mine state in Wałbrzych.

4.5. Lock-in disruption

The political and economic transformation of 1989 removed the strongest source of lock-in in Wałbrzych – protection from market competition. It exposed the structural issues of mines and their uncompetitiveness in the free-market economic system. (Michalkiewicz, 1993; Piątek & Piątek, 1999) Additionally, in the reality of shock therapy, unemployment and social impoverishment were not grounds for continuing coal extraction (removal of micro-economic lock-in sources). In parallel, the local mining lobby was too weak to hold up the phase-out.

The shutdown of the mines marked the start of the severe socio-economic crisis in Wałbrzych. In 1991, a year after the restructuration started, the registered unemployment rate was over three times higher than Poland's overall average (see Figure 1). Apart from individuals registered as unemployed, 36% of employees dismissed from the mines between 1993 and 1999 (in total 7.8 thousand) stayed on social security benefits or took long-term leave until reaching retirement age (Kowalski, 2000). The phase-out resulted in significant unemployment among the young and the middle-aged. In 1995, 74% of former colliery workers eligible for social security benefits were aged 35 or below. In 2002, out of the total Wałbrzych population with their own livelihood, 37% obtained it from a non-earning source – 15 p.p. more than on national level with an equal share of retirees (GUS, 2021).

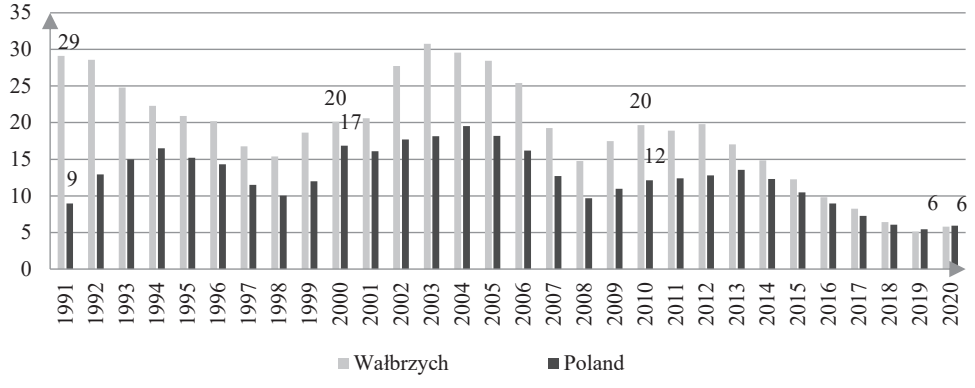

Fig. 1. Yearly average unemployment rate in Wałbrzych and in Poland (%)

Source: own elaboration according to data from (Powiatowy Urząd Pracy w Wałbrzychu, 2021).

The structural crisis deepened owing to the decay of the city's sports and cultural activities, as well as the closure of mining-dependent entities. Additionally, many small businesses (i.e. restaurants, local groceries) failed, mainly in districts dominated by miners such as Podgórze (Duda, 2019). Wałbrzych struggled with a whole range of socio-economic issues becoming a negative symbol of Poland's shock therapy.

4.6. Current state

Recently, 30 years since the coal phase-out started in Wałbrzych, the city has been recovered from the crisis caused by the mines' closure. While it still struggles with a range of socio-economic issues (i.e. depopulation, an ageing society, low attractiveness of the local labour market), they remain on a similar level as in other middle-size cities in Poland (Uchwała nr XXIX/306/20, 2020).

The unemployment rate recently stabilized at around the national level (see Figure 1). The demographic and educational structure of unemployment proves the offsetting effects of the mines' closure. Firstly, the predominance of people with vocational or lower secondary and below level of education significantly diminished (Uchwała nr XXX/321/21 Rady Miejskiej Wałbrzycha, 2021). Secondly, number of long-term unemployed decreased (Uchwała nr XXX/321/21 Rady Miejskiej Wałbrzycha, 2021). Finally, the age structure shifted – especially among men, individuals aged 30 or below are no longer the biggest group of unemployed (GUS, 2021). The offsetting of unemployment can be attributed predominantly to the operations of WSE (Wałbrzyska Strefa Ekonomiczna) – a special economic zone which attracted to Wałbrzych global manufacturers such as Toyota, Cersanit and Faurecia.

The city has undergone significant revitalization of its infrastructure with the major efforts made in housing and a ring road (currently under construction).

Wałbrzych has also been developing its tourist potential. The biggest mine in the city, "Julia", was converted into the Science and Art Centre "Former Mine" and is positioned as the biggest post-industrial tourist attraction in Poland. Książ Castle – another major landmark – has been broadened its tourist product offer (i.e. opening an underground sightseeing route) attracting a growing number of tourists. In 2018, the castle received over 0.5 million visitors and enjoyed a further, almost 30% growth in 2019. The city has also gained an increasing recognition as a destination for hiking, reinforced by investment in observation points in the closest neighborhood of Wałbrzych, namely the Mountains of Borowa and Trójgarb.

5. Conclusions

It has been shown in the subject literature that a lock-in is not a permanent state (Unruh, 2000), and it can only delay substitution or decline of unsustainable solutions. Despite the lock-in described by Grabher (1993), the last coal mine in the Ruhr area was closed in December 2018 (Bjorkoman, 2018), VHS was pushed out of the market by innovation in the form of DVD (Arthur, 1989). For Wałbrzych, the external shock disrupting lock-in occurred in the form of Poland's shock therapy.

This paper suggests that Wałbrzych followed the third-level path dependence. The extraction of coal continued until the late 1990s, despite public awareness of structural issues (technical debt, inefficiencies, lack of price competitiveness and serious ecological hazards), as well as the existing alternatives to mining-dependent development. It is demonstrated that the coal lock-in in Wałbrzych originated from a sequence of economical, historical and political events. The first time, the coal phase-out in Wałbrzych was brought into the public domain in the interwar period, however the outbreak of WWII determined the further extraction. After the war, two factors conditioned the continuation of the mines' operation, Firstly, incorporation of Wałbrzych into Poland, and secondly, the critical importance of coal to the Polish economy in the context of the post-war reconstruction. Despite serious technical and workforce issues, extraction further continued in the 1950s, driven by the country's strenuous industrialization, further inflating demand for coal and on principle favouring heavy industry.

Until the 1990s, a socio-technical carbon lock-in had developed in Wałbrzych. Its strongest sources were in micro-economic aspects – the potential collapse of the local labour market driving society's impoverishment in the event of the mines' closure – and the exogenous factor of protection from market competition. The above facets were strongly reinforced by the country-wide imagery of coal mining as the backbone of Polish economy, combined with local expectations of continued extraction due to anthracite deposits. Eventually, the lock-in was disrupted in the

1990s by external shocks in the form of political and economic transformation. The transition into a free market economy exposed the lack of competitiveness of the local collieries while the threat of micro-economic issues did not pose a barrier to transition at the time of the shock therapy. Due to the lack of strong formal institutions and human actors able to lobby for a slower phase-out, all the Wałbrzych mines were closed by 1998.

The rapid disruption of the lock-in resulted in a deep socio-economic crisis in the city, which has been overcome only recently. The recovery is best reflected in the fact that the strategic socio-economic goals of the city for 2021-25 focus on addressing issues typical of Polish 'shrinking' cities. This is a significant shift when compared to former strategies focused predominantly on the offset of the effects of the liquidation of the local mining (Uchwała nr XXX/321/21 Rady Miejskiej Wałbrzycha, 2021).

The history of Wałbrzych development in the context of the carbon lock-in described in this paper is highly relevant to the current discussion around the coal phase-out in Poland. Recently, growing environmental pressure from European Union climate policy resulted in the decision to close Poland's coal mining industry by 2049. This decision can be viewed as an exogenous factor leading to the disruption of the lock-in hindering Polish coal phase out (discussed by Zoll (2021)). As demonstrated, a versatile lock-in perspective allows to explain the causes and validity of the phase-out, and therefore can be used as an effective tool in communication of the transition process to the local community. Wałbrzych itself is well-suited to act as an example of a Polish mining region which underwent a coal phase-out. Therefore, conclusions from the negative socio-economic effects of the rapid mines closure in Wałbrzych should be taken into account by decision makers when designing current phase-out programmes. Moreover, Wałbrzych can serve as an example of a mining area eventually successfully transitioning out from an economy once dominated by mining. Today, 30 years after the restructuration started, the city is entering a new phase of its development with unemployment stabilized at the national level, growing tourism activities and industry operating in the local Special Economic Zone.

The two areas which were only briefly discussed in this paper – a socio-economic assessment of the process of mines closure, together with a thorough analysis of the city's recovery from the crisis caused by the coal phase-out – deserve to be addressed by separate papers.

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