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Sectoral changes of employment in Poland during the COVID-19 pandemic: Are reallocation shock effects applicable?[1]

***Eugeniusz Kwiatkowski*[2], *Agata Szymańska*[3]**

Abstract: The aim of this study is to analyse changes in employment and their determinants in twenty sectors of economic activity in Poland during the COVID-19 pandemic. The study focuses on the direct short-run employment effects. The changes in employment in the pandemic period (restricted to 2020q2–2021q2) with the changes in the pre-pandemic period (2015q1–2020q1) are compared. Statistics Poland and Eurostat are the sources of data. The analyses are based on quarterly and annual frequencies and cover the period from 2015q1 to 2021q2. Changes in employment are explained by the changes in gross value added, the differences in elasticities of employment with respect to the gross value added and the impact of the pandemic period. The results suggest that employment was affected by a reallocation shock—a decrease in employment that occurred in some sectors (e.g. arts, entertainment and recreation) was associated with an increase in other sectors (e.g. human health and social work activities).

Keywords: employment, gross value added, pandemic, COVID-19, reallocation shock, lockdown, sectors of economic activity.

JEL codes: E24, J21.

Introduction

The year 2020 experienced an unprecedented pandemic that involved a range of negative impacts on societies and economies and which affected the whole world. The origins of the pandemic date back to 2019, when the first cases of infection with the SARS-CoV-2 virus were reported in Wuhan, China. The virus spread quickly and in January 2020, the first cases occurred in the US and

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Italy and in March in other countries, including Poland. The rapid spread of the virus caused governments in many countries, including Poland, to introduce various administrative restrictions (lockdowns) aimed at inhibiting the rapid transmission of the virus. These restrictions negatively affected various economic areas including the basic variable of the labour market, that is, employment.

The aim of this study is to determine the directions and dynamics of changes in employment in sectors of economic activity in Poland during the COVID-19 pandemic and to explain the changes in employment in light of the changes in the gross value added (*GVA*), employment elasticities and the impact of the pandemic period. This study focuses on direct short-run employment effects. The analyses undertaken are fundamental for the identification of sectors characterized by the increase or decrease of employment during the COVID-19 pandemic and to help determine to what extent these changes can be attributed to the effects of the reallocation shock.

The empirical base of the study consists of quarterly and annual data related to employment and *GVA* in twenty sectors of economic activity in Poland. The data cover the period from 2015 to 2021. The main sources of data are Statistics Poland and Eurostat.

The structure of this paper is as follows. After characterizing the development of the pandemic in Poland and justifying it as a negative economic shock in Section 1, a brief literature review of the economic effects of the pandemic, especially for the labour market, is presented in Section 2. Section 3 presents the main methodological approach. Section 4 shows the variation in the direction and dynamics of employment across twenty sectors of economic activity during the pandemic and identifies "growing" and "declining" sectors. Section 5 attempts to provide an econometric explanation of this variation. Finally the last Section offers some conclusions.

1. The COVID-19 pandemic as a negative economic shock

The first cases of infection were officially reported in Poland in March 2020. In the months following as well as in early 2021 the pandemic developed rapidly. As reported by the Lancet COVID-19 Commission by the end of September 2021, due to COVID-19 the total number of infections exceeded 2.9 million cases in Poland and the cumulative number of total deaths was higher than 75,000. However, the pandemic did not develop uniformly across the study period as shown by the computed average monthly rates of daily new infections and daily deaths per million people as presented in Figure 1. The data indicate that the highest number of new infections and deaths due to COVID-19 occurred in the fourth quarter of 2020 and the first quarter of 2021. As shown in Figure 1, the highest average daily number of new infections occurred in

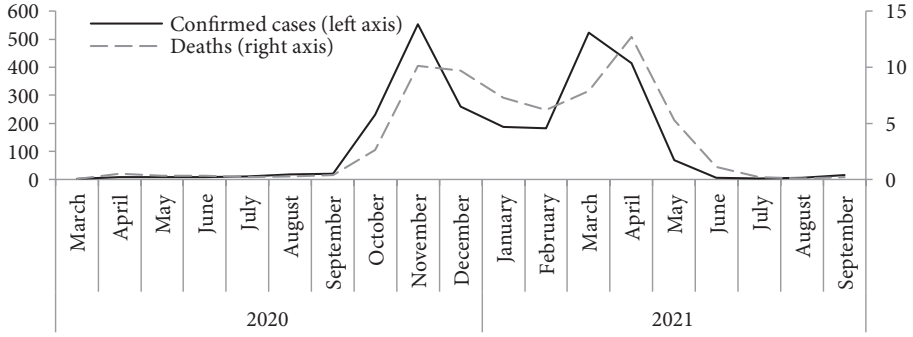


Figure 1. Average daily numbers of new infections and new deaths due to COVID-19 per one million population in Poland
Source: Based on the Lancet Covid-19 Commission (n.d.).

November 2020 whereas the highest average daily number of deaths occurred in April 2021.

The dynamic development of the pandemic and its direct impact on the economies and societies affected governments' reactions aimed at limiting the scope of the negative consequences of the virus by introducing administrative restrictions (lockdowns). These restrictions were mainly in the form of bans on public gatherings, restrictions on mobility and closing public facilities and other institutions providing certain services. Figure 2 presents a synthetic index illustrating the degree of restrictiveness of lockdowns in Poland. The index is scaled with values ranging from 1 (minimum restrictiveness) to 100 (maximum restrictiveness). As presented in Figure 2 the most far-reaching administrative tightening occurred in the second quarter of 2020 and the first quarter of 2021 while the lowest was in the summer.

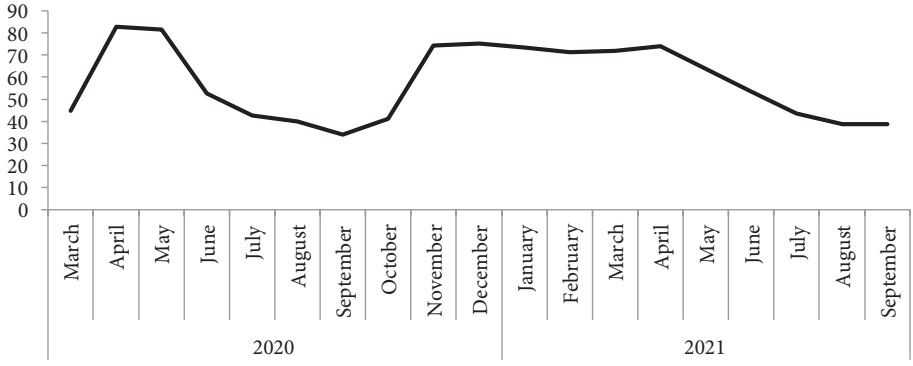


Figure 2. Average monthly index of lockdown restrictiveness in Poland in 2020–2021
Source: Based on the Lancet COVID-19 Commission (n.d.).

The restrictions and lockdowns introduced by governments were an administrative shock to society and the economy (see the report prepared by Hausner (Kunica, 2020)), and that shock quickly turned into a negative economic shock. The pandemic involved changes in consumer behaviour resulting in a decrease in demand for many products caused by a negative demand shock (Stiglitz, 2020). On the other hand the pandemic caused disruptions in the functioning of businesses due to increased sickness absenteeism, broken supply chains, shortages of some products and materials and increases in prices, inducing a negative supply shock.

The combined negative demand–supply shock associated with the pandemic affected the economy including the labour market. Shock influenced a variety of adaptation processes. The nature of these processes has already been widely described in the theory of adjustment processes to economic shocks (see Smith, 2003; Cahuc & Zylberberg, 2004). The theory emphasizes that negative economic shocks induce adjustments in the goods' market in the form of price changes, changes in the size of inventories, changes in the timing of deliveries and finally causing a reduction in production. In the labour market the processes of adjustments include reductions in wages, working time and labour productivity as well as in the level of employment.

Negative economic shocks and associated adjustments in the labour market can vary in nature and extent. The literature distinguishes between general aggregate activity shocks and reallocation shocks (also known as structural shocks) (Blanchard & Diamond, 1989, pp. 1–6). The main difference between the two shocks is that the aggregate activity shock has a unidirectional impact on the entire economy or the labour market while the reallocation shock affects the economic sectors in different directions. This evokes the question of which of these shocks dominate the economy during the pandemic. An important theoretical tool for identifying both shocks and answering the above question is the concept of the Beveridge curve (Kwiatkowski, 2007, pp. 60–77).

Consistent with the concept of the Beveridge curve and in a dynamic economy there are always certain quantities of unemployed and vacancies. The quantities of unemployment and vacancies tend to fluctuate with the business cycle and the degree of structural mismatch between labour supply and demand. Economic downturns are usually associated with an increase in unemployment and a decrease in job vacancies while economic upturns are associated with a decrease in the number of the unemployed and an increase in vacancies. On the other hand there may be structural mismatches in the labour market meaning the simultaneous co-occurrence of unemployment and vacancies. These observations are fundamental for theorems aimed at identifying the type of economic shock and the causes of unemployment considered from the point of view of the occurrence of one of these two shocks. Thus, if an increase in the total unemployment rate is accompanied by a decrease in the total rate of job vacancies, a negative shock to the general economy occurs, denoting that

the increasing unemployment is attributed to the consequences of recession. On the other hand a simultaneous increase in the unemployment and vacancy rates signals the presence of a reallocation shock that affects greater structural mismatches in the labour market; in other words despite more vacancies there are more unemployed people in the labour market. This situation might occur when the shock affects different sectors in different ways, that is some segments of the economy shrink while others expand rapidly. These cases are illustrated in Figure 3 which shows the Beveridge curve.

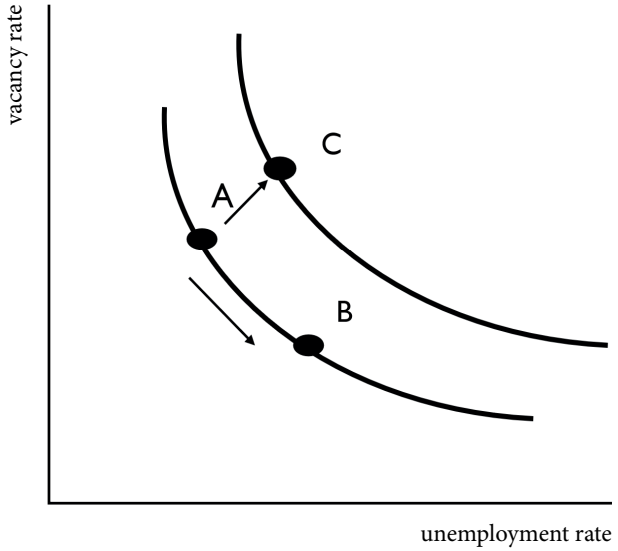


Figure 3. Beveridge curves
Source: Own work.

As presented in Figure 3, the negative aggregate activity shock is shown as a shift from the position defined by point A to position B while the reallocation shock is illustrated by a shift in the labour market from point A to point C. The shift from point A to point C can be associated, among others, with different responses of labour demand and employment in sectors of economic activity.

2. Literature review

The problem of sectoral changes in employment has been repeatedly discussed in the literature including Polish studies. One of them is a study by Kwiatkowski, Kucharski and Tokarski (2002) who analysed the sectoral changes of employment in agriculture, industry and services by region in Poland from 1995 to 2000. In this study the changes in employment were explained by the changes

in the sectoral structure of gross value added (*GVA*) and by diversified values of elasticities of employment in the considered sectors.

The trends of changes in the industrial and service sectors in Poland and especially the formation of core variables in the business cycle were analysed in the study by Growiec and others (2015). The authors, by using the tools of spectral analysis in the study of employment and *GVA* in Poland from to 1995–2012, pointed to the existence of a systematic reallocation of employment from the industry sector to the market services sector and emphasized the stabilizing role of market services in the business cycle.

Recently there has been an observable, increasing trend in the number of studies concerning the economic effects of the COVID-19 pandemic including its effects on the labour market. An important theoretical economic analysis of the effects of the COVID-19 pandemic was contained in the article by Guerrieri, Lorenzoni, Straub and Werning (2020). The authors emphasized theoretical arguments for interpreting the COVID-19 pandemic shock as a negative supply-demand shock. The authors presented the theory of Keynesian supply shocks, i.e. supply shocks that entail intensified changes in demand. Consistent with this theory a negative supply shock causes a decline in production and employment not only in the sectors affected by this shock but due to the decline in demand, also in other sectors of the economy. As emphasized such processes are highly probable in economies with multiple sectors and incomplete markets based on heterogeneous agents with liquidity constraints and different propensities to consume while the products manufactured in both sectors i.e. affected by the shock and not affected by the shock, are characterized by low substitutability across sectors. The authors presented a detailed mechanism of a negative Keynesian supply shock. The mechanism implying declines in output, employment and income in both types of sectors is perceived as an important determinant for understanding the supply-demand shock adopted in this article.

Recent literature has emphasized the role of COVID-19 in involving the reallocation shocks. The studies investigating the importance of the pandemic on the reallocation of employment, productivity, vacancies, the increasing or decreasing significance of some occupations are e.g.: Aaronson, Lewers and Sullivan (2021), Andrews, Charlton and Moore (2021), Barrero, Bloom, Davis and Meyer (2021), Barrot, Grassi and Sauvagnat (2021), McDermott and Hansen (2021) or IMF (2021c). In the paper by Barrero and others (2021) a number of arguments in favour of a reallocation shock during the pandemic period were presented. Based on individual data of firms, taken from The Survey of Business Uncertainty, the authors constructed measures of expected job reallocation rates across American firms at a one-year look-ahead horizon. The study emphasized that these rates increased from 1.54% in January 2020 to 5.39% in April 2020 with a large part of the job reallocations relating to intra-industry reallocation.

The impact of COVID-19 on changes in sectoral employment was also investigated by Brinca, Duarte and Faria-e-Castro (2020, 2021) who particularly emphasized the impact of the pandemic on sectoral employment. The results presented by Khan, Bibi, Lyu, Latif and Lorenzo (2021) for the US emphasized that COVID-19 negatively impacted employment in some sectors of economic activity, mainly the accommodation sector. Interesting assessments were also provided by the ILO (2020) report which analysed the impact of the pandemic on sectoral output.

The European Commission report (2021a) on the labour market in the European Union during the pandemic focuses not only on the changes in the aggregate size of the economically active, employed and unemployed populations in the EU in 2020 but also highlights the varying effects of the pandemic on employment across occupations and certain sectors of economic activity. As presented the differences between occupations and sectors in terms of changes in employment have been partly due to their susceptibility to remote work, the degree of social interaction necessary in the performance of work and belonging to occupations and sectors that are important for health and safety (i.e. critical occupations).

Recently many empirical studies have been conducted to show the effects of the pandemic on the labour market in selected countries. A study by Lemieux, Milligan, Schirle and Skuterud (2020) examined the impact of the pandemic on the Canadian labour market by using monthly data from February to April 2020. The study found that there was a more than 32% decline in total weekly hours and a 15% decline in employment. Moreover activities related to accommodation and food services, entertainment and large event planning were the one of the most vulnerable to the effects of the pandemic.

Forsythe, Kahn, Lange and Wiczer (2020) conducted a similar study on the US labour market. They reported that in April 2020 the industries surveyed experienced a decline in employment of about 5–15% compared to February 2020 with the largest decline in leisure and hospitality (by 50%) and non-essential retail (by 33.3%). In contrast the essential retail and nursing occupational groups appeared quite resilient to pandemic shocks.

In the literature considerable attention has been paid to the effectiveness of lockdowns. The study by Aum, Lee and Shin (2020) compared the situation in the labour market in South Korea (without a lockdown) and in the UK and US (lockdowns implemented). They found that all the countries studied experienced a decline in employment during the pandemic but the decline was greater in the US and UK (by 5–6%) than in South Korea (by 2–3%).

Fundamentally different conclusions about the effectiveness of lockdowns have been derived from several other studies (Kaplan, Moll, & Violante, 2020; Eichenbaum, Rebelo, & Trabandt, 2021). The results of the study by Eichenbaum and others (2021) presenting simulations within a dynamic stochastic general equilibrium (DSGE) model based on the widely used susceptible, infected, recov-

ered (SIR) pandemic model concluded that although lockdown leads to a weakening of the economy and a worsening of the situation in the labour market the absence of lockdown is not an optimal policy.

In this context interesting results are presented by Kaszowska-Mojsa and Włodarczyk (2020), who used a set of models of economic agents' behaviour and the DSGE model with a labour market component to carry out several simulations concerning the formation of core economic variables during the pandemic. They assumed different programmes and restrictions related to the preventive measures taken by governments during the pandemic. As a result they concluded that the behaviour of economic agents affects the ability of lockdowns to reduce the negative economic and social effects of a pandemic.

3. Methodology

The research undertaken in this study was conducted in two stages. First the changes in the number of employed in twenty sectors in the pandemic period were identified to determine "increasing" and "decreasing" sectors with respect to changes in employment. Second an attempt was made to explain the diversity of changes in employment with respect to changes in *GVA*.

The analysis of employment changes is based on quarterly data in twenty sectors of economic activity in Poland from 2015q1 to 2021q2. Data on employment were derived from the Eurostat database. A list of the sectors is presented in Table 1.

To distinguish between "increasing" and "decreasing" sectors during the pandemic period the indicators of the rates of change in employment in A–T sectors (listed in Table 1) were computed. Due to data availability the pandemic period was limited to the period from 2020q2 to 2021q2. The quarterly rate of change in employment was computed with respect to the corresponding quarter of the previous year. After identifying the "increasing" (and "decreasing") sectors in the pandemic period each group of sectors was divided into three subgroups depending on whether the rate of increase (decrease) in employment in the sector during the pandemic period was higher, lower or opposite in direction compared to the average rate during the pre-pandemic period (i.e. in the period from 2015q1 to 2020q1). In each sector the average rate of change in employment in the pandemic period calculated as the average change of five quarters (2020q2, 2020q3, 2020q4, 2020q1, 2020q2), was compared to the similarly calculated average rate of change in employment for all quarterly observations from 2015q1 to 2020q1.

Changes in employment during the pandemic period were explained by three main determinants: by the variation in the *GVA* reflecting the proxy of changes in demand and output; by the estimates of the elasticity of employment with respect to the *GVA*; and by the particular impact of the pandemic period. The

Table 1. List of sectors of economic activity

Code	Label
A	Agriculture, forestry and fishing
B	Mining and quarrying
C	Manufacturing
D	Electricity, gas, steam and air conditioning supply
E	Water supply; sewerage, waste management and remediation activities
F	Construction
G	Wholesale and retail trade; repair of motor vehicles and motorcycles
H	Transportation and storage
I	Accommodation and food service activities
J	Information and communication
K	Financial and insurance activities
L	Real estate activities
M	Professional, scientific and technical activities
N	Administrative and support service activities
O	Public administration and defence; compulsory social security
P	Education
Q	Human health and social work activities
R	Arts, entertainment and recreation
S	Other service activities
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use

Source: Based on Eurostat (2008).

quarterly data concerning the *GVA* in twenty sectors covered the period from 2015q1 to 2021q2 and were derived from Statistics Poland. The data were deflated by different price indices appropriate to the individual sectors for which the base year was 2008. For most sectors the consumer price index was used while in the case of five sectors (B—mining and quarrying, C—manufacturing, D—electricity, gas, steam and air conditioning supply, E—water supply; sewerage, waste management and remediation activities, and F—construction), the deflators were the price indices of sold production appropriate for these sectors.

The applied econometric approach was drawn from studies that took into consideration both neoclassical and Keynesian determinants of employment (e.g. Hamermesh, 1986; Pesaran, Pierse, & Kumar, 1989; Lewis, & MacDonald, 2002) but in this study it was limited only to the Keynesian determinant, i.e. the gross value added which was introduced as a proxy of demand and output

because of limitations in the availability of statistical data for all analysed sectors of economic activity.

As mentioned the estimates of employment elasticity were based on a very simplified labour demand function for which the employment (*EMPL*) is a function of the gross value added (*GVA*) (in constant prices of the year 2008) and a dummy variable *pandemic* that takes the value 1 in the period of a pandemic (i.e. the period covering 2020q2–2021q2) and 0 otherwise. It should be emphasized that the estimates of employment elasticities in relationship to the gross value added reflect not only the direct reactions of firms to changes in demand and production but also the impact of the state policy on production and employment and the impact of existing legal regulations in the field of labour market institutions. The dummy variable for the pandemic period is understood as a variable that captured all processes that occurred during the pandemic, i.e. not only the shock involved by the lockdowns and infections but also the impact of governments' supporting programmes, the effects of the use of teleworking in particular sectors, the importance of particular sectors for health, safety and fed (the critical and non-critical sectors) as well as the required degree of social interaction.

The elasticities were estimated based on data with quarterly frequencies covering the period from 2015q1 to 2021q2. The starting point is the power form of the function which, when logarithmised and reduced to a linear form permitted an interpretation of the parameters in terms of elasticities. Before logarithmisation the variables *GVA* and *EMPL* used in the model were seasonally adjusted using the TRAMO/SEATS method.

Two approaches were used in the analysis of employment elasticities. The first was to describe the employment elasticity for each of the twenty sectors separately. In this case the general model for each sector is the same and is described as follows:

$$ln\_EMPL_t = \alpha_0 + \alpha_1 ln\_GVA_t + \alpha_2 pandemic_t + e_t \tag{1}$$

In the second approach, the panel approach, estimates of employment elasticities were provided for a group from all twenty sectors and two subsamples referring to "decreasing" and "increasing" sectors in the pandemic period. Estimates were based on Beck and Katz's (1995) panel-corrected standard error procedure. In this case the general model for each of the three groups is the same and is described as follows:

$$ln\_EMPL_{i,t} = \beta_0 + \beta_1 ln\_GVA_{i,t} + \beta_2 pandemic_{i,t} + \varepsilon_{i,t} \tag{2}$$

where:

- *ln_EMPL* is the logarithm of the seasonally adjusted number of employed,
- *ln_GVA* is the logarithm of the seasonally adjusted *GVA*, expressed in constant 2008 prices,
- e_t and $\varepsilon_{i,t}$ are error terms,

– parameters α_1 and β_1 indicate the elasticities of employment with respect to the gross value-added, and
– parameters α_2 and β_2 indicate the impact of pandemic period on employment changes.

4. Sectoral changes in employment

The adaptation processes in the labour market to economic shocks and the decisions made by economic entities initiating these adjustments are always taken under certain institutional conditions and under the determinants created by state policy. Also in Poland during the pandemic period the decisions of economic entities in the field of production and employment were affected by the existing institutional environment of the labour market including current state policy. It is worth taking a closer look at them because of their significant effects on the employment changes in the Polish economy.

The labour market institutions in Poland during the pandemic period were the result of earlier adopted regulations. It is worth emphasizing the most important changes in labour market institutions in Poland in 2015-2020 (see e.g. European Commission data; European Commission, 2021a; Eurostat data base; OECD data for details):

– in 2017 the earlier statutory retirement age was restored, which had been in force before January 1st, 2013 (i.e. 60 for women and 65 for men),
– generally the employment protection legislation did not change (EPL indexes remained unchanged throughout the period), but the level of employment protection in the field of temporary contracts was significantly lower than in the case of permanent contracts.
– the share of fixed-term employment in relation to total employment has remained relatively high in Poland (15% in 2020) despite a downward trend in recent years; this decrease was related to the change in legal regulations in 2016 which limited to 33 months the maximum period of fixed-term contracts with the same employer,
– in recent years the absolute level of the minimum wage has increased as well as the ratio of the minimum wage to the average wage in the economy (46.9% in 2020); compared to Western European countries the level of the minimum wage in Poland is still relatively low,
– the tax wedge was characterized by a relatively low level especially in the group of employees with many children and by a significant progression in the group of employees with higher salaries,
– the unemployment benefits are not very generous (the maximum duration is six months, and the amount of the unemployment benefit is significantly reduced after three months).

During the pandemic period the Polish government initiated a set of measures aimed at employment, workplaces and job protection. The important legislation was included in the *Act on special measures regarding prevention, counteraction and combating COVID-19 other contagious diseases and crisis situations related* (2 March 2020). A set of different measures and actions were also introduced under the "Anti-crisis Shields" which were based on the *Act on special measures*. The following measures should be mentioned (see: OECD, 2021; European Commission, 2021b; IMF, 2021a, 2021b; *Tarcza antykryzysowa*, n.d. for details):

- The most advanced measures were issued in 2020 and in 2021. Generally the government launched a set of regulations aimed at five pillars: workplace protection and employee safety; financing of entrepreneurs; healthcare; strengthening the financial system; and public investments.
- For example the regulations aimed at workplace protection and employee safety concerned: numerous issues regarding remote work, including public administration; economic downtime or reduction of employees' working time up to 20%; care allowances for parents of children aged up to eight (aid was based on the need to temporarily provide personal care due to closing of nurseries, nursery schools and schools) or parents of a disabled child; a solidarity allowance for people who after March 15, 2020 lost their source of income due to the economic situation caused by the COVID-19 crisis.
- Examples of support for business activity were: preferential loans to cover the costs of running a business; exemption from social security contributions for three months; support in financing the salary costs of employees and social security contributions due to a decrease in turnover as a result of the coronavirus pandemic (the amount of support depended on the amount of turnover decrease); demurrage allowances; special assistance—the Polish Tourist Voucher—supporting Polish families on the one hand, and entities that are tourism entrepreneurs or public benefit organizations on the other.
- In 2020 the *COVID-19 Counteracting Fund* was established within the Bank Gospodarstwa Krajowego in order to finance or subsidize the implementation of tasks related to counteracting COVID-19. The fund offered a set of instruments related to combating the effects of COVID-19 including the implementation of tasks that will be needed as a fiscal impulse to stimulate economic activity, as part of the "Anti-crisis Shield".
- According to the 2020 execution, the total expenditure of the Fund on the implementation of tasks related to counteracting COVID-19 amounted to more than 92,735 million Polish zlotys. The largest funds were distributed to: labour, health, computerization, economic affairs, culture and protection of the national heritage, social security contributions.

Table 2 shows indicators computed for the rates of change in the number of employed in twenty sectors of economic activity and for the total economy in the pandemic period and in the period 2015q1–2020q1. These indicators were calculated based on quarterly data consistent with the methodology described in Section 3.

Table 2. Average changes in employment in twenty sectors of economic activity and in total economy (based on quarterly data) in pre-pandemic period 2015q1–2020q1 and pandemic period 2020q2–2021q2 (in %)

Sector	Average quarterly change	
	2015q1–2020q1 (%)	2020q2–2021q2 (%)
Total	0.65	–0.02
A	–3.28	–0.71
B	–2.98	–5.34
C	1.86	–2.85
D	–1.60	11.49
E	2.06	1.39
F	2.03	1.05
G	–0.16	–1.72
H	2.41	4.27
I	3.50	–11.03
J	4.09	5.51
K	1.37	1.55
L	0.03	–6.39
M	2.96	2.67
N	–2.06	–0.73
O	–0.30	0.50
P	0.46	0.43
Q	0.91	5.69
R	0.96	–3.68
S	2.50	9.14
T	–4.46	56.38

Source: Based on Eurostat data (n.d.).

Several important findings emerged from the data analysis presented in Table 2. With regard to employment in the total economy there was a small (–0.02%) decrease in the pandemic period whereas the average change for the

pre-pandemic period pointed to an increase in total employment. The reduction in employment in the pandemic period was undoubtedly the result of pandemic shock but that trend cannot be attributed to the effect of a negative shock on overall economic activity. This is due to the fact that strong declines in employment in some sectors were accompanied by some increases in employment in others. Such employment responses to the pandemic shock signalled the effect of a reallocation shock.

On the basis of the changes in sectoral employment the identification of the groups and subgroups of the "increasing" and "decreasing" sectors is possible during the pandemic period (see Table 3). In the pandemic period the data indicate a decrease in employment in eight sectors (A, B, C, G, I, L, N, and R). This group of "decreasing" sectors includes the sectors in which there was an average upward trend in employment from 2015q1 to 2020q1, e.g. C (manufacturing), I (accommodation and food service activities), L (real estate activities) and R (arts, entertainment and recreation). The reasons for the collapse of the trend in employment in these sectors during the pandemic period can be attributed to disruptions in supply chains (it might especially affect sector C) and lockdowns that reduced the activity in sectors requiring high social interaction (especially in sectors I and R).

The group of sectors with a reduction in employment during the pandemic period included sectors in which the decline in employment intensified during the pandemic compared to the earlier pre-pandemic period. These sectors include sectors B (mining and quarrying) and G (wholesale and retail trade; repair of motor vehicles and motorcycles). It seems that the recognized trend (i.e., deepening the decline in employment) was related to rigidities that inhibited market demand as well as to the fact that the services provided in these sectors did not meet the most urgent needs and necessities of consumers during the pandemic. In contrast the group of "declining" sectors, for which the average decline in pre-pandemic period was higher included sector A (agriculture, forestry and fishing) and sector N (administrative and support service activities).

During the pandemic period there was an upward trend in employment in some sectors of economic activity (such as sectors D, E, F, H, J, K, M, O, P, Q, S, and sector T). Within this group it is interesting to note the case of sectors D (electricity, gas, steam and air conditioning supply), O (public administration and defence; compulsory social security) and T (activities of households as employers; undifferentiated goods- and services-producing activities of households for their own use), which experienced a strong increase in employment during the pandemic period although they had, on average, a declining trend between 2015q1 and 2020q1. Such a reversal of the trend during the pandemic can be explained by some examples: in the case of sector D by the importance of services provided to secure the essential needs of the population and enterprises. The reverse trend in sector T can be explained taking the assumption that the sector may be perceived as a shock absorber of tensions in the la-

bour market (i.e. those laid off from work in other sectors of economic activity might have been employed by households as a babysitter, carer for the elderly, private nurse, cook, cleaner). The case of sector O (public administration and defence; compulsory social security) might be related to the overall situation of that sector—i.e. before the pandemic the sector was not as competitive as the private sector in terms of wages and many workers were leaving public administration. Whereas during the pandemic period public administration appeared to be a sector with stable workplaces.

The group of "increasing" sectors during the pandemic period also includes sectors characterized by the average growing trend in employment in 2015q1–2020q1 while the pandemic contributed to a further increase in the growth rate. These sectors were H (transportation and storage), J (information and communication), K (financial and insurance activities), Q (human health and social work activities) and S (other service activities). Various reasons underpinned employment growth in these sectors during the pandemic period such as the phenomenon of the development of new forms of trade with home delivery (especially for sector H) and the increase in demand for medical (Q) and information (J) services undoubtedly playing a role.

Table 3. Sectors with increasing and decreasing employment and their subgroups in pandemic period 2020q2–2021q2 compared to the pre-pandemic period 2015q1–2020q1

Sectors with increasing employment during the pandemic period	D, E, F, H, J, K, M, O, P, Q, S, T		
	Including sectors for which the average quarterly positive growth rate during the pandemic period (2020q2-2021q2) relative to the average quarterly rate of change for the pre-pandemic period (2015q1–2020q1) was:		
	higher	lower	opposite
	H, J, K, Q, S	E, F, M, P	D, O, T
Sectors with decreasing employment during the pandemic period	A, B, C, G, I, L, N, R		
	Including sectors for which the average quarterly negative growth rate during the pandemic period (2020q2-2021q2) relative to the average quarterly rate of change for the pre-pandemic period (2015q1–2020q1) was:		
	higher	lower	opposite
	B, G	A, N	C, I, L, R

Source: Based on Eurostat data (n.d.).

The differences in the dynamics of employment changes in individual sectors of economic activity during the pandemic and pre-pandemic periods resulted in changes in the sectoral structure of employment. They may have implied the

accompanying processes of the reallocation of the labour force between sectors. Figure 4 shows the percentage shares of each of the sectors of economic activity in total employment from 2018 to 2020.

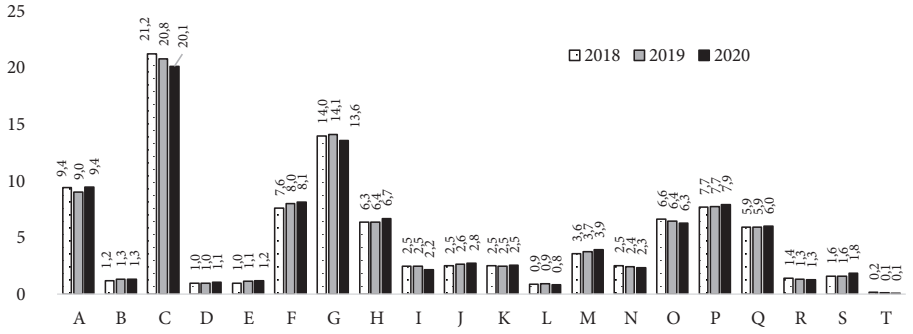


Figure 4. The share of the employment in sectors from A to T in total employment in the year 2018, 2019, and 2020 (in %)
Source: Based on Eurostat data (n.d.).

As shown in Figure 4, several sectors experienced a decrease in the share of total employment in 2020 compared to previous years. This mainly concerns sectors C, G, I, L, N, and O. On the other hand sectors F, H, J, M, P, Q, and S increased in importance during the period under analysis. The stable share was related to financial and insurance activities (sector K).

5. Analysis of determinants of employment changes in sectors of economic activity

The presented changes in the number employed in particular sectors of economic activity have deeper causes. A rich body of economic theory related to the determinants of employment is helpful in recognizing these causes. However, it should be noted that full use of the theories is impossible in the present study because of limitations in the availability of statistical data for all analysed sectors of economic activity. For these reasons, an attempt to explain changes in employment is limited to three determinants here: first the changes in *GVA* reflecting a proxy of changes in demand and production in individual sectors of economic activity; second the degree of employment sensitivity with respect to changes in *GVA*; and third the impact of the pandemic period on employment changes.

With regard to the first determinant Figure 5 illustrates the average rates of change in gross value added (*GVA*) and employment (*EMPL*) for the pandemic period. More detailed data reporting quarterly changes of these two variables in each quarter of the pandemic period are presented in Figure A1 in the

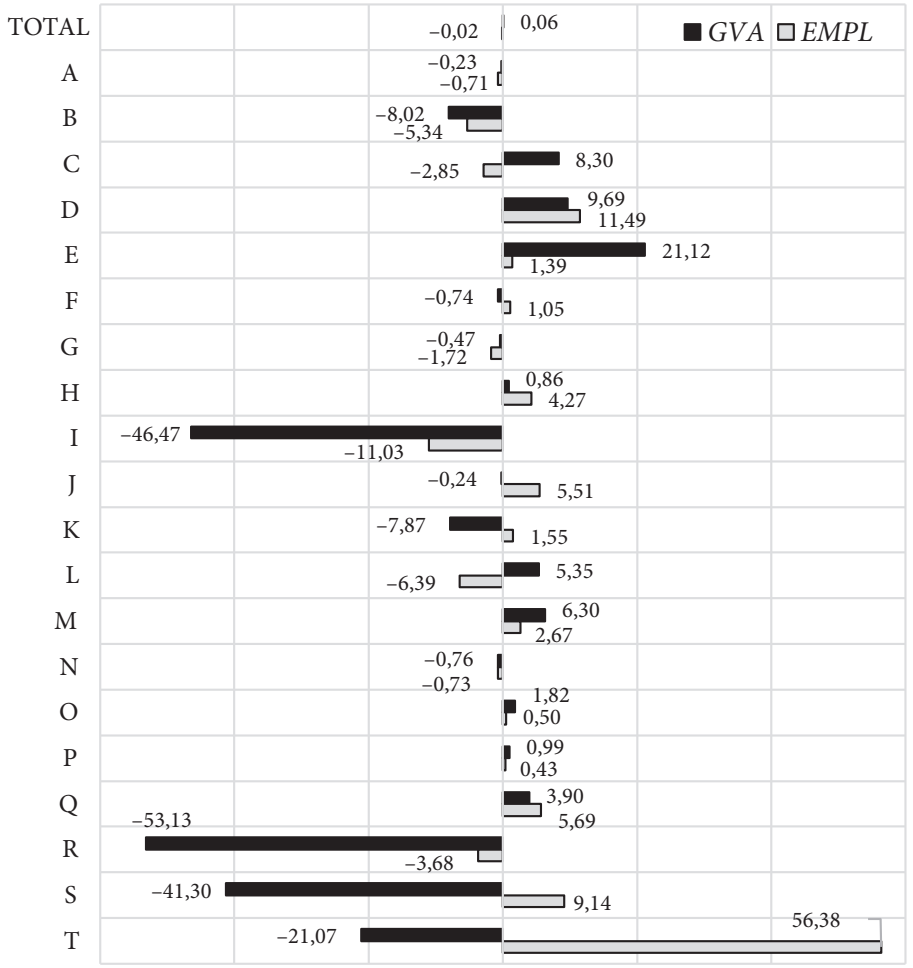


Figure 5. Average rate of change in gross value added (*GVA*) and employment (*EMPL*) in the pandemic period 2020q2–2021q2 (in %)
Source: Based on Statistics Poland (n.d.) and Eurostat data (n.d.).

Appendix. However, the data presented in Figure 5 confirm the importance of the relationship between changes in *GVA* and in employment. As shown in Figure 5, in 13 cases the change in *GVA* entailed a change in employment in the same direction. The data identify seven sectors with an increase in both variables (sectors D, E, H, M, O, P, and Q). These sectors can be identified as important for the functioning of society and the economy in the initial stage of the pandemic (especially those sectors providing services in health, education, information and communication). In the pandemic period, the decrease in both variables concerned six sectors: A, B, G, I, N, and R. The case of sectors I and R reflects that a large decrease in the *GVA* was associated with a smaller decline

in employment. These observations suggest that changes in *GVA* significantly affected the direction of employment changes in several sectors although the sensitivity of employment to changes in *GVA* varied considerably.

The econometric analyses undertaken in this study are aimed at describing the elasticity of employment with respect to *GVA*. Two approaches have been used to achieve this goal. The first concerns the elasticity of employment with respect to *GVA* for each of the twenty sectors individually based on a linear regression model. In the second approach a panel model was used, based on which elasticity parameters were estimated for a group of all twenty sectors and separately for "decreasing" sectors and "increasing" sectors. The detailed methodology was presented in Section 3.

Before estimations the variables were examined using the unit root test and the Phillips-Perron test (variables in the regression model for a single sector) and the Levin-Lin-Chu unit-root test (variables in the panel model) were used. The test results are presented in the Appendix in Tables A1 and A2, respectively. The test results indicate a lack of stationarity in the levels of the variables for most individual sectors as well as for the group of sectors analysed. Therefore, the first differences were tested. However, the tested first differences of employment in the case of sectors M and T as well as the tested first differences of *GVA* for sector P failed to reject the null hypothesis (i.e. the hypothesis in which the variable under analysis is assumed to contain a unit root); thus the second differences of the variables for these three sectors were tested. Despite the first difference of variables for these three sectors not allowing the rejection of the null hypothesis (see Table A1 in the Appendix) it was decided to estimate models for all sectors using the first differences of variables. As a result the final equations are as follows. Separate sections were estimated on the basis of equation (3):

$$\Delta ln\_EMPL_t = \alpha_0 + \alpha_1 \Delta ln\_GVA_t + \alpha_2 pandemic_t + e_t \tag{3}$$

whereas, the panel approach used equation (4):

$$\Delta ln\_EMPL_{i,t} = \beta_0 + \beta_1 \Delta ln\_GVA_{i,t} + \beta_2 pandemic_{i,t} + \varepsilon_{i,t} \tag{4}$$

Table 4 presents estimates for sectors for which estimated coefficients of elasticities were statistically significant. The estimates of parameters of the regressions for each of the individual sectors are presented in Table A3 in the Appendix. The analysis of results presented in Table 4 indicates that the estimates of the coefficients for elasticity (i.e. α_1) turned out to be statistically significant only in eight out of the sixteen analysed sectors (sectors M, P, T, and N were excluded from further analyses—see Table A1 and Table A3 in the Appendix). The estimates turned out to be positive and statistically significant in the case of sectors F, G, I, and R denoting that the percentage increase in

the change of *GVA* was associated with the percentage increase in the change in employment. For example the estimation of α_1 for sector G (wholesale and retail trade; repair of motor vehicles and motorcycles) amounted to 0.122, indicating that the increase in the change in *GVA* by 1% increased the change in employment by 0.122%. For sectors A, D, J and S the estimates of were negative and statistically significant, implying the opposite response of change in employment to the increase in the change in *GVA*. The estimation of α_1 for sector Q (human health and social work activities) was very high (–2.086) indicating that an increase in the change of *GVA* by 1% led to a decrease in the change of employment by 2.086%.

The estimates of the relationship between changes in employment and a dummy variable for the pandemic period were statistically significant only in the case of four out of sixteen analysed sectors. The relationship was positive in sectors D (electricity, gas, steam and air conditioning supply) and Q (human health and social work activities). This indicates that the pandemic period increased the positive changes in employment in these sectors. This result is consistent with the information presented in Table 3. These sectors were identified as sectors of growing importance during the pandemic period. They can be regarded as critical for the health and life of the population. For example the estimate of α_2 for sector Q indicates that in the pandemic period

Table 4. Statistically significant estimates of elasticities—regression based on first differences of variables for individual sectors, quarterly time sample from 2015q1 to 2021q2

Sector	α_0 (intercept)		α_1 (Δln_GVA_t)		α_2 (pandemic$_t$)	
A	–0.008	(0.006)	–0.085**	(0.035)	–0.019	(0.020)
C	0.003	(0.004)	0.011	(0.014)	–0.010**	(0.004)
D	–0.004	(0.006)	–0.573**	(0.229)	0.046***	(0.013)
F	0.006*	(0.003)	0.113*	(0.057)	–0.003	(0.006)
G	–0.002	(0.003)	0.122**	(0.051)	0.008	(0.010)
I	0.005	(0.007)	0.063***	(0.015)	–0.004	(0.021)
J	0.021**	(0.010)	–0.874*	(0.474)	–0.009	(0.015)
Q	0.025	(0.015)	–2.086	(1.367)	0.015**	(0.007)
R	–0.103***	(0.018)	0.080***	(0.012)	–0.077***	(0.009)
S	0.011	(0.008)	–0.054***	(0.015)	–0.016	(0.009)

Notes: The estimates are based on the equation (3). In columns 1–3, the value of the standard error is shown; ***, **, and * denote the estimates at the significance levels of 0.01, 0.05, and 0.1, respectively.

Source: Based on Statistics Poland (n.d.) and Eurostat data (n.d.).

in relation to the non-pandemic period the increase in the change of employment was on average 0.015% higher, other conditions remaining the same. The negative and statistically significant estimation of the parameter concerns sectors C (manufacturing) and R (arts, entertainment, and recreation). This indicates that the pandemic decreased the change in employment compared to the pre-pandemic period. The reasons for this relationship may be associated with the breaking of the supply chains (mainly affecting sector C) and a high degree of social interaction (for example in the case of sector R). For example the estimate of α_2 for sector R indicated that the change in employment during the pandemic period was lower on average by 0.077%. The result unambiguously confirmed the impact of the pandemic on the decrease in the change in employment in sector R, i.e. it was strongly affected by the lockdown due to its association with direct contact with the consumer and the limited possibility of remote services provision.

The results of the parameter estimates for the panel models are presented in Table 5. The additional analysis showing the pre-estimated relationship for correlations between the $\Delta ln\_EMPL_{i,t}$ and $\Delta ln\_GVA_{i,t}$ variables is presented in Table A4 in the Appendix. As shown in Table A4, the group of "increasing" sections was characterised by the negative correlation between both variables regardless of the time sample concerned: whole period, pre-pandemic subsample or pandemic subsample.

The results presented in Table 5 indicate that the statistically significant and positive estimates of the elasticity expressed by the coefficient β_1 concerned the group of all twenty sectors and "decreasing" sectors. This relationship is positive and in the case of a group of "decreasing" sectors an increase in the change in

Table 5. Estimates of elasticities in panel models, time sample from 2015q1 to 2021q2

	β_0 (intercept)	β_1 (Δln_$GVA_{i,t}$)	β_2 (pandemic$_{i,t}$)	Obs.
All 20 sectors	0.001 (0.003)	0.042** (0.020)	0.013** (0.006)	500
"Increasing" sectors	0.003 (0.004)	–0.045 (0.056)	0.021** (0.009)	300
"Decreasing" sectors	–0.003 (0.003)	0.070*** (0.018)	–0.001 (0.007)	200

Notes: The estimates are based on the equation (4). "Increasing" sectors denotes sectors with increase in employment during the pandemic period, whereas the "decreasing" sectors denotes sectors with decrease in employment during the pandemic period (see Table 3 for details). In columns 1–3, the value of the standard error is shown; ***, **, and * denote the estimates at the significance levels of 0.01, 0.05, and 0.1, respectively. Panel-corrected standard error procedure with heteroscedastic error structure and the autocorrelation structure common to all the panels.

Source: Based on Statistics Poland (n.d.) and Eurostat data (n.d.).

the *GVA* by 1% had on average, with other factors unchanged, the effect of increasing the change in employment by about 0.070%. The results obtained for β_2 show that in the period of the pandemic the change in employment in the group of "increasing" sectors was on average higher than in the non-pandemic period by approximately 0.021% whereas the estimate for "decreasing" sectors was admittedly negative but statistically insignificant. The statistically significant and positive effect of the pandemic period was obtained for all twenty sectors. In the case of the total economy the conditions of the pandemic period caused on average the 0.013% increase in the change of employment.

It should be noted that the regressions with the independent variable of $\Delta ln\_GVA_{i,\,t-1}$ instead of $\Delta ln\_GVA_{i,\,t}$ were also analysed in both econometric approaches but the results were not statistically significant in most cases. As regards the impact of the pandemic year on change in employment in the model with lags the obtained estimates identified similar sets of "decreasing" and "increasing" sectors as in the reported model. However, these estimates are not reported here.

Generally, the results of the study were partially in line with those presented in the literature. For example, Brinca and others (2020, 2021) based on the US labour market concluded that nearly two-thirds of initial COVID-19 shocks were supply-side shocks that affected certain subsectors of domestic services (such as hotels, restaurants, etc.), construction and manufacturing. Alternatively sectors such as utilities and transportation were affected less while other sectors including information and financial services suffered very little or improved their performance. In this study the simple recognition between "increasing" and "decreasing" sectors led to similar results. Sectors I (accommodation and food service activities) and C (manufacturing) were classified as "decreasing" sectors in the pandemic period in contrast to the pre-pandemic period. The sectors such as J (information and communication) or K (financial and insurance activities) were classified as "increasing" sectors. Moreover, the increase in these sectors was higher than during the pre-pandemic period. The sectors such as D (electricity, gas, steam and air conditioning supply) or E (water supply; sewerage, waste management and remediation activities) i.e. the utility sectors, were classified as "increasing" sectors. These obtained results were also in line with the general findings proposed by Guerrieri and others (2021) who emphasized that supply shocks may led to a decline in demand.

Moreover, the European Commission (2021a) distinguished between teleworkable and non-teleworkable occupations, occupations with high and low levels of required social interaction and critical or non-critical occupations (distinguished from the point of view of the impact of the occupation on the ability to keep citizens healthy, safe and fed) and recognized the behaviour of employment during the pandemic period. The study emphasized that critical occupations (e.g. health professionals) experienced a small decrease in employment in 2020 in EU26 while in the case of non-teleworkable non-critical and occupa-

tions requiring a high level of social interaction (e.g. wholesalers, waiters, bartenders) the decrease was the highest. At the same time the highest increase was in teleworkable, critical occupations requiring a low level of social interaction (e.g. information and communication technology professionals). As presented in this study the Polish case showed a high decrease in sector G (wholesale and retail trade; repair of motor vehicles and motorcycles), I (accommodation and food service activities) while the increase concerned for example sector J (information and communication). The results may be perceived as consistent with the conclusions presented in European Commission publication (2021a).

Moreover, the work by Lemieux and others (2020) expected large shifts across industries and predicted that employment in hospitality, event planning or live arts and entertainment will suffer a large decline in labour demand. In this study employment during the pandemic period decreased as opposed to the pre-pandemic period in sectors such as: R (arts, entertainment, and recreation), I (accommodation and food service activities) as predicted by Lemieux and others (2020). Moreover, the results obtained in this study were similar to the general conclusions presented by Khan and others (2021) for the US. As emphasized by the authors during the COVID-19 pandemic the employment in leisure and hospitality was the most vulnerable sector (mainly its segments such as museums and historical places; performing arts and sport).

The obtained results are also supported by the ILO (2020) analyses. As presented in ILO (2020) the impact of COVID-19 on output was evaluated as high in accommodation and food services; real estate, business and administrative activities; manufacturing; wholesale and retail trade, repair of motor vehicles and motorcycles. In this study these sectors were classified as "decreasing" during the pandemic period. On the other hand the small impact of COVID-19 on production was assigned by ILO to education; human health and social work activities; public administration and defence, compulsory social security; utilities. This classification was consistent with the findings here based on the employment analyses. These sectors were categorised as "increasing" sectors during the pandemic period.

Conclusions

The COVID-19 pandemic caused changes in employment in many sectors of economic activity in Poland but as shown in this study these changes were not unidirectional. The analysis of twenty sectors in the pandemic period shows that the decline in employment in some sectors was accompanied by employment increases in others. Such changes suggest that the negative pandemic shock was rather a reallocation shock instead of an aggregate activity shock.

The pandemic and lockdown shock caused strong downward trends in employment in several sectors in the pandemic period. In particular the tenden-

cy concerned such sectors as: agriculture, forestry and fishing (A), mining and quarrying (B), manufacturing (C), wholesale and retail trade; repair of motor vehicles and motorcycles (G), accommodation and food service activities (I), real estate activities (L), administrative and support service activities (N) and arts, entertainment and recreation (R). The decline in employment in these sectors might be related to the effects of disrupted supply chains or reduced possibilities of direct contact with customers during lockdown in sectors requiring high social interaction.

However, during the pandemic employment increased in several sectors. This included such sectors as: electricity, gas, steam and air conditioning supply (D), water supply; sewerage, waste management, remediation activities (E), construction (F), transportation and storage (H), information and communication (J), financial and insurance activities (K), professional, scientific and technical activities (M), public administration and defence, compulsory social security (O), education (P), human health and social work activities (Q), other service activities (S), activities of households as employers, undifferentiated goods- and services-producing activities of households for their own use (T).

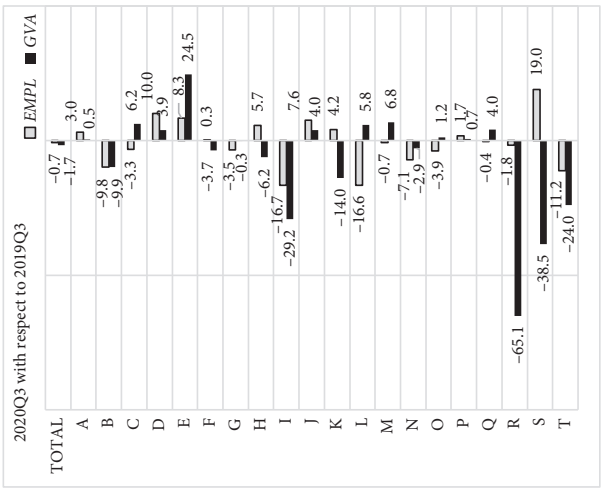
Changes in employment were caused by many factors. One of them is related to changes in the gross value added (*GVA*) reflecting the proxy of changes in demand and output. Employment changes were also determined by different employment elasticities. Analysis of elasticities for changes in employment relative to the changes in *GVA* in the years 2015–2021 indicated that statistically significant estimates were obtained for eight sectors but these elasticities varied in their values. For four sectors these elasticities were positive (sectors: construction—F, wholesale and retail trade; repair of motor vehicles and motorcycles—G, accommodation and food service activities—I, arts, entertainment and recreation—R), while a negative relationship was obtained for sectors agriculture, forestry and fishing (A), electricity, gas, steam and air conditioning supply (D), information and communication (J) and other service activities (S).

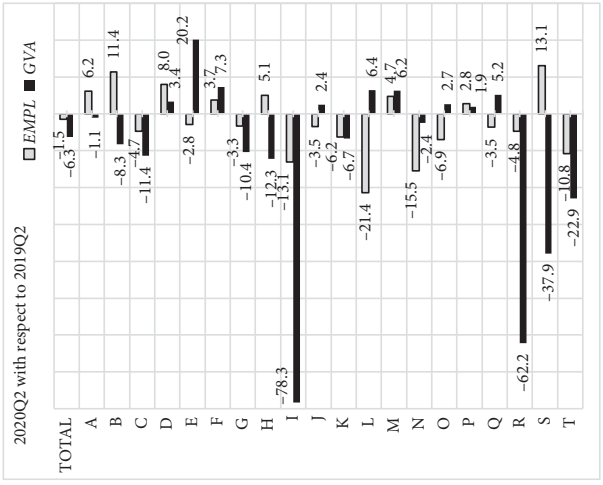
In contrast estimates of the impact of the pandemic shock on changes in employment indicated that only in a few sectors the impact was statistically significant. In comparison to the pre-pandemic period in the sectors: electricity, gas, steam and air conditioning supply (D) and human health and social work activities (Q) the pandemic increased the average change in employment growth while in the sectors: manufacturing (C), and arts, entertainment and recreation (R) the pandemic decreased it. These results also suggest a conclusion about the reallocation shock occurrence on Poland's labour market during the pandemic. However it is necessary to emphasize that the pandemic period was related not only to the COVID-19 shock and infections but also many other effects caused by the COVID-19 pandemic, e.g. administrative lockdowns, government support and the effects of the labour market reforms, changes in the importance of some sectors and occupations to keep citizens healthy, safe and fed (critical and non-critical occupations) and by the effects

of the required level of social interactions or the possibility of remote work on the employment in different sectors during the pandemic.

Summing up: the presented results are in line with the results emphasized in the existing literature. The obtained results may generate a few policy implications. Firstly the experiences of the pandemic shock imply the need to analyse and evaluate the measures taken by the government during the pandemic and to draw conclusions about the effectiveness of these measures, especially with respect to the effectiveness in the field of employment and job protection. Secondly due to the critical role of reallocation shocks in the pandemic period and the different responses of individual sectors to the pandemic shock, government policy supporting business and jobs protections should be more selective and targeted at the most vulnerable sectors. Thirdly reallocation processes entail shifts in labour force between firms, sectors and occupations. State policy should enable these shifts through appropriate regulations for labour market institutions. Extremely restrictive regulations of labour law in particular with regard to employment protection legislation may prevent the desired reallocations and shifts. Fourthly, due to the increasing importance of remote work for influencing employment in many sectors of the economy state policy should support the development of technical infrastructure enabling remote work in as many sectors as possible.

Appendix


2020Q3 with respect to 2019Q3
EMPL
GVA
TOTAL
A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
S
T
-0.7
-1.7
3.0
0.5
-9.8
-9.9
-3.3
6.2
10.0
3.9
8.3
24.5
-3.7
0.3
-3.5
-0.3
-6.2
5.7
-16.7
-29.2
7.6
4.0
-14.0
4.2
-16.6
5.8
-0.7
6.8
-7.1
-2.9
-3.9
1.2
0.7
1.7
-0.4
4.0
-1.8
-65.1
-38.5
19.0
-24.0
-11.2


2020Q2 with respect to 2019Q2
EMPL
GVA
TOTAL
A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
S
T
-1.5
-6.3
6.2
-1.1
-8.3
11.4
-4.7
-11.4
8.0
3.4
20.2
-2.8
3.7
7.3
-3.3
-10.4
-12.3
5.1
-13.1
-78.3
-3.5
2.4
-6.2
-6.7
-21.4
6.4
4.7
6.2
-15.5
-2.4
-6.9
2.7
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-22.9

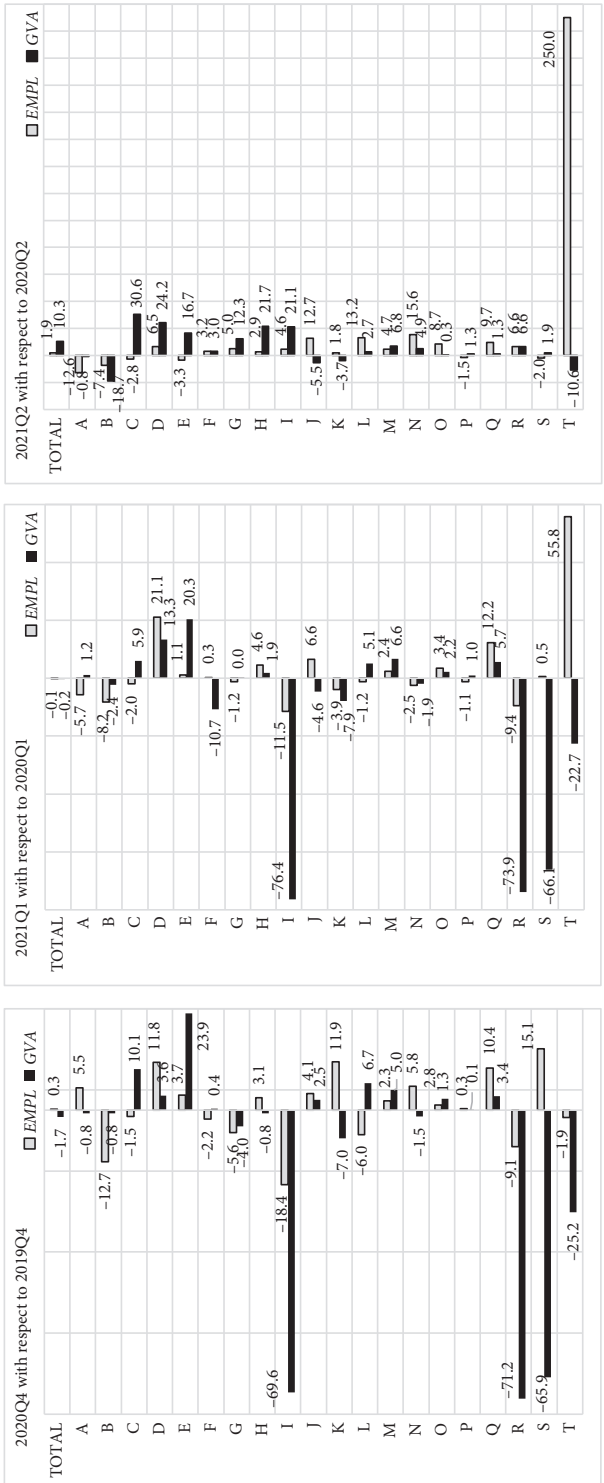

Figure A1. The quarterly rate of changes in gross value added (*GVA*) and the number of employed (*EMPL*) in the period of pandemic with respect to the same quarter of the previous year (in %)

Source: Based on Statistics Poland and Eurostat data.

Table A1. Results of the Phillips-Perron unit root test

Section	*ln_EMPL*	Δ*ln_EMPL*	*ln_GVA*	Δ*ln_GVA*	Δ(Δ*ln_EMPL*)	Δ(Δ*ln_GVA*)
A	–2.2711 (0.4331)	–3.446766 (0.0687)	–2.0263 (0.5594)	–4.6517 (0.0057)		
B	–1.8510 (0.6492)	–4.6101 (0.0063)	–2.4398 (0.3522)	–4.5404 (0.0073)		
C	–0.3475 (0.9841)	–6.0399 (0.0003)	–3.6767 (0.0432)	–12.6311 (0.0000)		
D	–1.6401 (0.7472)	–7.1349 (0.0000)	–0.0471 (0.9929)	–3.6550 (0.0460)		
E	–2.1145 (0.5134)	–5.1743 (0.0018)	1.9617 (1.0000)	–4.2675 (0.0131)		
F	–2.2809 (0.4283)	–5.5484 (0.0008)	–2.0129 (0.5664)	–4.5069 (0.0078)		
G	–3.8153 (0.0326)	–4.3213 (0.0117)	–3.6583 (0.0448)	–9.9314 (0.0000)		
H	–4.0368 (0.0206)	–7.7078 (0.0000)	–2.3997 (0.3707)	–5.4115 (0.0011)		
I	–1.6373 (0.7484)	–3.9693 (0.0244)	–2.4250 (0.3589)	–9.4008 (0.0000)		
J	–4.8543 (0.0035)	–11.1693 (0.0000)	1.2237 (0.9999)	–3.9744 (0.0242)		
K	–3.9949 (0.0225	–8.9226 (0.0000)	–1.1267 (0.9039	–7.1758 (0.0000)		
L	–2.65218 (0.2627)	–8.9799 (0.0000)	–1.8973 (0.6259)	–4.9477 (0.0030)		
M	–2.1572 (0.4912)	–2.9961 (0.1535)	–2.6924 (0.2476)	–5.2506 (0.0015)	–5.3462 (0.0014)	–22.6837 (0.0000)
N	–4.1911 (0.0149)	–13.3873 (0.0000)	–2.2405 (0.4486)	–5.9935 (0.0003)		
O	–2.3443 (0.3971)	–5.7296 (0.0005)	–2.4122 (0.3649)	–5.8384 (0.0004)		
P	–2.3650 (0.3871)	–4.6179 (0.0062)	–1.9399 (0.6042)	–2.2247 (0.4558)	–14.1582 (0.0000)	–7.3506 (0.0000)
Q	–1.7459 (0.7000)	–4.8453 (0.0038)	–1.1847 (0.8920)	–4.1844 (0.0156)		
R	–1.6192 (0.7560)	–5.2154 (0.0017)	–1.6284 (0.7522)	–4.6483 (0.0058)		
S	–2.6878 (0.2492)	–5.6803 (0.0006)	–2.2790 (0.4292)	–9.0866 (0.0000)		
T	–1.1731 (0.8944)	–0.997368 (0.9256)	–1.3079 (0.8623)	–4.3623 (0.0107)	–4.1223 (0.0184)	–16.7839 (0.0000)

Notes: The *p*-value is given in parentheses, and the regression tested includes the intercept and trend.

Source: Based on Statistics Poland and Eurostat data.

Table A2. Results of the Levin-Lin-Chu unit root test

	ln_EMPL	*Δln_EMPL*	*ln_GVA*	*Δln_GVA*
All 20 sectors	–1.9555 (0.0253)	–7.1802 (0.0000)	2.3320 (0.9902)	–3.6858 (0.0001)
"Increasing" sectors	–1.60000 (0.0548)	–6.0994 (0.0000)	3.4639 (0.9997)	–2.2365 (0.0127)
"Decreasing" sectors	–1.2315 (0.1091)	–3.7922 (0.0001)	–1.1547 (0.1241)	–3.2802 (0.0005)

Notes: "Increasing" sectors denotes sectors with increase in employment during the pandemic period, whereas the "decreasing" sectors denotes sectors with decrease in employment during the pandemic period (see Table 3 for details). The *p*-value is given in parentheses, the regression tested includes trend.

Source: Based on Statistics Poland and Eurostat data.

Table A3. Estimates of parameters—regression based on first differences of variables for individual sectors; quarterly time sample from 2015q1 to 2021q2

Sector	α_0	α_1	α_2	Observations	Jarque--Bera test for normality	Breusch-Godfrey Serial Correlation LM Test
A	–0.008 (0.006)	–0.085** (0.035)	–0.019 (0.020)	25	0.305 (0.859)	F-statistic 1.386115 Prob. F(2,20): 0.2731
B	0.001 (0.001)	0.128 (0.141)	–0.006 (0.025)	25	9.951 (0.006)	F-statistic 0.017963 Prob. F(2,20): 0.9822
C	0.003 (0.004)	0.011 (0.014)	–0.010** (0.004)	25	0.952 (0.621)	F-statistic 1.151476 Prob. F(2,20): 0.4012
D	–0.004 (0.006)	–0.573** (0.229)	0.046*** (0.013)	25	0.428 (0.808)	F-statistic 3.457928 Prob. F(2,20): 0.0513
E	–0.010 (0.020)	1.238 (0.964)	–0.034 (0.027)	25	0.669 (0.716)	F-statistic 3.642631 Prob. F(2,20): 0.0448
F	0.006* (0.003)	0.113* (0.057)	–0.003 (0.006)	25	1.736 (0.420)	F-statistic 0.767911 Prob. F(2,20): 0.4772
G	–0.002 (0.003)	0.122** (0.051)	0.008 (0.010)	25	0.707 (0.702)	F-statistic 0.951129 Prob. F(2,20): 0.4031
H	0.008* (0.004)	0.074 (0.066)	–0.001 (0.005)	25	0.513 (0.774)	F-statistic 0.615558 Prob. F(2,20): 0.5503
I	0.005 (0.007)	0.063*** (0.015)	–0.004 (0.021)	25	1.426 (0.490)	F-statistic 0.182106 Prob. F(2,20): 0.8349
J	0.021** (0.010)	–0.874* (0.474)	–0.009 (0.015)	25	0.977 (0.613)	F-statistic 1.434001 Prob. F(2,20): 0.2618

Sector	α_0	α_1	α_2	Observations	Jarque--Bera test for normality	Breusch-Godfrey Serial Correlation LM Test
K	–0.001 (0.007)	0.297 (0.234)	0.001 (0.011)	25	1.379 (0.502)	F-statistic 2.164038 Prob. F(2,20): 0.1410
L	–0.015 (0.015)	0.178 (0.137)	0.019 (0.018)	25	1.305 (0.521)	F-statistic 2.923375 Prob. F(2,20): 0.0770
M#	0.007 (0.006)	0.063 (0.098)	–0.002 (0.010)	25	1.323 (0.516)	F-statistic 3.682243 Prob. F(2,20): 0.0435
N	–0.015 (0.009)	0.391 (0.363)	0.013 (0.028)	25	52.920 (0.000)	F-statistic 3.948012 Prob. F(2,20): 0.0359
O	0.002 (0.004)	–0.352 (0.223)	0.008 (0.011)	25	0.499 (0.779)	F-statistic 1.063795 Prob. F(2,20): 0.3639
P#	0.001 (0.006)	0.241 (0.517)	–0.004 (0.005)	25	29.652 (0.000)	F-statistic 0.132629 Prob. F(2,20): 0.8766
Q	0.025 (0.015)	–2.086 (1.367)	0.015** (0.007)	25	0.342 (0.843)	F-statistic 4.994496 Prob. F(2,20): 0.0174
R	–0.103*** (0.018)	0.080*** (0.012)	–0.077*** (0.009)	25	0.761 (0.684)	F-statistic 1.305768 Prob. F(2,20): 0.2931
S	0.011 (0.008)	–0.054*** (0.015)	–0.016 (0.009)	25	0.549 (0.760)	F-statistic 0.768432 Prob. F(2,20): 0.4770
T#	–0.023 (0.034)	0.283 (0.445)	0.259 (0.139)	25	0.622 (0.733)	F-statistic 5.899302 Prob. F(2,20): 0.0097

Notes: The estimates are based on the equation (3). In columns 1–3, the value of the standard error is shown; ***, **, and * denote the estimates at the significance levels of 0.01, 0.05, and 0.1, respectively. In column 5, the *p*-values are given in brackets. The OLS estimates include the Newey-West estimator. # denotes the nonstationarity of the first differenced of employment for sectors M and T, whereas in the case of the P sector, the nonstationarity of the first difference of the variable for the *GVA*. In the Breusch-Godfrey test, the applied null hypothesis tested is that there is no serial correlation at up to two lags.

Source: Based on Statistics Poland and Eurostat data.

Table A4. Correlation matrices

Whole period (2015q1–2021q2)						
	all sectors		"increasing" sectors		"decreasing" sectors	
	Δ*ln_EMPL*	Δ*ln_GVA*	Δ*ln_EMPL*	Δ*ln_GVA*	Δ*ln_EMPL*	Δ*ln_GVA*
Δ*ln_EMPL*	1.0000		1.0000		1.0000	
Δ*ln_GVA*	0.0672	1.0000	–0.0392	1.0000	0.1025	1.0000
Pre–pandemic period (2015q1–2020q1)						
	all sectors		"increasing" sectors		"decreasing" sectors	
	Δ*ln_EMPL*	Δ*ln_GVA*	Δ*ln_EMPL*	Δ*ln_GVA*	Δ*ln_EMPL*	Δ*ln_GVA*
Δ*ln_EMPL*	1.0000		1.0000		1.0000	
Δ*ln_GVA*	–0.0186	1.0000	–0.0088	1.0000	–0.0166	1.0000
Pandemic period (2020q2–2021q2)						
	all sectors		"increasing" sectors		"decreasing" sectors	
	Δ*ln_EMPL*	Δ*ln_GVA*	Δ*ln_EMPL*	Δ*ln_GVA*	Δ*ln_EMPL*	Δ*ln_GVA*
Δ*ln_EMPL*	1.0000		1.0000		1.0000	
Δ*ln_GVA*	0.1204	1.0000	–0.0815	1.0000	0.1782	1.0000

Source: Based on Statistics Poland and Eurostat data.

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