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# Examination of Selected Economic Perspectives in the Mining Industry

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**Abstract**
The objective of this study was to evaluate and compare the development of the mining industry in Slovakia from an economic point of view. Attention was also paid to possible changes after the intervention leading to the transformation of the mining industry, especially in the Hornonitriansky region. Descriptive analysis, frequency analysis, and regression analysis (Interrupted Time Series) were used to meet this objective. The analyses included four economic indicators related to industrial areas, namely turnover, employed persons, nominal wages, and labour productivity. The data were analysed for the period 2008–2020. Compared to other industrial areas, the mining industry showed nominal wages at a slightly above-average level, while other indicators were at a lower level. In terms of the position in the overall structure of industrial areas, the mining industry had less positive positions but was comparable to several industries. Nominal wages and labour productivity in the mining industry showed a markedly increasing trend during the analysed period, while turnover increased only slightly. In terms of the number of employees, there was a visible decreasing trend. The trends in the analysed period were significant. The intervention (amendment) showed a positive relationship with nominal wage increases in the short term. Regarding the post-intervention period, the trend after the intervention did not differ significantly from the trend before the intervention. Mining in Slovakia is a viable industrial area that achieves comparable results as some other industrial areas. All the findings of the study indicate that the mining industry in Slovakia requires special attention in political and social discussions.

**Keywords**
Mining industry, development, economic indicators, nominal wages, employees, turnover, labour productivity, comparison, industrial areas, transformation, government intervention, Slovakia.

## Introduction and Theoretical Background

In Slovakia, the mining industry has been developing from the 13th century to the present day. There are many mineral resources and mining deposits, which makes the mining industry in Slovakia an area that needs to be examined from different perspectives (Fazekašová & Fazekaš, 2020; Pavolová et al., 2016; Sofranko et al., 2020; Teplická et al., 2021). The mining industry occupies a special position among all industrial areas, as its activities provide raw materials for other industries. Thus, it is at the beginning of the industrial chain, which underlines its importance. From this point of view, the mining industry presents a special element in economic life. On the other hand, this position also points to the fact that the mining industry is input-intensive but produces very low value-added outputs, which is reflected in low returns (Hrehova et al., 2012; Unceta, 2021). Industrial companies have many opportunities to increase their performance (Ambriško et al., 2017; Rosova et al., 2020; Straka et al., 2020), but this is not the rule of mining companies, although ways are sought (Tyulenev et al., 2018). In fact, the economic balance can only be increased by a fundamental restructuring of the production process itself.

Nevertheless, it should be noted that the mining industry has, in addition to its primary contribution to the economy (mining itself), various other secondary contributions through interconnected industries, which increases its economic value. Therefore, there is a need to promote linkages between mining and other local economic sectors (Unceta, 2021). Evidence suggests that the mining industry creates a spillover effect resulting in an increase in non-mining employment, as well as a positive effect on income indicators (Williams & Nikijuluw, 2020b). In this regard, it should be noted that more than 40% of jobs and added value from the European Union's manufacturing sector depend on raw materials (Pellegrini, 2016). In addition, mining can lead to positive changes in regions over time, as the findings of a study conducted by Williams and Nikijuluw (2020a) show that mining local government areas in Australia recorded more positive social and economic outcomes than non-mining local government areas. Mining can also increase the pressure on public services, housing, and labour markets at the regional level. Similar findings were revealed by Hajkowicz et al. (2011), who focused on quality of life indicators but also pointed to the contrast in the research community in assessing the social and economic effects of the mining industry. This contrast can be explained by a range of factors, including the nature of the particular commodity, company structure, and location (Tonts et al., 2012). With a focus on the European region, findings from Poland indicate that the financial and social benefits of mining activity outweigh the financial, social and environmental costs generated by this industry (Krawczyk & Śliwińska, 2020). Based on these findings, it can be concluded that the mining industry is economically important, especially at the regional level, but even here, there may be variability in socio-economic performance across different resource industry contexts.

The shadowy aspect of the mining industry is its adverse impact on the environment as a whole and on the quality of environmental components (atmosphere, biosphere, pedosphere, hydrosphere, lithosphere, and human society) (Mohsin et al., 2021). In this context, there are many negative effects, such as a change in the relief and character of the rock environment, changes in climatic aspects and influencing air quality, a negative transformation of the hydrological regime, soil degradation, degradation of ecological systems. Mining affects not only natural but also socio-economic components, including devastation or complete liquidation of settlements, industrial, agricultural, forestry, water management or recreational facilities, technical infrastructure, and others (Chovancová & Adamišin, 2016). In addition, restoring the functionality of the natural and social components of the landscape and the ecological balance is a complex and time-consuming and economically demanding process. There are also several foreign studies focusing on the negative consequences of mining (Ma et al., 2021; Mohsin et al., 2021; Strzałkowski & Ścigała, 2020). Ma et al. (2021) pointed to considerable damage to natural vegetation and agricultural land as a result of mining, but also a high consumption of surface water and groundwater, profoundly transforming landscapes with long-term impacts on biodiversity, ecosystem processes, and ecosystem services. Toxic gases released during operational activities should also be taken into account (Gavurova et al., 2021b; Mohsin et al., 2021). This puts pressure on environmental and economic sustainability. All the negative consequences are motivating for the development of innovative tools, approaches, and practices in the mining industry that could improve through their environmental, technical, and economic benefits (Rehman et al., 2021). In this regard, economic burden and environmental degradation can be controlled through the use of environmentally friendly mining operations and technologies, while it is also possible to consider the further use of environmentally degraded and polluted areas (Čech et al., 2020; Lorite et al., 2021; Mohsin et al., 2021; Setiawan et al., 2021; Worlanyo & Jiangfeng, 2021).

In addition to the development of innovative technologies, another tool is legislation with well-established socio-economic and environmental standards (Horodníkova et al., 2008; Mohsin et al., 2021). Many countries are taking steps to transform the mining industry and, in a sense, to dampen it. Such interventions are crucial not only for the protection of natural resources but also for countries to meet their sustainable development goals aimed at averting serious environmental and socio-economic damage (United Nations, 2015). In other words, the interest of countries is directed towards achieving a transformed economy that provides wide and inclusive

socio-economic development, not just short-term profit. This can be achieved through a raw materials policy that defines the objectives of the exploitation of domestic mineral resources as a response to long-term needs of economic and social development of society while respecting the environmental aspects of sustainable development (Šimková et al., 2016). The research community also agrees that, despite some benefits, the further functioning of the mining industry should require some effective restructuring activities (Krawczyk & Śliwińska, 2020; Manowska et al., 2017). For this purpose, the linkages between the mining industry and other economic sectors, society, state and municipalities are very important in the process of consolidating the benefits and opportunities for the industry (Macedo et al., 2017). In this context, linkage building needs to be framed using an 'economic transformation rationale' (Weldegiorgis et al., 2021).

Slovakia is not lagging behind in the effort to transform the mining industry. Therefore, at the end of 2018, it was decided to dampen coal mining in the Hornonitriansky region (starting in 2019). The priority of this intervention was the transformation, on the basis of which the region is preparing to end lignite mining. The transformation of this industry is taking place through a fair mechanism aimed at eliminating the socio-economic effects of the transition to a climate-neutral economy in the European Union. A successful transformation must therefore be fair and socially acceptable in order to reduce the negative effects of the cessation of coal mining on the socio-economic status of the regions. For this purpose, state aid was prepared in the form of incentives to minimise the negative effects of conversion, retraining of employees, job creation in the region and the sources of their financing. The Action plan envisages that mining will take place in the Hornonitriansky region until 2026. The last mine will be closed in 2027 (Akčný plán transformácie uhoľného regiónu horná Nitra, 2020; Euroactiv, 2018).

All the above-mentioned facts were the motivation for the authors of this study to examine the mining industry in Slovakia from an economic point of view and to focus on possible changes in the industry as a result of the intervention (amendment) initiated in 2018.

## Material and Methods

The objective of this study was to evaluate and compare the development of the mining industry in Slovakia from an economic point of view. Attention was also paid to possible changes after the intervention leading to the transformation of the mining industry.

Following this main objective, several analytical steps were performed. First, the overall state and development of the mining industry in Slovakia was evaluated, and the mining industry was compared with other industrial areas. Subsequently, the significance of the government intervention established in the fourth quarter of 2018, when the transformation of the mining industry began (implementation in 2019), was assessed.

For the purposes of the investigation, the analyses included four economic indicators related to individual industries, namely:

- turnover for own services and goods – *Turnover* (in thousands EUR at current prices),
- average number of employees – *Employees* (in persons),
- average nominal monthly wage of an employee – *Wage* (in EUR),
- labour productivity from turnover for own services and goods – *Productivity* (in EUR).

These indicators were assessed in the following 16 industrial areas:

- Mining and quarrying.
- Electricity, gas, steam, and air-condition supply.
- Manufacture of basic metals and fabricated metal products, except machinery and equipment.
- Manufacture of coke and refined petroleum products.
- Manufacture of computer, electronic and optical products.
- Manufacture of electrical equipment.
- Manufacture of food products, beverages and tobacco products.
- Manufacture of chemicals and chemical products.
- Manufacture of machinery and equipment n.e.c.
- Manufacture of pharmaceuticals, medicinal, chemical and botanical products.
- Manufacture of rubber and plastic products, and other non-metallic mineral products.
- Manufacture of textiles, apparel, leather and related products.
- Manufacture of transport equipment.
- Manufacture of wood and paper products, and printing.
- Other manufacturing, and repair and installation of machinery and equipment.
- Water supply, sewerage, waste management and remediation activities.

All data were collected from the database of the Statistical Office of the Slovak Republic (2021) from 2008 to 2020, while the indicators were recorded at quarterly intervals.

Descriptive and frequency analyses were used for the initial analytical processing. This step provided a first look at the data and made it possible to evaluate and compare the state and development of the mining industry in Slovakia. In addition, the Interrupted Time Series regression analysis was used to verify the significance of changes in the mining industry after the establishment of the amendment in 2018.

## Results

This section is devoted to the presentation and interpretation of the main results with regard to the fulfilment of the main objective of the study. Thus, the section presents the state and development of selected indicators in individual industrial areas, a comparison of the mining industry with other industries, and the results of the regression analysis focused on changes in the mining industry after the intervention initiated in 2018.

*Tab. 1. Mean values of selected indicators in the classification of individual industrial areas (2008–2020)*

| Industry | **Turnover** | **Employees** | **Wage** | **Productivity** |
|---|---|---|---|---|
| Mining and quarrying | 139,807.6 | 7,304.8 | 1,015.35 | 19,380.1 |
| Electricity, gas, steam, and air-condition supply | 2,998,133.9 | 18,232.3 | 1,526.77 | 165,991.8 |
| Manufacture of basic metals and fabricated metal products, except machinery and equipment | 2,668,211.1 | 99,206.5 | 904.92 | 26,722.2 |
| Manufacture of coke, and refined petroleum products | 826,856.5 | 2,494.1 | 2,001.00 | 331,411.3 |
| Manufacture of computer, electronic and optical products | 1,412,678.7 | 16,856.8 | 934.60 | 84,777.5 |
| Manufacture of electrical equipment | 802,348.0 | 31,244.8 | 952.88 | 25,576.2 |
| Manufacture of food products, beverages and tobacco products | 1,087,872.6 | 38,273.0 | 789.42 | 28,473.6 |
| Manufacture of chemicals and chemical products | 467,858.5 | 8,960.6 | 1,077.21 | 52,188.6 |
| Manufacture of machinery and equipment n.e.c. | 1,009,793.4 | 40,338.7 | 1,042.35 | 24,647.1 |
| Manufacture of pharmaceuticals, medicinal chemical and botanical products | 58,676.1 | 2,262.5 | 1,127.54 | 25,838.3 |
| Manufacture of rubber and plastic products, and other non-metallic mineral products | 1,445,748.2 | 49,422.6 | 953.60 | 29,199.9 |
| Manufacture of textiles, apparel, leather and related products | 403,505.2 | 35,874.8 | 616.31 | 11,500.5 |
| Manufacture of transport equipment | 5,560,891.8 | 69,160.6 | 1,140.23 | 78,571.7 |
| Manufacture of wood and paper products, and printing | 892,576.7 | 38,781.1 | 727.02 | 23,183.4 |
| Other manufacturing, and repair and installation of machinery and equipment | 761,577.0 | 41,411.1 | 866.75 | 18,487.3 |
| Water supply, sewerage, waste management and remediation activities | 272,025.5 | 21,086.3 | 886.71 | 12,928.9 |

Note: Turnover – turnover for own services and goods (in thousands EUR), Employees – the average number of employees (in persons), Wage – average nominal monthly wage of an employee (in EUR), Productivity – labour productivity from turnover for own services and goods (in EUR). The darker the shade, the higher the mean value in the analysed period.

*(Source: own processing based on data from the Statistical Office of the Slovak Republic, 2021)*

Table 1 shows the mean values of selected indicators for individual industrial areas in Slovakia based on data from the time series 2008–2020. In terms of turnover for own services and goods, the highest mean value was found in the industrial area Manufacture of transport equipment, followed by the industrial areas such as Electricity, gas, steam, and air-condition supply and Manufacture of basic metals and fabricated metal products, except machinery and equipment. On the other hand, the lowest mean turnover was identified for Manufacture of pharmaceuticals, medicinal, chemical and botanical products. With a focus on the number of employees, it can be stated that Manufacture of basic metals and fabricated metal products was characterised by the highest mean value of employed persons during the analysed period. This industrial area can therefore be considered the largest employer. A higher mean value was also recorded in Manufacture of transport equipment. The smallest employers were companies operating in the industrial areas such as Manufacture of pharmaceuticals, medicinal chemical and botanical products, and Manufacture of coke and refined petroleum products. However, Manufacture of coke and refined petroleum products was identified as the industrial area with the highest mean value for indicators of wage and labour productivity. In terms of wage and labour productivity, higher mean values were also observed for the industrial area Electricity, gas, steam, and air-condition supply. From the opposite point of view, the lowest mean wage and labour productivity were found in Manufacture of textiles,

apparel, leather and related products. With a focus on Mining and quarrying as a priority industry of this study, there were wages at a slightly above-average level, while other indicators showed rather lower than higher mean values in the analysed period 2008–2020.

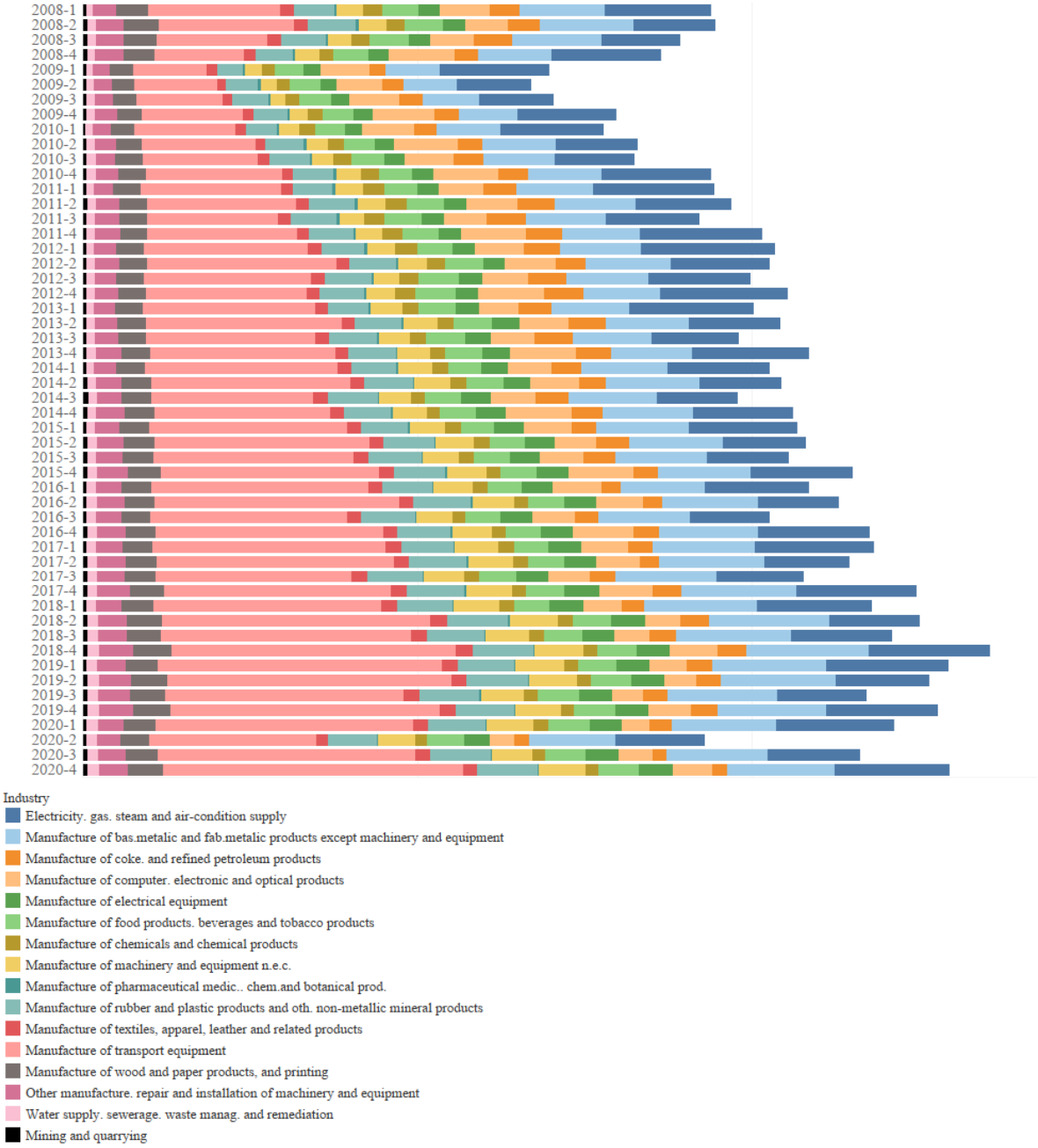


*Fig. 1. Development and comparison of turnover for own services and goods in individual industrial areas (Source: own processing based on data from the Statistical Office of the Slovak Republic, 2021)*

Figure 1 shows the development of turnover for own services and goods in the structure of individual industries in Slovakia during the period 2008–2020. Based on the figure, it can be stated that the crisis year 2009 was identified as a year with a considerable decline in turnover across the analysed industrial areas. In the following years, an increase was observed until 2020. A clear decline in the second quarter of 2020 was probably due to the COVID-19 crisis.

In the case of the black-coloured mining industry, it can be concluded that a stable trend was maintained during the analysed period. In terms of the position of the mining industry in the overall structure of industrial areas in relation to the turnover indicator, the mining industry occupied a less positive position. Together with the industrial area Manufacture of pharmaceuticals, medicinal chemical and botanical products, it acquired the lowest level of turnover for own services and goods.

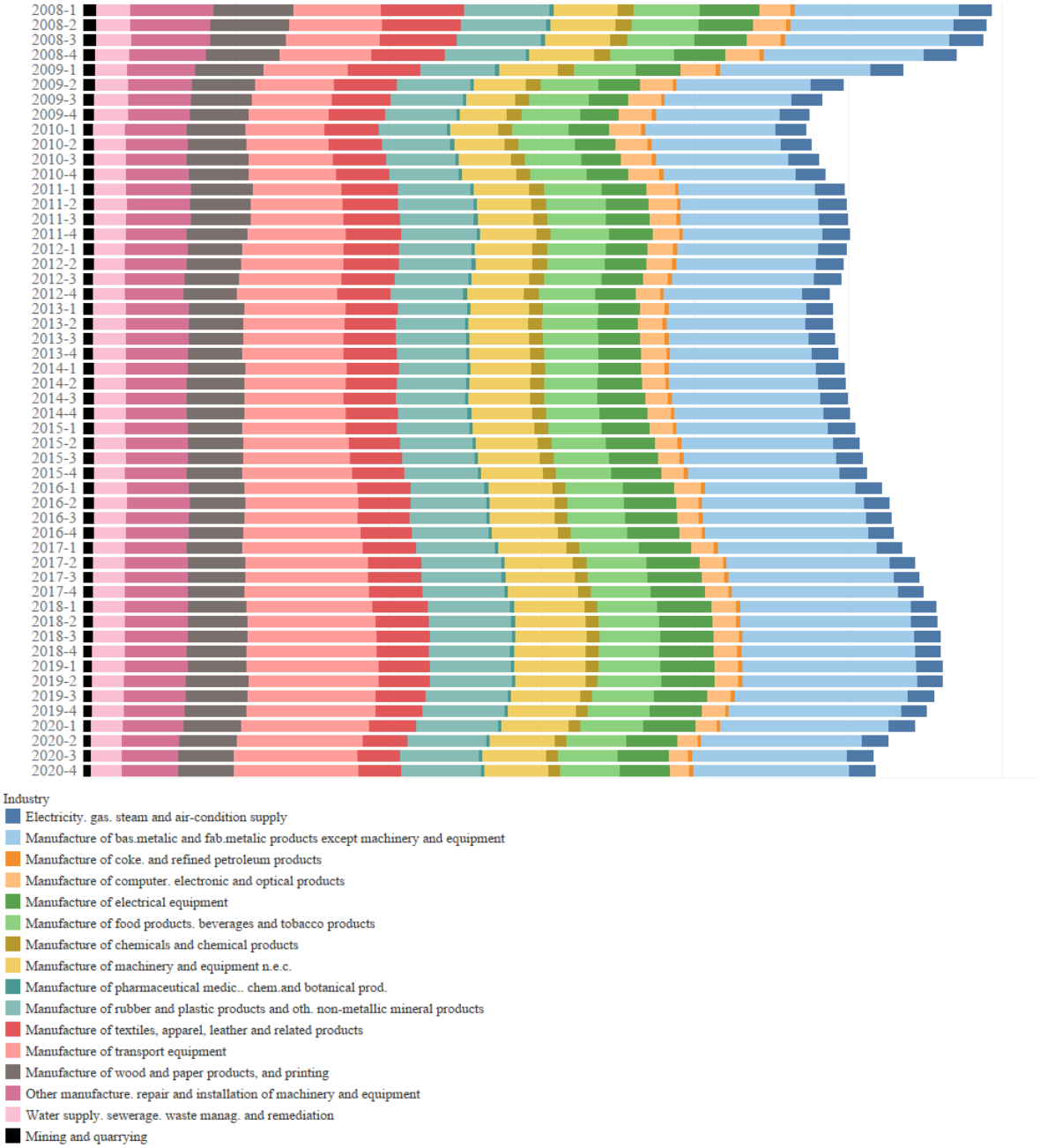


*Fig. 2. Development and comparison of the average number of employees in individual industrial areas (Source: own processing based on data from the Statistical Office of the Slovak Republic, 2021)*

Figure 2 presents the development of the average number of employed persons in the structure of individual industries in Slovakia. As can be seen, the largest decline occurred around 2009, i.e., the crisis year. After this period of crisis, a slight increase can be observed until 2020, when there was a clear decline again. This can be seen as a likely side effect of the COVID-19 health crisis.

In the mining industry, which is highlighted in black, a slight but stable decline in employment can be observed during the analysed period (2008–2020). The figure also presents the position of the mining industry in the overall structure of industrial areas in terms of employment. It is obvious that this industry did not have a key position in Slovakia compared to other industrial areas. A lower employment rate was observed only in the industrial areas such as Manufacture of pharmaceuticals, medicinal, chemical and botanical products, as well as Manufacture of coke and refined petroleum products.

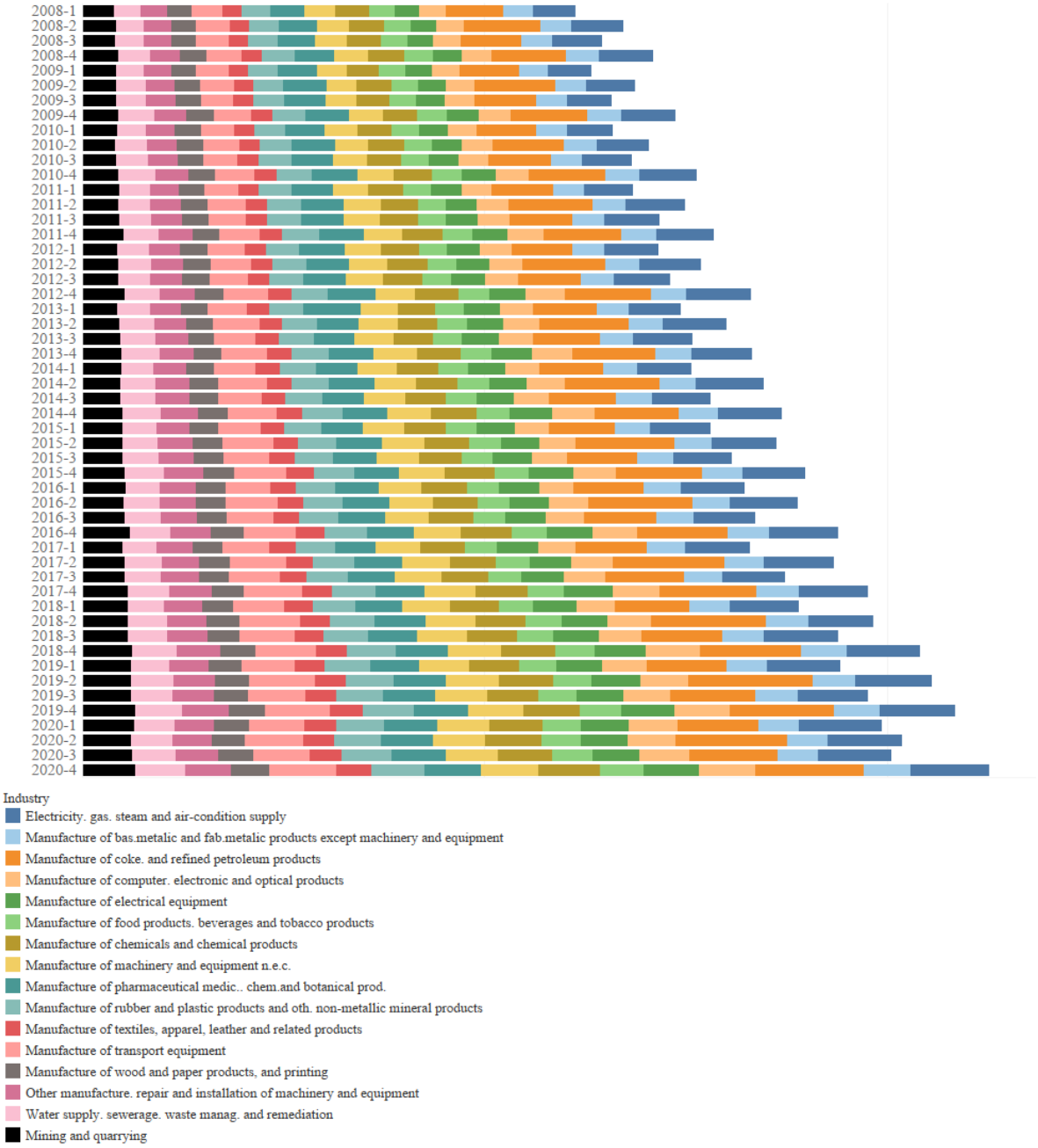


*Fig. 3. Development and comparison of the average nominal monthly wage of an employee in individual industrial areas (Source: own processing based on data from the Statistical Office of the Slovak Republic, 2021)*

The development of the average nominal monthly wage of an employee in individual industrial areas from 2008 to 2020 is shown in Figure 3. Based on this Figure, a stable increase and a certain seasonality of nominal wages were observed in selected industries. Within the individual analysed years, wages were lower in their first quarter, followed by an increase in the second quarter. The third quarter was characterised by a decline, which was again followed by an increase in the last fourth quarter. However, this cycle had an upward trend overall. Seasonality was most pronounced in the industrial area Manufacture of coke and refined petroleum products, but also in other industries.

Mining and quarrying were not an industrial area with a clear seasonality. On the contrary, this industry was characterised by a stable increase in nominal wages. Focusing on the position of the mining industry among all other industrial areas in terms of wages, the industry showed a more positive assessment. This industry recorded a higher level of nominal wages than industries such as Manufacture of textiles, apparel, leather and related products, Manufacture of wood and paper products, and printing, or Manufacture of food products, beverages and tobacco products.

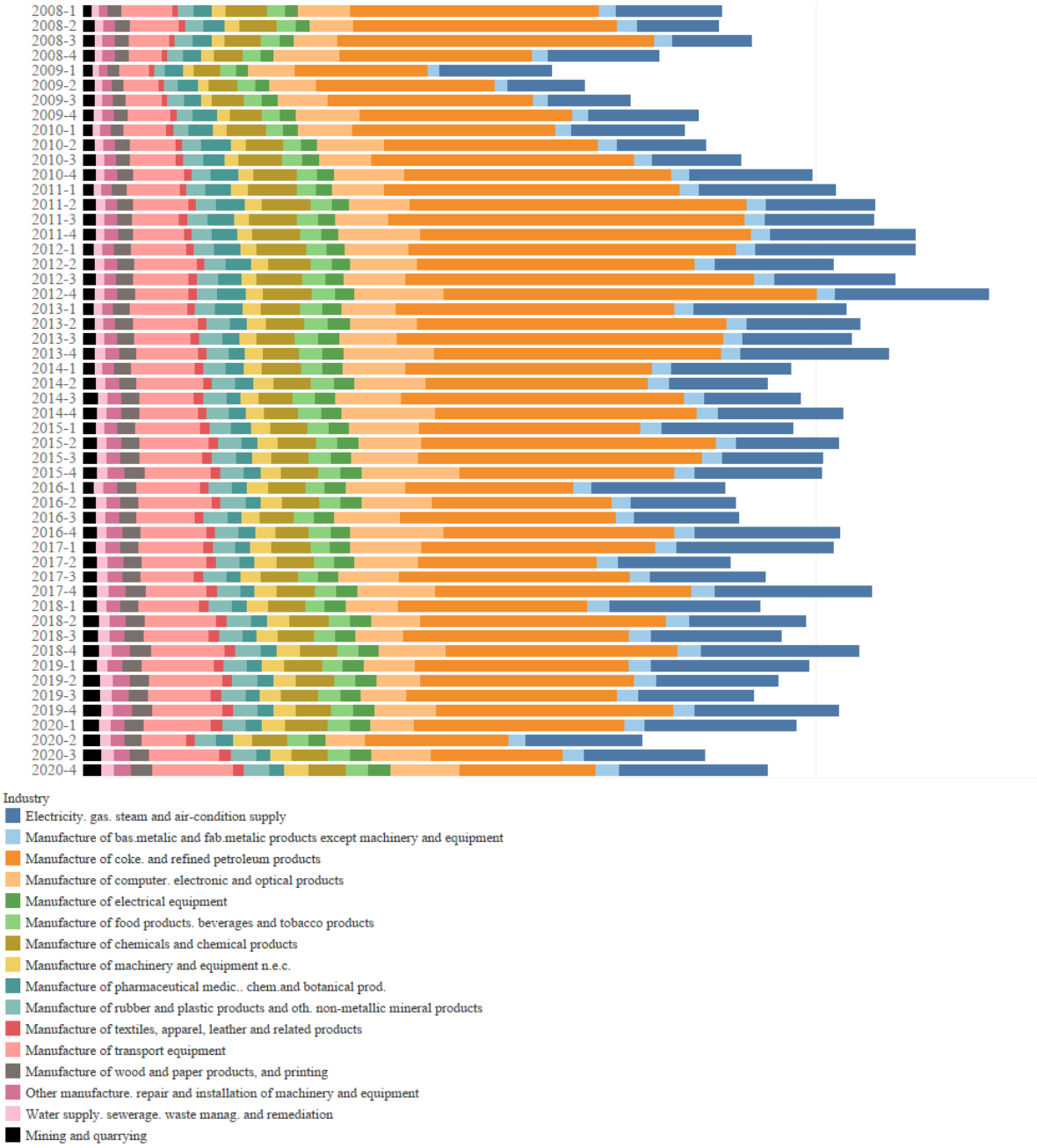


*Fig. 4. Development and comparison of labour productivity in individual industrial areas*
*(Source: own processing based on data from the Statistical Office of the Slovak Republic, 2021)*

Figure 4 shows the development of labour productivity in the structure of individual industries in Slovakia during the analysed period 2008–2020. The beginning of the crisis year 2009 was characterised by a clear decline in productivity across industries. Subsequently, from an overall point of view, a relatively sharp increase was observed until 2014, followed by stagnation until 2020. In several cases, it was possible to see a slight stable increase (for instance, Manufacture of transport equipment, Manufacture of textiles, apparel, leather and related products) or fluctuations at a relatively stable level from 2009 to 2020 (for instance, Manufacture of machinery and equipment n.e.c., Manufacture of food products, beverages and tobacco products, Manufacture of electrical equipment). Overall, there was a decline in labour productivity in industrial areas in 2020. This was probably an accompanying phenomenon of the COVID-19 crisis. However, a slight recovery was identified in the third and fourth quarters of 2020.

With a focus on black-coloured Mining and quarrying, an increase was observed in this industrial area. Thus, labour productivity increased despite all the surrounding conditions (crisis, interventions and measures to dampen this industry). In terms of the position of the mining industry in the overall structure of industrial areas in the context of labour productivity, the mining industry had a less positive position but comparable to several

industries. A similar productivity level was found in the industrial area Other manufacturing, and repair and installation of machinery and equipment. Compared to the mining industry, a lower level was evident in industrial areas such as Water supply, sewerage, waste management and remediation activities, or Manufacture of textiles, apparel, leather and related products.

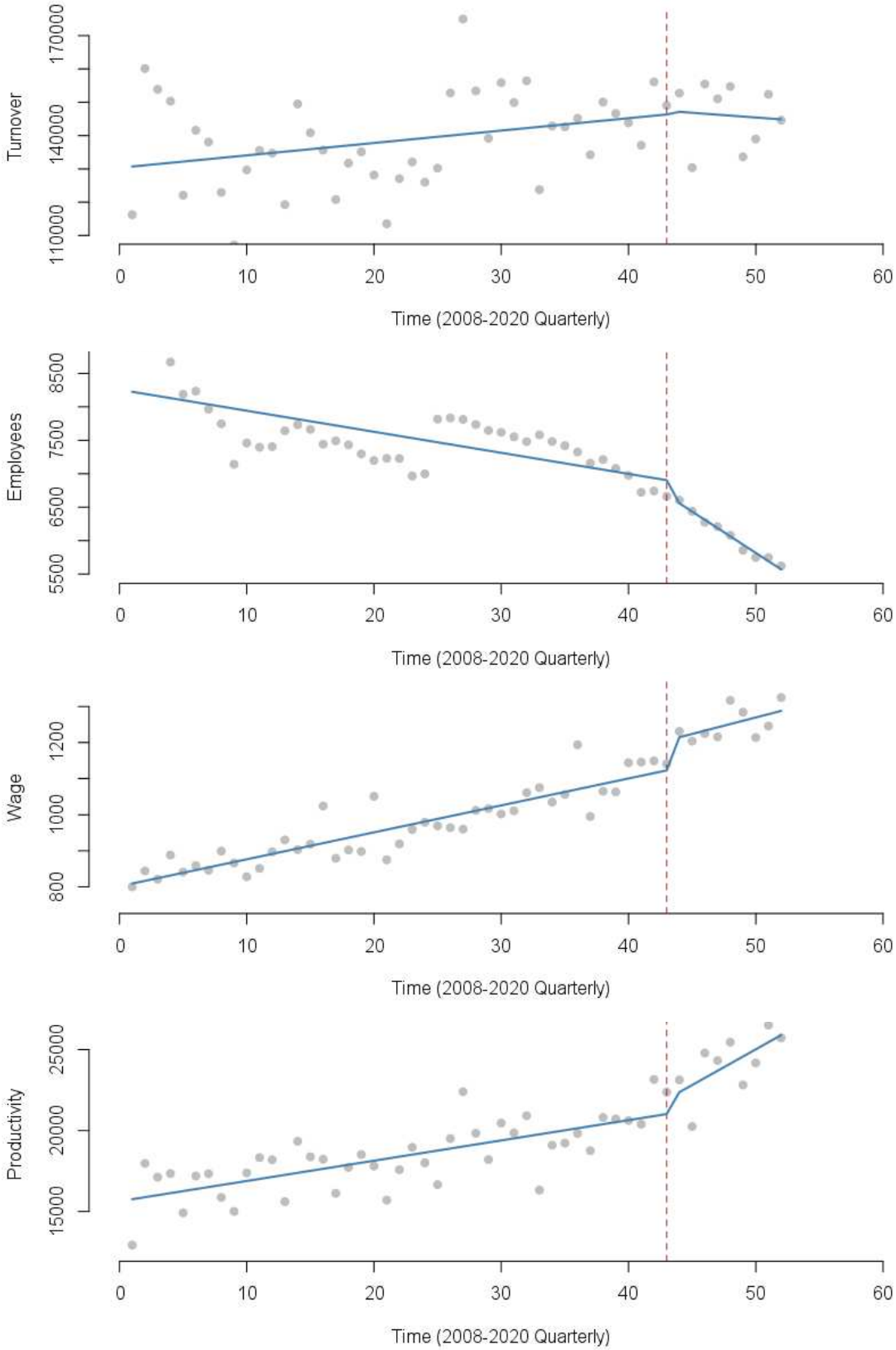


*Fig. 5. Development trend of the mining industry and the significance of the amendment established in 2018 (Source: own processing based on data from the Statistical Office of the Slovak Republic, 2021)*

Figure 5 presents the development trend of the mining industry in Slovakia, in which the amendment established in the fourth quarter of 2018 is highlighted. In the case of nominal wages and labour productivity in the mining industry, a markedly increasing trend was recorded, while turnover increased only slightly. In the case of the number of employees, there was a visible decreasing trend.

The intervention was focused on the transformation of the mining industry, especially in the Hornonitriansky region, and its implementation began in 2019. It is clear from the figure that the two dominant indicators, namely the number of employees and labour productivity, were characterised by a certain change in the trend since the fourth quarter of 2018 when the amendment was initiated. The significance of the intervention was assessed in the following Table 2.

*Tab. 2. Results of the Interrupted Time Series regression analysis – selected indicators in the mining industry*

| Variables | **Employees** | **Productivity** | **Wage** | **Turnover** |
|---|---|---|---|---|
| | Coefficient (*p*-value) | Coefficient (*p*-value) | Coefficient (*p*-value) | Coefficient (*p*-value) |
| (Intercept) | 8,256.8 (<0.001) | 15,631 (<0.001) | 801.55 (<0.001) | 130,327 (0.001) |
| Time | -31.47 (<0.001) | 125.23 (<0.001) | 7.4728 (<0.001) | 372.1 (0.025) |
| Amendment (4th quarter 2018) | -221.63 (0.445) | 908.59 (0.435) | 82.784 (0.020) | 1,076.5 (0.917) |
| Time after amendment (4th quarter 2018) | -92.08 (0.058) | 315.79 (0.104) | 1.6605 (0.771) | -654.7 (0.702) |
| Multiple $R^2$ | 0.79 | 0.777 | 0.914 | 0.14 |

Note: Turnover – turnover for own services and goods in the mining industry, Employees – average number of employees in the mining industry, Wage – average nominal monthly wage of an employee in the mining industry, Productivity – labour productivity from turnover for own services and goods in the mining industry.

*(Source: own processing based on data from the Statistical Office of the Slovak Republic, 2021)*

Table 2 provides the results of the Interrupted Time Series regression analysis, which assessed the effect of the government intervention aimed at the transformation of the mining industry. Attention was focused on changes in the industry in terms of selected indicators. In terms of the analysed period (Time), significant coefficients were confirmed in all selected indicators related to the mining industry. The trend in the analysed period was therefore significant. At the same time, based on the acquired positive coefficient, almost all indicators showed a significant positive direction of the trend. The only exception was the indicator of employed persons, which acquired a negative coefficient and thus showed a significant negative direction of the trend. With a focus on the intervention initiated in the fourth quarter of 2018 (Amendment (4th quarter 2018)), the only significant coefficient was found for the indicator of nominal wages. In this context, the intervention showed a positive relationship with nominal wage increases in the short term. Regarding the post-intervention period (Time after amendment (4th quarter 2018)), no significant result was found at a significance level of $\alpha < 0.05$. This means that the trend after the intervention did not differ significantly from the trend before the intervention.

## Discussion and Conclusions

This study focused on the state and development of the mining industry in Slovakia from an economic point of view. The evaluation and comparison with other industrial areas were carried out for the period 2008–2020. Attention was also paid to possible changes after the intervention focused on the transformation of the mining industry, especially in the Hornonitriansky region.

The results revealed that nominal wages in the mining industry were at a slightly above-average level, while other indicators were at a lower level than in other industrial areas. In terms of the position in the overall structure of industrial areas, it was obvious that the mining industry did not have a key position compared to other industrial areas in Slovakia. The mining industry occupied less positive positions, especially for turnover for own services and goods, and employed persons. In terms of labour productivity, its position was at a comparable level with other industrial areas, i.e., the mining industry was close to some other industrial areas. The most positive position of the mining industry was identified in the case of nominal wages. Focusing on the development during the analysed period, nominal wages and labour productivity were characterised by a markedly increasing trend, while turnover increased only slightly. On the other hand, a decreasing trend was observed in the number of employed persons. In terms of development, the crisis years of 2009 and 2020 were a major challenge for industrial areas as a whole, as a decline in economic indicators was evident in those years. The results of the regression analysis revealed that the trends in the analysed period were significant. Also, the intervention aimed at the transformation of the mining industry showed a positive relationship with nominal wage increases in the short term. In terms of the post-intervention period, the trend after the intervention did not differ significantly from the trend before the intervention.

By initiating the transformation of the mining industry, Slovakia has joined the efforts to reduce environmental pollution caused by mining (Ma et al., 2021; Mohsin et al., 2021; Strzałkowski & Ścigała, 2020).

Despite the transformation that has begun, the intervention has not significantly translated into economic indicators such as turnover, employment, wages, and productivity in the mining industry in the short term. However, the transformation is at the beginning, and it is also a long-term process, the effects of which will become apparent over time. In other words, the effect of current interventions can be felt in the later future. Another explanation may be the fact that the mining industry may focus on ancillary and substitute activities that can cover the gap due to damping, and therefore change is not evident in the ongoing process. Last but not least, it should be borne in mind that the mining industry itself is difficult to adapt to change, intervention and substitution, which slows down the process even more (Suh, 2021).

In line with the European Green Deal, the process of transformation must be continued (European Association for Coal and Lignite, 2021b), but all aspects must be taken into account in such a way that the region and industry do not suffer socio-economic disadvantages and also continue in a favourable trend. The findings of this study showed that mining in Slovakia is a viable industrial area that achieves comparable results as some other industrial areas. Its position is lower but not negligible. In addition, the socio-economic benefits of the mining industry were confirmed by other foreign studies (Hajkowicz et al., 2011; Krawczyk & Śliwińska, 2020; Pellegrini, 2016; Williams and Nikijuluw, 2020a; Williams and Nikijuluw, 2020b). These benefits were evident, especially at the regional level, which is a very important fact in the political discussions on socio-economic inequalities between individual regions. The inequalities between the regions in Slovakia are no exception. All this indicates that the mining industry requires special attention. The transformation of the mining industry is being driven by technological change and political will; therefore, there is a need for linkages between the mining industry, other economic sectors, state and municipalities (Macedo et al., 2017; Unceta, 2021; Weldegiorgis et al., 2021). Cooperation and support are a necessity in the transformation process. In fact, political pressure for carbon neutrality puts coal mining and coal power companies in a particularly difficult position (Endl et al., 2018). Therefore, emphasis should be placed on an integrated, equitable and economically efficient transformation that takes into account the interests of mining companies and the interests of coal and lignite regions. Last but not least, the protection of the value chain in economic life should not be forgotten (European Association for Coal and Lignite, 2021a). In addition to transformation, environmental degradation can be controlled through the use of environmentally friendly mining operations and innovative technologies, while further use and reclamation of mining areas also play an important role (Čech et al., 2020; Lorite et al., 2021; Mohsin et al., 2021; Setiawan et al., 2021; Worlanyo & Jiangfeng, 2021). All these steps, together with the transformation of the industry, can lead to environmental benefits. For this reason, new innovative approaches in management processes are important, not only for industrial enterprises (Jurkasova et al., 2016; Straka et al., 2018). Many authors consider environmental aspects to be key aspects in research and practice (Pitukhina et al., 2017a; Pitukhina et al., 2017b; Přívara & Přívarová, 2019).

Due to the fact that Slovakia is rich in mineral resources and mining deposits (Fazekašová & Fazekaš, 2020; Pavolová et al., 2016; Sofranko et al., 2020; Teplická et al., 2021), this issue is of great importance at the political and social level. This study pointed to this industry from an economic point of view, and a positive trend was considered. All the findings of this study are important for decision-makers, who will face the challenges of the mining industry and will develop policies in line with the environment as well as business and innovation aspects within the mining value chain. In the context of the pursuit of green Slovakia, it is necessary to look for new alternatives that will be able to cover future energy needs, such as effective material use and renewable energy sources (Taušová et al., 2021; Tausova et al., 2007).

In conclusion, it should be noted that environmental degradation due to mining should not be ignored; therefore, transformation is a good starting point for Slovakia. However, it is always necessary to look for ways to improve a viable industry, increase its economic value, implement innovative approaches, all in accordance with the country's environmental and economic sustainability. In terms of the high importance of this study, the findings provide valuable inspiration for other economic sectors; thus, the applied analytical approach can be used in various areas of economic life (Gavurova et al., 2020a; Gavurova et al., 2020b; Gavurova et al. 2021a; Ivankova et al., 2021; Koľveková et al., 2019; Privara et al., 2018; Rigelský et al., 2021; Stefko et al., 2020). Future research ambitions should focus on other indicators that reflect the economic value of the mining industry, as well as on other economic sectors that can be compared with the mining industry.

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