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Mining, Poverty, and Income Inequality in Central and Eastern European Countries: What Do the Data Tell Us?

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Abstract

The study investigates the effect of mining on both poverty and income inequality in Central and Eastern European countries (CEECs) using econometric estimation methods with panel data spanning from 2009 to 2019. Another objective of this paper was to determine if the complementarity between mining and infrastructural development reduced poverty and or income inequality in CEECs. What triggered the study is the failure of the existing literature to have a common ground regarding the impact of mining on poverty and or income inequality. The existing literature on the subject matter is contradictory, mixed, and divergent; hence, it paves the way for further empirical tests. The study confirmed that the vicious cycle of poverty is relevant in CEECs. According to the dynamic generalized methods of moments (GMM), mining had a significant poverty reduction influence in CEECs. The dynamic GMM and random effects revealed that the complementarity between mining and infrastructural development also enhanced poverty reduction in CEECs. Random effects and pooled OLS shows that mining significantly reduced income inequality in CEECs. However, random effects and the dynamic GMM results indicate that income inequality was significantly reduced by the complementarity between mining and infrastructural development. The authorities in CEECs are therefore urged to implement mining growth and infrastructural development-oriented policies in order to successfully fight off the twin challenges of poverty and income inequality.

Keywords: mining, poverty, income inequality, panel data, CEECs

JEL: I3, I14, I24, L71, N14

Introduction

The background of the study, the contribution to the literature, and the organization of the study are the three major components constituting this section.

Background of the study: The positive impact of mining on economic growth is well supported in the literature (Prebisch 1950; Singer 1950; Bhagwati 1958; Cavalcanti, Mohaddes, and Raissi 2011; Tilton 2012; Arezki et al. 2013; Esfahani, Mohaddes, and Pesaran 2014; Kalumbu 2014). They argued that the extraction of mineral resources is labor-intensive and therefore employs a huge number of people, and it has a cascading effect on poverty and inequality reduction in the local communities. Other researchers, such as Harvey et al. (2010; 2017), and Olakojo (2015), noted that mineral extraction boosts economic growth, creates employment, and reduces income inequality and poverty on condition that a favorable environment, such as infrastructural and financial development, exists.

Although there seems to be consensus in the literature on the positive role that mining plays in promoting economic growth, its cascading influence on poverty and income inequality has not been exhaustively investigated. The few empirical researchers who investigated the impact of mining on poverty and income inequality produced results that are divergent, conflicting, mixed, and far from conclusive. Some, such as Hinton (2011), Maier et al. (2014), Fleming and Measham (2015), Ngobese (2015), Loayza and Rigolini (2016), and Barreto et al. (2018), noted that mining managed to reduce income inequality and poverty. Others, namely Fatah (2008), Gregoryan (2013), Adu et al. (2016), Addison, Boly, and Mveyange (2017), and Ankra et al. (2017), observed that mining exacerbates poverty and income inequality.

Others, including Ross (2006), Sudarlan, Indiastuti, and Yusuf (2015), Mancini and Sala (2018), Sincovich et al. (2018), and Zhou (2019), failed to find any meaningful relationship between mining and poverty and or income inequality. They noted that the impact of mining on poverty and income inequality depends on the stage of mining activities. For example, in Australia, Reeson, Measham, and Hosking (2012) noted that poverty and income inequality was low but later went up as mining activity intensified. The lack of consensus both in the theoretical and empirical literature on the impact of mining on poverty and income inequality allows room for further empirical tests.

These empirical studies on the subject matter also suffer from the following methodological limitations. They wrongly assumed that the relationship between mining and poverty/income inequality is linear, ignoring the endogeneity problem normally prevalent in the poverty and income inequality econometric functions. The vicious cycle of poverty was not considered in most of those studies, and none of them focused on CEECs. This means the CEEC story on the mining-poverty/income inequality nexus is still untold to the best of the author's knowledge. The study is important because it will help CEECs to develop mining and infrastructural development policies that will effectively alleviate poverty and income inequality.

Contribution of the study: This paper contributes to the literature in five ways. Firstly, the use of the dynamic GMM enables the author to consider not only the vicious cycle of poverty and inequality but also the endogeneity problem that normally characterizes both poverty and income inequality functions. Secondly, this study took into account the fact that both poverty and income inequality functions are non-linear, unlike some prior studies. Thirdly, to the best of the author's knowledge, it is the first study to investigate the impact of mining on both poverty and income inequality using CEECs as a unit of analysis. Fourthly, to the best of the author's knowledge, this study is the first to explore the impact of the combination of mining growth and infrastructural development on both poverty and income inequality. Fifthly, this study uses more recent panel data, enabling authorities to make relevant decisions on income inequality and poverty reduction policies.

Structure of the paper: Six additional sections describe the remaining structure of this paper. Section 2 presents the theoretical literature on the impact of mining on poverty and income inequality. Section 3 discusses the influence of mining on poverty and income inequality from an empirical literature point of view. Section 4 describes the effect of infrastructural development on poverty and income inequality. Section 5 outlines the role played by infrastructural development on mining sector growth. Section 6 describes the research methodology, results presentation, and discussion. Section 7 concludes the paper.

Impact of mining on income inequality and poverty – Literature review

Sudarlan, Indiastuti, and Yusuf (2015) summarized the positive role that mining plays in enhancing poverty and income inequality reduction in four ways. Firstly, it enables developing and poor countries to build a mutually equitable and beneficial mining regime. Secondly, mining helps to improve education as mining companies are generally engaged in corporate social responsibilities that uplift the local communities, consistent with Sudarlan, Indiastuti, and Yusuf (2015, p. 195). Thirdly, mining normally spearheaded by foreign investors transfers technology into the domestic economy, which goes a long way in enhancing innovation and economic growth. Fourthly, mining is in the primary sector of production, is labor-intensive, and hence creates quite a lot of jobs for the poor and the uneducated. This transfers wealth and reduces poverty and income inequality among the societies.

According to Adei, dan Addei, and Kwadjose (2011), the negative impact of mining is divided into three categories:

1. It increases (a) the number of patients suffering from respiratory diseases, (b) land degradation hence negatively impacting on the environment, (c) wildlife habitat loss, (d) air and water pollution as the mining waste is thrown into the rivers and gas emissions poisons the air.

2. Mining towns promote social ills, such as prostitution, crime, native life changes, and the fight for natural resources among the local people.
3. High mortality rates, which are caused by smoking, low levels of education, and an increased number of years residing in coal mining areas. Sudarlan, Indiastuti, and Yusuf (2015) also confirmed that these negative impacts of mining continue to entrench the people in the poverty cycle and increases the income inequality gap.

Table 1. Empirical literature on the impact of mining on income inequality and poverty

Author	Country/ Countries of study	Period	Methodology	Results
Reeson, Measham, and Hosking (2012)	Regional Australia	1975–2010	Multi-regression analysis	Income inequality initially decreased but later went up as mining activity intensified in Australia. However, income inequality was quite low even at the early stages of mining activities.
Sudarlan, Indiastuti, and Yusuf (2015)	Indonesia	2002–2011	Panel data analysis	Mining was found to have had an insignificant effect on both income inequality and poverty in Indonesia.
Addison, Boly, and Mveyange (2017)	Africa	2001–2012	Panel data analysis	When minerals are aggregated, mining was found to have increased inequality in Africa. When minerals were analyzed as individuals, the impact of mining on inequality was found to be mixed.
Gregoryan (2013)	Armenia	2000–2008	Multi-regression analysis	Mining was found to have a high likelihood of increasing poverty and inequality in Armenia.
Ross (2006)	Worldwide	Not applicable	Literature review analysis	The pros and cons of mining on the well-being of the people where mining is taking place were explored. Both sides are compelling.
Mancini and Sala (2018)	Worldwide	Not applicable	Literature review analysis	The literature on the socio-economic impact of mining is quite mixed and divergent globally.
Adu et al. (2016)	Ghana	Survey data for 1998/1999, 2005/2006, and 2012/2013 was used	Descriptive statistical analysis	Households at the bottom of the income distribution were the ones that heavily experienced the positive impact of mining on income inequality

Author	Country/ Countries of study	Period	Methodology	Results
Sincovich et al. (2018)	Australia	Critical literature review	Critical literature review	The positive and negative impact of mining on income inequality, poverty, unemployment, and economic growth were outlined in the case of Australia.
Fleming and Measham (2015)	Australia	2001 and 2011	Descriptive statistics and multiple regression analysis	Income inequality increased faster in mining regions than in non-mining regions. The results, therefore, showed that mining reduced income inequality.
Fatah (2008)	Province of South Kalimantan in Indonesia	Not available in the abstract used.	Social accounting matrix approach	Coal exploitation had negative consequences on the local environment, in the form of land degradation and water-borne diseases. This exacerbates poverty and inequality if stringent environmental rules and policies are not applied.
Loayza and Rigolini (2016)	Peru	2007 district survey data	Multi-linear regression analysis	Mining districts were found to have had lower poverty rates and household consumption per capita in Peru.
Maier et al. (2014)	United States of America, China, and World-Wide	1990–2014	Literature review analysis	Evidence in the literature explaining the role of mining in poverty alleviation and income inequality reduction in mining regions is evident.
Barreto et al. (2018)	Kenya, Uganda, and Rwanda	Case study approach	Case study methodology	Small scale mining had a positive impact on livelihood improvements and poverty reduction in the three African countries studied.
Ankra et al. (2017)	Ghana	2015 salary data	Descriptive statistics	The top ten percent of the mining companies' staff members were allocated about half of all the basic salary. This means that mining increased income inequality in the case of Ghana.
Zhou (2019)	Mongolia's Oyu Tolgoi Province	House-hold-level census data (2007–2016)	Descriptive statistics	Health, respiratory diseases, and unemployment generally went down in mining areas while school dropout rates, digestive problems, and internet users went down.

Table 1. (continued)

Author	Country/ Countries of study	Period	Methodology	Results
Ngobese (2015)	Amajuba district in South Africa	Interviews in 2014	Descriptive statistical analysis	Mining had a lot of positive influences in the Amajuba district. These include reducing unemployment, enhancing livelihoods, and reducing income inequality.
Hinton (2011)	Uganda	Both primary and secondary data	Descriptive statistical analysis	Artisanal mining played a huge role in alleviating unemployment and reducing poverty, but gender income inequality remained, with women being the most disadvantaged.

Source: author compilation.

The effect of infrastructural development on income inequality and poverty

According to Estache and Fay (1995), improved infrastructure reduces poverty and income inequality through better water quality, road infrastructure, lower manufacturing costs, and low transportation costs. Infrastructural development was argued to be a key integral component of poverty and income inequality reduction as it links people to important economic activities and helps them gain access to productive opportunities (Jacoby 2000). By contrast, it was noted by Tsaurai and Nyoka (2019), however, that scarce government and private sector resources could have been channeled towards infrastructural development away from small credit provision, whose direct positive influence on poverty and income inequality alleviation is unquestionable. The measure of infrastructural development used in this study is fixed telephone subscriptions (per 100 people).

The role played by infrastructural development on mining growth

According to the Minerals Council South Africa (2017), better infrastructure development is one of the factors that enhances gold mining in South Africa. Other factors that were singled out by the same report as inhibiting gold mining in South Africa include the cost of extracting the gold, gold price fluctuations, unreliable electricity supply, skills shortages, and a lack of investment in the gold mining sector. Dunning's (1973) eclectic paradigm hypothesis argued that locational advantages, such

as the level of infrastructural development, market size, and financial development, among others, were the major factors that attract foreign investment to the mining industry in the host country. Denisia (2010, p. 108) also noted that infrastructure development, financial markets, political, and other macro-economic factors are locational advantages that attract foreign capital to not only the mining sector but the whole economy. Moosa (2010) also supported the view that infrastructural development is only one of the factors that foreign investors consider before they are attracted into investing in the mining sector/whole economy of the host country. Considering that the positive impact of foreign direct investment (FDI) on poverty reduction is well supported in the literature, it follows that factors that attract FDI to the mining sector, such as infrastructure development, enhance poverty reduction and income inequality in the local communities. Xongo (2013) also noted that developed infrastructure is one of the preconditions that the country must have for the mining sector to be able to significantly enable poverty reduction.

Research methodology, presentation of the results, and discussion

Data description, model specification, control variables, panel unit root, and co-integration tests and data analysis.

Nature of data and its description: The data used in this study spans from 2009 to 2019. The dependent variables include income inequality and poverty, while independent variables include infrastructural development, trade openness, information and communication technology (ICT), FDI, human capital development, and financial development. The sources of secondary data include the African Development Bank, World Development Indicators, United Nations Development Programme, the Organization for Economic Cooperation and Development, International Financial Statistics, and the International Monetary Fund. These databases were selected because of their reputation and easy accessibility. The CEECs used in this study include Albania, Croatia, Hungary, Romania, Slovenia, Estonia, Bulgaria, the Czech Republic, Poland, Slovakia, and Lithuania.

General and econometric model specification: Equation 1 is the general model specification for the poverty function, while equation 2 is a general model specification for the income inequality function.

$$POV = f(MIN, INFR, OPEN, ICT, FDI, HCD, FIN) \quad (1)$$

$$INEQ = f(MIN, INFR, OPEN, ICT, FDI, HCD, FIN) \quad (2)$$

POV, INEQ, MIN, INFR, OPEN, ICT, FDI, HCD, and FIN, respectively, represent poverty, income inequality, mining, infrastructural development, trade openness,

ICT, FDI, human capital development, and financial development. The choice of the independent variables was, to a larger extent, informed by similar empirical studies such as Fatah (2008), Hinton (2011), Maier et al. (2014), Fleming and Measham (2015), Ngobese (2015), Loayza and Rigolini (2016), Ankra et al. (2017), Barreto et al. (2018), Sincovich et al. (2018), Zhou (2019). The GINI coefficient was used as a measure of income inequality in this study.

Equations 3 and 4 stand for the econometric equations of poverty and income inequality, respectively.

$$POV_{it} = \beta_0 + \beta_1 MIN_{it} + \beta_2 INFR_{it} + \beta_3 (MIN_{it} . INFR_{it}) + \beta_4 X_{it} + \varepsilon it \quad (3)$$

$$INEQ_{it} = \beta_0 + \beta_1 MIN_{it} + \beta_2 INFR_{it} + \beta_3 (MIN_{it} . INFR_{it}) + \beta_4 X_{it} + \varepsilon it \quad (4)$$

Table 2. Variable interpretations

β_0	Intercept term
t	Time
i	Country
εit	Error term
β_1 to β_4	Co-efficient of independent variables
X_{it}	Independent variable in country i at time t.
POV_{it}	Poverty in country i at time t
$INEQ_{it}$	Income inequality in country i at time t
MIN_{it}	Mining development in country i at time t
$INFR_{it}$	Infrastructural development in country i at time t

Source: author compilation.

Equations 3 and 4 are estimated using panel data analysis methods such as fixed effects, pooled ordinary OLS, and random effects, in line with other similar studies by Sudarlan, Indiastuti, and Yusuf (2015) and Addison, Boly, and Mveyange (2017). Consistent with Denisia (2010), infrastructural development plays a critical role in attracting FDI to the mining sector and consequently poverty and income inequality reduction. It is against this background that this study also examined the impact of the complementarity between mining and infrastructural development on poverty and income inequality.

$$POV_{it} = \beta_0 + \beta_1 POV_{it-1} + \beta_2 MIN_{it} + \beta_3 INFR_{it} + \beta_4 (MIN_{it} . INFR_{it}) + \beta_5 X_{it} + \varepsilon it \quad (5)$$

$$INEQ_{it} = \beta_0 + \beta_1 INEQ_{it-1} + \beta_2 MIN_{it} + \beta_3 INFR_{it} + \beta_4 (MIN_{it} . INFR_{it}) + \beta_5 X_{it} + \varepsilon it \quad (6)$$

The lag of poverty influences poverty (the vicious cycle of poverty), in line with Azher's (1995) theoretical predictions. The control variables that were used, denoted by X, include trade openness, FDI, ICT, financial development, and human capital de-

velopment. The measure of poverty that was used is the mean mortality rate, while the GINI coefficient is the proxy of income inequality employed in the study. Both equations 5 and 6 were econometrically estimated using the dynamic GMM approach.

Control variables: The variables used as control factors for the income inequality and poverty functions include trade openness, ICT, FDI, human capital, and financial development. The next few paragraphs discuss how each control variable affects poverty and income inequality from a theoretical point of view.

Trade openness, which is proxied by total exports and imports (% of GDP), positively influences poverty and income inequality reduction, according to Balassa (1978). He argued that trade openness enables domestic firms to access cheaper raw materials and technology worldwide, thereby enhancing their expansion ability, wealth creation, unemployment, poverty, and income inequality reduction.

ICT enhances quality education, research capabilities, innovation skills, and employment creation, thereby enabling people to easily secure well-paying jobs (Richmond and Triplett 2017). They noted that ICT might widen income inequality among people from different social classes. The rich have money to acquire the best ICT gadgets while the poor are further driven into a technology-related abyss. Individuals who use the Internet (% of population) was used as a measure of ICT.

FDI enables people to acquire skills, enhances human capital development, and creates employment and wealth, thereby reducing poverty and narrowing the income inequality gap (Boakye-Gyasi and Li 2015). In contrast, FDI increases poverty and the income inequality gap because most foreign investors' profit is not used for the benefit of local people but is repatriated back to the home country (Jaumotte, Lall, and Papageorgiou 2013). FDI can have either a positive or negative impact on poverty and income inequality. Net FDI inflows (% of GDP) is the proxy of FDI used in this study.

Although human capital development reduced poverty, Castello-Climent and Domenech (2014) noted that it was not sufficient to reduce the income inequality gap. According to Johansen (2014), human capital development increases people's competency levels, skills, education, and productivity at the workplace. Such a scenario helps people get a promotion, boosts their income and wealth, and reduces poverty levels and income inequality gaps. The theoretical rationale on the positive relationship running from human capital development towards poverty/income inequality reduction was confirmed by Becker and Chiswick (1966).

Better access to small loans and convenient financial products enables people to get the funding necessary to begin small self-employment projects. The latter provides jobs and income, helping to end poverty and income inequality (World Bank 2001). The development of the financial sector makes it difficult for the poor to access credit because they do not possess collateral security. Meanwhile, the rich get richer because they have assets that can act as collateral security. According to Dhrifi (2013), this increases poverty among the poor and widens the income inequality gap. The impact of financial development on poverty and/or income inequality can be either way. The

measure of financial development used in this study is the market capitalization of listed domestic companies (% of GDP). All the variables' data were transformed into natural logarithms before being used further in the study to decisively address spurious results, the possible problem of multicollinearity, and extreme values (Aye and Edoja 2017; Tsaurai 2021).

Panel unit root tests: The use of four panel unit root test methods such as the Levin, Lin, and Chu test (2002), the PP Fisher Chi-Square test; the Augmented Dicky Fuller (ADF) Fisher Chi-Square and Im, Pesaran, and Shin test (2003) to estimate the stability of data used is consistent with other empirical studies such as Aye and Edoja (2017) and Tsaurai (2020).

Table 3. Panel root tests – Individual intercept

	Level			
	LLC	IPS	ADF	PP
LPOV	–2.32*	–4.21*	3.12	6.98
LINEQ	–2.92***	–1.18**	62.18**	84.913***
LMIN	–2.65***	–3.17***	–2.56***	–6.17***
LINFR	–1.56***	–0.35***	55.82**	97.12***
LOPEN	–3.76***	–3.87***	99.12**	122.76***
LICT	–0.36	0.67	29.32	61.39**
LFDI	–2.54***	–1.76***	64.23***	102.12***
LHCD	–0.73*	–0.99*	32.18**	48.27***
LFIN	–3.14**	–3.94*	10.21**	17.37**
First difference				
LPOV	–11.21**	–19.54**	56.18**	71.32*
LINEQ	–9.42***	–7.02***	147.25***	278.03***
LMIN	–5.16***	–8.53***	–6.18***	–16.02***
LINFR	–10.16***	–11.34***	195.92***	420.14***
LOPEN	–9.32***	–10.27***	185.93***	642.82***
LICT	–7.37***	–8.45***	155.12***	298.42***
LFDI	–10.11***	–11.23***	163.15***	543.51***
LHCD	–6.16***	–7.04***	116.32***	300.42***
LFIN	–7.23***	–8.04**	91.78***	187.26***

Note: LLC, IPS, ADF, and PP stand for Levin, Lin, and Chu; Im, Pesaran, and Shin; ADF Fisher Chi-Square, and PP Fisher Chi-Square tests, respectively. *, ** and *** denote 1%, 5% and 10% levels of significance, respectively.
Source: author's compilation – E-Views figures.

Poverty, income inequality, mining, infrastructural development, trade openness, ICT, FDI, human capital development, and financial development variables were found to be stationary at first difference. The results mean that all the variables used in this study were stable at first difference, allowing the author to proceed to the next stage, which is panel co-integration tests, in line with Odhiambo (2014).

Panel co-integration tests: The Kao (1999) panel co-integration test was used in this study. Table 4 present the results.

Table 4. Results of Kao co-integration tests

Series	ADF t-statistic
POV MIN INFR OPEN ICT FDI HCD FIN	–2.9121***
INEQ MIN INFR OPEN ICT FDI HCD FIN	–5.43716***

Source: author compilation.

Consistent with Tembo (2018), a long-run relationship was found to exist in both poverty and income inequality functions. Put differently, a co-integration relationship could not be rejected at the one percent significance level in either the income inequality or poverty functions. The finding enabled the author to proceed to the next stage of analysis.

Main data analysis and interpretation of the results: Four econometric methods were used in this study. These include the dynamic GMM, fixed effects, random effects, and pooled OLS. The proxy of mining in this study is mineral rents (% of GDP).

Table 5. The poverty function panel results

	Dynamic GMM	Fixed effects	Random effects	Pooled OLS
POV_{it-1}	0.1735***	–	–	–
MIN	–0.1672*	–0.0092	–0.2186	–0.0372
INFR	–0.3672*	–0.1736	0.0267	0.1782
MIN.INFR	–0.1792***	–0.0328*	0.1811	0.0003
OPEN	–0.1628*	–0.0327*	0.0163	–0.1823*
ICT	0.0126***	–0.3271**	–0.1417**	0.1732**
FDI	–0.1732***	–0.0317***	–0.0327	–0.1723
HCD	0.2227**	0.2371	0.1026	0.1692
FIN	–0.1888**	–0.4555**	–0.0103*	–0.1932**
Adjusted R-squared	0.67	0.62	0.55	0.58
J-statistic/F-statistic	148	57	62	43
Prob(J-statistic/F-statistic	0.00	0.00	0.00	0.00

***, ** and * denote 1%, 5% and 10% levels of significance, respectively.
Source: author's compilation from E-Views.

Using the mean mortality rate as a measure of poverty, the lag of poverty was found to have had a significant positive impact on poverty. In other words, the mortality rate was positively influenced by its own lag, in line with Azher's (1995) vicious cycle of poverty argument. The dynamic GMM approach produced results that show that mining had a significant negative impact on the mean mortality rate while fixed effects, pooled OLS, and random effects show a non-significant relationship with the

mean mining mortality rate. In general, these results indicate that mining reduced poverty in CEECs across all the four-panel methods used.

Infrastructural development's influence on mean mortality was found to be negative and significant under the dynamic GMM, yet fixed effects show that mining had an insignificant negative effect on mean mortality. These results show that infrastructural development reduced poverty in CEECs, which is consistent with Estache and Fay (1995). The positive non-significant impact of infrastructural development on mean mortality was observed under the random effects and pooled OLS, in line with Tsaurai and Nyoka (2019), whose study argued that that scarce government and private sector resources channeled towards infrastructural development away from small credit provision exacerbates poverty.

The impact of the complementarity between mining and infrastructural development on mean mortality was found to be negative but significant under both the fixed effects and dynamic GMM methodologies. This means that the combination of mining and infrastructural development significantly reduced poverty in CEECs, a finding that is consistent with Xongo (2013), whose study found that developed and better infrastructure is one of the preconditions that a country must have for the mining sector to be able to significantly reduce poverty. However, a non-significant positive relationship running from the complementarity between mining and infrastructural development towards mean mortality was observed under the pooled OLS and the random effects. These results mean that the interaction variable exacerbates poverty, contradicting the available literature that states that infrastructural development is one of the locational advantages of foreign investment in the mining sector (Moosa 2010).

Under the dynamic GMM, fixed effects, and pooled OLS, the influence of trade openness on mean mortality was found to be negative but significant. Put differently, trade openness contributed to a reduction in poverty in the CEECs, in line with Balassa's (1978) argument earlier in the sub-section on control variables. By contrast, the random effects produced results that show a non-significant relationship running from trade openness towards mean mortality. This means that trade openness generally increased poverty under the random effects, a finding which contradicts the available literature.

ICT was found to have a significant positive impact on mean mortality under both the pooled OLS and the dynamic GMM approaches, in line with Richmond and Triplett (2017), whose study noted that ICT may increase poverty and widen income inequality among people from different social classes. Fixed and random effects, however, noted that ICT's impact on mean mortality in CEECs was negative but significant. On the other hand, the results resonate with Richmond and Triplett (2017), who stated that ICT enhances quality education, research capabilities, innovation skills, and employment creation, thereby enabling people to easily secure well-paying jobs.

FDI had a significant negative impact on mean mortality under both the dynamic GMM and fixed effects, and a non-significant negative effect on mean mortality under the random and pooled OLS. These results are like those obtained under the income

inequality function (see results in Table 6). They generally mean that FDI reduced poverty, which is consistent with Boakye-Gyasi and Li's (2015) theoretical rationale that FDI enables people to get skills, enhances human capital development, and creates employment and wealth, thereby reducing poverty and narrowing the income inequality gap.

A significant positive relationship running from human capital development towards mean mortality was observed under the dynamic GMM approach, while fixed effects, random effects, and pooled OLS show that human capital development had a non-significant positive effect on mean mortality. These results are like the findings produced under the income inequality function (see Table 6) across all four econometric estimation methods. They contradict the available literature on the human capital development-poverty/income inequality nexus propagated by Becker and Chiswick (1966), Castello-Climent and Domenech (2014), and Johansen (2014).

Financial development had a significant negative effect on mean mortality across all four econometric estimation methods. Apart from the random effects, the other three panel data analysis methods (dynamic GMM, pooled OLS, fixed effects) produced results that show that financial management's influence on mean mortality was negative but significant. This means that financial management reduced poverty and income inequality in CEECs, consistent with the World Bank (2001), which stated that better access to small loans and convenient financial products enables people to get the funding necessary to begin small self-employment projects.

Table 6. The income inequality function panel results

	Dynamic GMM	Fixed effects	Random effects	Pooled OLS
INEQ	0.4823***	-	-	-
MIN_{it-1}	0.3288	0.1835	−0.1218*	−0.1997**
INFR	−0.6931	−0.0227*	0.1743*	0.1634
MIN.INFR	−0.6372***	−0.2871	−0.1835**	0.0092
OPEN	0.0665	−0.2273*	−0.0452	0.4521*
ICT	0.0438	0.4573**	−0.2763**	0.0435
FDI	−0.5563***	−0.4009***	−0.5764	−0.4111
HCD	0.0065	0.4521	0.58976	0.6548
FIN	−0.5466**	−0.5491**	−0.1632	−0.3318**
Adjusted R-squared	0.56	0.59	0.65	0.68
J-statistic/F-statistic	251	89	71	54
Prob(J-statistic/F-statistic)	0.00	0.00	0.00	0.00

***, ** and * denote 1%, 5% and 10% levels of significance, respectively.
Source: author's compilation from E-Views.

The GINI coefficient is the measure of income inequality that was used in this study. Consistent with Azher (1995), previous income inequality exacerbated income inequality (measured the GINI ratio) in the CEECs. A non-significant positive relation-

ship running from mining towards income inequality (GINI ratio) was observed under the dynamic GMM and fixed effects, in line with Adei, dan Addei, and Kwadjose (2011), whose study laid bare the negative impact of mining activities on local people. Random effects and pooled OLS show that mining had a significant negative influence on the GINI ratio, in line with Sudarlan, Indiastuti, and Yusuf (2015, p. 195), whose study observed that mining helps to reduce income inequality.

The dynamic GMM showed that infrastructural development had a non-significant influence on the GINI ratio while fixed effects' impact on the GINI ratio was negative and significant. The results show that infrastructural development reduced income inequality in CEECs, which is consistent with Estache and Fay (1995), whose study noted that infrastructure reduces poverty and income inequality through better water quality, road infrastructure, lower manufacturing costs, and low transportation costs. By contrast, both random effects and pooled OLS shows that infrastructural development increased income inequality in CEECs, in support of Tsaurai and Nyoka (2019). Only the dynamic GMM and random effects show that the complementarity between mining and infrastructural development reduced income inequality in CEECs, in line with Dunning (1973), Denisia (2010), Moosa's (2010), and Xongo (2013), theoretical rationales.

The impact of trade openness on income inequality is mixed. Dynamic GMM showed that trade openness had a non-significant positive influence on the GINI ratio, while a significant positive relationship running from trade openness towards the GINI ratio was observed under the pooled OLS. This means that generally, trade openness increased income inequality, in contrast to Balassa (1978). However, fixed and random effects show that trade openness helped reduce income inequality in CEECs, in line with the available literature. The results on the impact of ICT on income inequality are mixed. Dynamic GMM, fixed effects, and pooled OLS show that ICT increased income inequality while the random effects indicate that income inequality reduction was spearheaded by ICT.

Conclusions

The study aimed to investigate the effect of mining on both poverty and income inequality in CEECs using econometric estimation methods with panel data spanning from 2009 to 2019. Another objective of this paper was to determine if the complementarity between mining and infrastructural development reduced poverty and/or income inequality in CEECs. What triggered the study is the failure of the existing literature to have a common ground regarding the impact of mining on poverty and or income inequality. The existing literature on the subject matter is contradictory, mixed, and divergent; hence, it paves the way for further empirical tests. The study confirmed that the vicious cycle of poverty is relevant in CEECs.

According to the dynamic GMM, mining had a significant poverty reduction influence in CEECs. The dynamic GMM and random effects revealed that the complementarity between mining and infrastructural development also enhanced poverty reduction in CEECs. Random effects and pooled OLS shows that mining significantly reduced income inequality in CEECs. However, random effects and the dynamic GMM results indicate that income inequality was significantly reduced by the complementarity between mining and infrastructural development in CEECs. The authorities in CEECs are therefore urged to implement mining growth and infrastructural development-oriented policies to successfully fight off the twin challenges of poverty and income inequality. Further research should investigate the existence of threshold levels of mining growth, and infrastructural development that must be reached before significant poverty and income inequality reduction can happen.

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Górnictwo, ubóstwo i nierówności dochodowe w krajach Europy Środkowej i Wschodniej: co mówią dane?

Artykuł prezentuje wyniki badania wpływu górnictwa zarówno na ubóstwo, jak i na nierówności dochodowe w krajach Europy Środkowej i Wschodniej, przy użyciu metod estymacji ekonometrycznej z wykorzystaniem danych panelowych z lat 2009–2019. Drugim celem tego artykułu było ustalenie, czy komplementarność górnictwa i rozwoju infrastruktury zmniejsza ubóstwo lub nierówności dochodowe w krajach Europy Środkowej i Wschodniej. Impulsem do podjęcia badań był brak w istniejącej literaturze przedmiotu wspólnego stanowiska w kwestii wpływu górnictwa na ubóstwo i nierówności dochodowe. Istniejąca literatura na ten temat jest sprzeczna, niejednoznaczna i rozbieżna, dlatego też otwiera drogę do dalszych badań empirycznych. Badanie potwierdziło, że błędne koło ubóstwa występuje w krajach Europy Środkowej i Wschodniej. Zgodnie z dynamicznymi uogólnionymi metodami momentów (GMM), górnictwo miało znaczący wpływ na redukcję ubóstwa w krajach Europy Środkowej i Wschodniej. Dynamiczna metoda momentów GMM i efektów losowych ujawniły, że komplementarność górnictwa i rozwoju infrastruktury również przyczyniła się do zmniejszenia ubóstwa w krajach Europy Środkowej i Wschodniej. Metoda efektów losowych i metoda pooled OLS pokazują, że górnictwo znacząco zmniejszyło nierówności dochodowe w krajach Europy Środkowej i Wschodniej. Jednak wyniki uzyskane przy zastosowaniu metody efektów losowych i dynamicznej metody GMM wskazują, że nierówności dochodowe zostały znacznie zmniejszone dzięki komplementarności górnictwa i rozwoju infrastruktury. W związku z tym zachęca się władze krajów Europy Środkowej i Wschodniej do wdrażania polityk ukierunkowanych na rozwój górnictwa i rozwój infrastruktury, aby skutecznie walczyć z podwójnymi wyzwaniami związanymi z ubóstwem i nierównościami dochodowymi.

Słowa kluczowe: górnictwo, ubóstwo, nierówności dochodowe, dane panelowe, kraje Europy Środkowej i Wschodniej

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