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The effects of COVID-19 on Polish enterprises

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Abstract

The COVID-19 pandemic had massive impacts on economic sectors. This paper explores the economic effects of COVID-19 on 150,000 Polish enterprises. The paper analyses financial data from the Polish National Court Register and explores heterogenous impacts brought by the COVID-19 pandemic across multiple sectors. Its innovative contribution lies in adopting a granular perspective to assess the sector-specific impacts of COVID-19. This approach distinguishes the paper from much of the existing literature, which predominantly emphasises global or macroeconomic outcomes. The paper compares financial ratios across 2019 and 2020, applying Wilcoxon and Mann-Whitney tests to measure changes in profitability, liquidity, working capital, and leverage ratios. Key findings indicate a disparity in revenues across sectors, with some showing resilience in adapting to pandemic-induced challenges. The analysis reveals that 28 PKD divisions experienced significant revenue reductions (up to −70% in tourism-related sectors), while 25 divisions experienced gains (up to +23% in Information Technology sectors). Notably, while working capital metrics deteriorated across most sectors, with Days Receivables Outstanding increasing substantially, liquidity ratios improve across 80% of sectors.

Keywords

- COVID-19
- economic sectors
- Wilcoxon test

JEL codes: A30, C12, E60, G30, G38

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Introduction

The short-term impact of COVID-19 on businesses was largely predictable yet uncontrollable. Fear of infection led to substantial reductions in labour supply and demand in positions where infection probability is highest, and comparatively smaller reductions in positions that are less at risk. Throughout history, the threat of pandemics has been readily apparent due to the cyclical nature of these virus subtypes, which reoccur every 10–50 years (Potter, 2001). The daily number of confirmed COVID-19 cases in Poland and the U.S. is presented in Figure 1.

The business landscape has experienced substantial disruption through pandemics, as consumers focus on immediate personal safety through unsustainable actions (Funk et al., 2009). The retail and hospitality sectors faced severe downturns due to lockdowns and reduced consumer spending. These sectors also have high exposure to domestic and foreign customers compared to other sectors, increasing the potential for exposure (Lam et al., 2004). The COVID-19 pandemic primarily harmed small and medium-sized enterprises (SME) through reduced liquidity and the need for redundancies (Bartik et al., 2020; Fairlie, 2020; Lalinsky & Pál, 2022). The government sought to limit damages by offering aid to microenterprises based on monthly revenue decline. However, the liquidity provided through Polish programmes went to businesses that were too severely affected to be rescued and business enti-

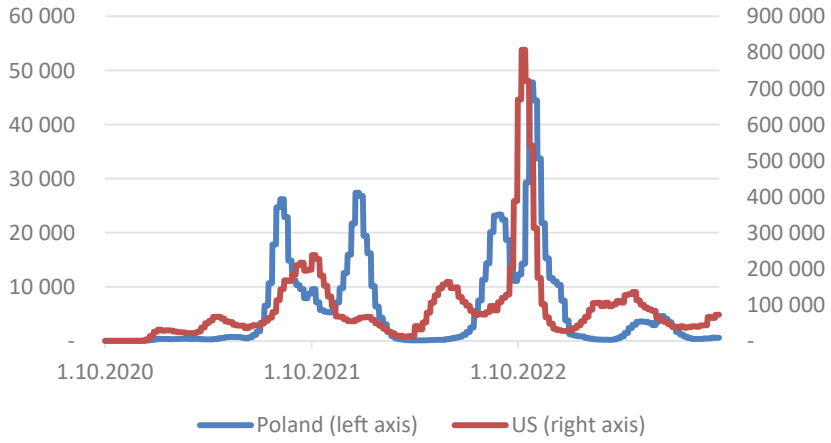

Figure 1. Daily new confirmed cases due to COVID-19 (rolling 7-day average)

Source: (https://ourworldindata.org/covid-cases).

ties that did not require such support (Kochaniak et al., 2023). The technology and e-commerce sectors saw unexpected growth.

By analysing a comprehensive dataset, this study provides a detailed and nuanced understanding of the heterogeneous effects of the pandemic on various sectors within a single country. The novel aspect of this research lies in its granular approach to examining sector-specific impacts of COVID-19. Thus, this paper sets itself apart from the reviewed literature, most of which focuses on global or macroeconomic effects. The in-depth analysis in this paper regarding financial ratios, such as profitability, liquidity, working capital, and financial leverage across different sectors provides a unique perspective on the varying degrees of vulnerability and resilience exhibited during the pandemic. Moreover, this study emphasises the role of government intervention, particularly the 'Anti-Crisis Shields' regulations implemented by the Polish government, thus adding a new dimension to the understanding of how targeted policy measures can help mitigate the adverse effects of the COVID-19 pandemic on specific sectors.

An important aspect is the ability of the global economy to adjust relatively quickly to fast-changing, severe conditions, facilitated both by governmental actions and company agility (Korneta & Rostek, 2021). The combination of an effective governmental response, e.g., economic stimulus packages, and the adaptability of businesses through innovation and restructuring may reduce the negative impacts of global crises such as pandemics, earthquakes, eruption of wars, etc. The ability of economies to bounce back under extreme circumstances highlights the resilience that can be fostered through targeted interventions and flexible business strategies (Korneta & Rostek, 2021).

Thus, by providing a detailed account of the specific measures employed, including subsidies, loan guarantees, tax deferrals, and exemptions, this study offers valuable insights into the effectiveness of these government policies in stabilizing affected industries, and in facilitating a resilient recovery. The integrative value of this research lies in its ability to bridge various strands of literature, including studies on macroeconomic effects, policy responses, supply chain disruptions, and sectoral dynamics. By incorporating insights from these diverse areas, the paper provides a comprehensive, holistic understanding of COVID-19's impact on the Polish economy.

This paper is significant due to the fact that we assess 150,000 companies in Poland, thus extending the international analysis of COVID-19 to this country. This is the first study that uses Polish data with a vast quantity of business classification (PKD) codes, covering many heterogeneous companies. Moreover, this paper studies macroeconomic governmental policies in addition to a microeconomic analysis of different sectors of the economy. As a country with a population of nearly 40 million, Poland is a key growing economy at the heart of the European Union.

The remainder of the paper is organised as follows: Section 1 reviews the literature; Section 2 presents the data and methodology; Section 3 presents and discusses the empirical findings; and last Section offers conclusions.

1. Literature review

This section reviews some recent papers dealing with the effects of COVID-19.

Raza (2023) and McKibbin et al. (2023) highlight the importance of coordinated fiscal and monetary policies in mitigating the adverse effects of the pandemic on prices, output, and GDP. Alon et al. (2023) find that emerging markets experienced larger output losses and greater fatalities compared to advanced and low-income economies, due to factors such as employment in high-contact occupations and limited public transfers. This study extends the analysis to Poland, an economy that experienced relatively higher growth as compared to the emerging markets studied by Alon et al. (2023).

Several studies focus on the pandemic's impact on specific sectors. Karaki et al. (2023) examine the role of consumer pessimism in amplifying financial uncertainty shocks across American industrial sectors. Nyakurukwa and Seetharam (2023) analyse the interconnectedness of sectors within the Johannesburg Stock Exchange, finding increased integration during the pandemic. McCann et al. (2023) and Basurto et al. (2023) assess the effectiveness of various policy measures in supporting economic recovery. McCann et al. (2023) emphasise the importance of providing liquidity finance to viable firms in Ireland, while Basurto et al. (2023) find that continuous mild lockdowns or lighter restrictions are more effective than alternating between strict lockdowns and complete reopenings. Guedegbe (2022) investigates the effects of COVID-19 policy responses on Nigerian agricultural households, highlighting the need to consider farm viability when designing containment measures.

Kyriazis et al. (2023) examine the hedging effectiveness of traditional stock indices, precious metals, and cryptocurrencies during the pandemic. J. Wang et al. (2023) measure the COVID-19 spillover impact on monetary policy transmission and business practices in Asian financial markets. Kazancoglu et al. (2023) examine the sector-specific impacts of the pandemic on global supply chains, focusing on Turkey and China, and emphasise the importance of governmental and managerial interventions in mitigating negative effects.

Ikhsan and Amri (2023) investigate the moderating role of the COVID-19 pandemic on the relationship between bank credit and sectoral output growth in Indonesia. X. Wang (2023) and Archanskaia et al. (2023) discuss the pandemic's adverse effects on corporate sectors globally and assess corporate financial distress in the European Union.

The following studies analyse the effect of COVID on employment in Poland. Kwiatkowski and Szymanska (2022) 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. Their results suggest that employment was affected by a realloca-

tion 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). The paper by Bartosik (2024) investigates changes in employment across groups of workers during the coronavirus pandemic in Poland. It analyses the impact of the coronavirus crisis on employment by comparing actual and predicted employment growth during the pandemic period, using Okun's law. The outcome of research indicates that the total employment response to output change was relatively small, compared to the historical pattern. However, the response was unequal across groups of workers. The youngest workers, particularly women, and those with temporary employment contracts were most affected by the pandemic.

The reviewed literature reveals a noticeable lack of sector-specific studies utilising big data to analyse the impact of COVID-19 on the Polish economy during the pandemic in 2022.

2. Research methods

2.1. Data

The financial data of private companies are stored at the Polish National Court Register (KRS) in Poland's Ministry of Justice. The financial accounts contain Balance Sheets and Profit and Loss Statements, but not Cash Flow Statements. These data are publicly available. However, it is possible to access only one company's data per download. The database used in this study includes more than 150,000 such individual records, and the company Notoria Serwis S.A. provides this dataset. For each company, the data contain business classification (PKD) codes. PKD is the hierarchical classification system of the social-economic activities carried out by economic entities.

Each company reports its main PKD code used in this paper. The current version of the PKD system is PKD 2007, which is fully coherent and comparable with the classification NACE Revision 2 in methodology, concept, scope and coding (up to the fourth digit). NACE (Nomenclature statistique des Activités économiques dans la Communauté Européenne) is the Statistical Classification of Economic Activities in the European Community established by the Council Regulation No 3037/90 of October 9th, 1990 (OJ No L 293 of Oct. 24th 1990). The current version is Revision 2 (Regulation (EC) No 1893/2006). It is the European implementation of the United Nations International Standard Industrial Classification of All Economic Activities (ISIC), Revision 4, consistent with the North American Industry Classification System

The PKD classification uses four-digit hierarchical levels, which include 21 sections, 88 divisions, 272 groups, and 615 classes. This paper uses divisions, since they are general but not too small to perform statistical testing. Furthermore, we eliminate 10 divisions with fewer than 30 companies in order to improve the statistical significance of the results. The 3 divisions which belong to the "Financial and insurance activities" section are omitted, as banks, trusts, insurance companies, and pension funds have different financial reporting standards. Thus, the majority of financial ratios investigated in this paper cannot be computed effectively. For example, in the financial reports of banks, insurance companies, etc., such positions as inventories, receivables, and payables (generally trade receivables) cannot be found.

Financial ratios for fiscal years 2019 and 2020 are compared to examine the effects of the COVID-19 pandemic. The pandemic reached Poland at the beginning of March 2020. During the period of the pandemic, some measures were implemented, such as social distancing, travel restrictions, and several national lockdowns, including closing schools, non-essential shops, and cultural institutions. These restrictions severely impacted the business activities of some enterprises, whereas they boosted sales and profits in others. The purpose of this article is to provide quantitative data on which sectors were affected and to what extent. Consequently, the paper has broader policy implications regarding other low-frequency, high-risk events.

This research considers only companies that reported financial data for 2019 and 2020, enabling the derivation of various operating and financial ratios. 155,410 companies are covered, which are classified into 75 divisions of PKD.

While the study relies on data including all registered companies required to report financial statements, potential selection bias may exist, since some sectors are excluded from analysis due to the small number of companies operating in them. The dataset only includes companies that survived and reported data for both 2019 and 2020, thereby potentially excluding firms that failed during the pandemic, which could underestimate the negative impacts (survivorship bias). Furthermore, larger companies typically have more comprehensive reporting requirements and resources for financial reporting, potentially leading to overrepresentation of larger firms and underrepresentation of smaller enterprises (size bias).

2.2. Financial ratios

Alongside Revenues from Sales (RS), which is the primary financial variable affected by COVID-19, we consider several other financial ratios selected from the following four categories: (1) profitability, (2) liquidity, (3) working capital, and (4) financial leverage, thus providing a comprehensive financial outlook of

the companies. These categories are similar to those used by Gunasekaran et al. (1995) and Kallunki et al. (1996), excluding the category (5), detailed cash flow positions, as these are not available for private companies, which were not obliged to report a detailed Cash Flow Statement.

The chosen ratios are the following: (1) profitability ratios: R1—Operating Profit Margin, R2—Return on Assets, (2) liquidity ratios: R3—Quick Ratio, R4—Cash Ratio, (3) working capital ratios are presented as: R5—Cash Conversion Cycle, R6—Days Receivables Outstanding, R7—Days Inventory Outstanding, R8—Days Payable Outstanding, and (4) financial leverage ratios: R9—Debt Ratio, R10—Interest Coverage Ratio. Appendix I provides the definitions of each ratio. Revenues from Sales (RS), and ratios R1, R2, R3, R4, R8, and R10, are called concordant ratios because their increases imply strengthening the financial position of a company. The ratios R5, R6, R7, and R9 are called discordant ratios because their increases indicate a worsening of a company's financial position.

2.3. The statistical test

To assess the statistical significance of variations in Revenues from Sales and financial ratios between the pre-pandemic year of 2019 and the first pandemic year of 2020, the paper uses the nonparametric one-sided Wilcoxon test (Wilcoxon, 1945). This test serves as a paired difference test for two matched samples i.e., observations for the same company from two consecutive years. It is crucial to note that this test does not require specific assumptions about a probability distribution, apart from the symmetricity of the differences and independence of them. Symmetrical distribution of differences means that the distribution of the differences between paired observations should be balanced around the means. The assumption of difference independence is satisfied when paired observations are randomly and independently drawn.

The Wilcoxon test was chosen because it is particularly suitable for comparing paired financial observations from the same companies across two time periods, while making minimal distributional assumptions, requiring only symmetry of differences rather than normality of the underlying data—a crucial consideration given the well documented non-normal nature of financial ratios discussed in financial literature. Let X_i^{2019}, X_i^{2020} be a pair of the same financial variable realisation for i-th company drawn from the joint distribution (X^{2019}, X^{2020}) in two consecutive years 2019 and 2020. The following hypotheses are tested:

$$H_0 : \begin{cases} X^{2019} < X^{2020} \text{ and } X \text{ is concordant variable} \\ X^{2019} \geq X^{2020} \text{ and } X \text{ is discordant variable} \end{cases} \quad (1)$$

and

$$H_1 : \begin{cases} X^{2019} \geq X^{2020} \text{ and } X \text{ is concordant variable} \\ X^{2019} < X^{2020} \text{ and } X \text{ is discordant variable} \end{cases} \quad (2)$$

These hypotheses are tested at the 0.05 significance level. Hence, the result for a given financial variable, and a PKD division, can be represented as an output variable (O) that can be defined as:

$$O = \begin{cases} 1 & \text{if} \quad H_0 \text{ is rejected} \\ -1 & \text{if} \quad H_1 \text{ is rejected} \\ 0 & \text{otherwise} \end{cases} \quad (3)$$

The output variable equals 1 if we observe a statistically significant positive change in this variable. If the output variable is equal to –1, a statistically significant negative change occurs. In other cases, the output equals zero. Table 1 presents the output table for all financial variables and PKD divisions. All statistical tests in this paper are calculated using the SciPy library in Python.

3. Results

3.1. Empirical findings and discussion

In 2020, the Polish government implemented several measures to provide liquidity and support businesses during the economic downturn caused by the COVID-19 pandemic. It provided the following liquidity facilities, known as Anti-Crisis Shields:

a. Subsidies for salaries and social security contributions: This helped companies retain employees and avoid layoffs. Regardless of their size, businesses could apply for a three-month subsidy in case of work stoppages or reduced working time. This subsidy covered social insurance contributions, ranging from 50% to 90% of the minimum wage for each employee, depending on the recorded decrease in turnover in 2020; for micro firms with up to 9 employees, social insurance contributions were covered by the budget for three months. For companies employing from 10 to 49 employees, 50% of social insurance contributions are paid by the government budget. The self-employed and also employees working on civil-law contracts were eligible for a one-time benefit. During the pandemic, there was an exemption from social security contributions for industries affected by the restrictions.

b. Loan guarantees: Through the National Economy Bank (BGK in Polish), the government guarantees loans issued by commercial banks to small-, medium-sized, and large businesses. This encouraged banks to lend by mitigating their risk.
c. Direct loans: The Polish Development Fund (PFR in Polish) also offered direct loans to many enterprises which could be partially written off. Even up to 70% of the financing was non-returnable upon fulfilling the relevant conditions related to maintaining employment, and continuing business activity, and the level of lost sales was substantial.
d. Deferral of tax payments: Businesses could postpone paying various taxes, including income tax, Value Added Tax (VAT), and social security contributions, offering temporary cash flow relief.
e. Tax exemptions: Certain sectors, such as hospitality and entertainment, received temporary exemptions from specific taxes.
f. Moratorium on loan repayments: The government implemented a temporary moratorium on loan repayments to banks for some businesses and private individuals facing COVID-19-related financial hardship, allowing them to request a loan repayment suspension from their respective lenders. However, a nationwide moratorium on all loan repayments was not introduced, since they could be chosen by the enterprises that needed this help. Although the interest accrued, increasing the gross value of loans, it did not have to be paid.
g. The most seriously hit country received specialised additional help from the government, which was approved by the European Commission and discussed later in the article.

Determining the exact amount of liquidity provided by the Polish government is challenging, due to the diverse nature of the support measures. However, estimates suggest that the total value of financial aid offered through various programs exceeded PLN 200 billion (approximately €45 bn) in 2020. It is noteworthy that this figure does not represent the actual amount utilized by businesses, as some companies might not have needed to use the full extent of available support. This aid was offered largely through the establishment of the COVID fund, dedicated to combating the negative impact of the pandemic and with a balance sheet size of PLN 100 bn. The fund was supervised by the Prime Minister but flows from the fund would be transferred to various ministers and other institutions involved in combating the negative consequences of the pandemic. Revenues were raised through BGK's bond issues.

As a consequence of various fiscal stimuli and a lower inflow of taxes, the government budget deficit soared to 6.9% of GDP, according to the European Union standards (ESA methodology). As a response to COVID-19, the reference policy rate of the National Bank of Poland (NBP) was lowered from 150 bps to an all-time low of 10 bps, significantly reducing the financial costs for en-

terprises. The NBP provided liquidity to banks, reduced the required reserve ratio from 3.5% to 0.5%, and changed the interest rate on required reserves to a level equal to the policy interest rate. The NBP also purchased Polish Treasury and government-guaranteed securities on the secondary market of 135.8 bn (5.8% of 2020 GDP). Additionally, the Polish Financial Supervisory Authority (PFSA) announced measures to grant banks some flexibility to meet capital and liquidity requirements.

According to Dębkowska et al. (2021), 86% of the surveyed entrepreneurs utilised the solutions provided by the Anti-Crisis Shield. Companies widely leveraged the range of available support instruments, often using several complementary tools simultaneously. State aid was rated, on average, 3.5 on a scale of 1 to 5. Ambroziak's (2022) paper aims to identify and initially assess the implementation of schemes under COVID-19-related state aid was granted in Poland for different instruments and beneficiary sizes. The study helped demonstrate how Polish aid schemes assisted mainly micro- and small-sized companies, which usually suffered from poor liquidity, by means of predominantly soft instruments.

Table 1 presents the variable values for financial ratios across the top 10 and lowest 10 PKD divisions. Appendix 3 provides a table with all PKD divisions. Additionally, to facilitate the analysis, rows in the table, i.e. PKD divisions, were sorted according to a change in variable Revenues from Sales (RS) between 2019 and 2020.

Table 1. The output table, first and last 10 sectors affected by COVID-19

PKD	d% RS	RS	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
79	–70	–1	–1	–1	–1	0	–1	–1	0	1	–1	–1
51	–55	–1	0	0	0	1	–1	–1	0	0	0	0
90	–46	–1	–1	–1	0	0	–1	–1	0	1	–1	–1
55	–39	–1	–1	–1	–1	0	–1	–1	0	1	–1	–1
56	–24	–1	–1	–1	–1	–1	–1	–1	–1	1	–1	0
91	–18	–1	–1	–1	–1	0	–1	–1	0	0	–1	0
93	–16	–1	–1	–1	0	1	–1	–1	0	1	–1	0
15	–14	–1	0	0	1	1	–1	–1	–1	0	0	0
60	–13	0	0	0	0	1	0	0	0	0	0	0
94	–13	–1	0	0	0	1	–1	–1	0	0	0	0
…												
21	8	1	1	1	0	1	0	0	–1	0	0	0

table 1 continued

PKD	d% RS	RS	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
03	8	1	0	0	1	1	0	0	0	0	1	0
63	8	1	1	0	1	1	–1	–1	0	0	0	0
59	10	–1	0	–1	0	0	–1	–1	0	1	–1	0
84	10	0	0	0	1	0	0	–1	0	1	0	0
38	17	1	1	1	1	1	–1	–1	0	0	1	1
75	19	1	0	0	1	1	–1	–1	0	0	0	0
95	20	0	0	0	0	0	–1	–1	0	0	0	0
27	21	0	1	0	0	1	–1	0	–1	1	0	1
62	23	1	1	0	1	1	–1	–1	0	0	1	0

Source: own calculations.

There are a few general observations that can be drawn from Table 1. First, the effect of the pandemic on Revenues from Sales (RS) was mixed across the economy—in 28 PKD divisions, enterprises recorded a significant reduction in sales, in 22 divisions sales did not change statistically significantly, and for 25 divisions, sales improved to a significant degree. These outcomes are based on the quantity of divisions, not on the volume of goods and services they generate. The behaviour of profitability ratios, i.e. Operating Profit Margin (R1), and Return on Asset (R2) are naturally positively correlated with the change of Revenues from Sales (RS). However, one observes that Operating Profit Margin (R1) does not drop as significantly as Revenues from Sales (RS). The reason is that part of anti-crisis aid, discussed later in detail, is recorded as "Other operational profits" in the Profit and Loss statement.

Second, in almost all divisions, Days Receivables Outstanding (R6) deteriorated as enterprises decided to delay paying their trade receivables during the pandemic. Days Inventory Outstanding (R7) worsened as well, albeit in a smaller number of PKD divisions. It is worth noting that in most cases, when a drop in sales occurred in enterprises, their vendors spontaneously decided to extend the term of payables, as is indicated by an increase of the variable Days Payable Outstanding (R8). Despite this, the overall Cash Conversion Cycle (R5) worsened across almost all divisions.

Third, regardless of the worsening cash conversion, which might naturally lead to lowering liquidity, overall liquidity, measured by Quick Ratio (R3) and Cash Ratio (R4), substantially increased for almost all PKD divisions. This phenomenon is attributed to a liquidity injection from the Polish government into the economy , as well as other liquidity-improving programs and measures enforced by law.

Finally, the Debt Ratio (R9) increased to a partial degree because of the moratoria on loan repayments, during which interest was accrued and not repaid. At the same time, the Interest Coverage Ratio (R10) did not change significantly for many divisions. This was a result of adjusting financial costs to a drop in operating profits, due to the interest rate being reduced to an all-time low by the National Bank of Poland.

We decided to look in detail into those divisions in which Revenues from Sales either decreased or increased substantially, i.e. above 20%. The divisions in which Revenues from Sales statistically significantly dropped most were as follows: 'Tour operator, middlemen, agents and other reservation service and related activities' (–70.0%), "Air transport" (–55.1%), "Creative, arts and entertainment activities" (–46.4%), "Accommodation" (–38.6%), and "Food and beverage service activities" (–24.2%). The first two are related to a sharp reduction in people's mobility following the start of the pandemic and tourism stopping; the third relates to the closing of theatres, cinemas, and art galleries because of social distancing rules; the fourth (Accommodation) refers to the locking down of hotels and hostels caused by tourism having to stop.[3]

The last division indicates a problem encountered by many restaurants and catering activities to switch from physical meetings with their clients to remote delivery of their products. For these divisions, almost all financial ratios (apart from Days Payable Outstanding for "Accommodation") deteriorated during the first pandemic year, and liquidity ratios did not improve or even deteriorated. The decreases in Revenues from Sales were so dramatic that even liquidity injections by the government did not boost their cash position. Thus, many restaurants and catering enterprises stood on the verge of bankruptcy. Thanks to the special support dedicated to these sectors, which is mentioned below, many enterprises from these sectors survived.

During the pandemic in Poland, the national carrier Polskie Linie Lotnicze LOT S.A. received support under the Support Program. This program was adopted by the Council of Ministers on December 21, 2020, and was intended to enable LOT Polish Airlines to remain on the market in the face of COVID-19. The European Commission's decision on December 22, 2020 approved the support package for PLL LOT, which amounted to PLN 2.9 bn. This support was intended to ensure that the company maintained financial liquidity and an adequate amount of capital necessary to run its business. The program assumed the recapitalization of PLL LOT from the state budget and granted a loan from the Polish Development Fund.

The tourist voucher was launched in Poland as a new form of support for the tourism industry weakened by the COVID-19 pandemic. It was payable regardless of income level and amounted to a one-off amount of PLN 500 (USD 125) for each child up to 18 years of age. Additionally, children with a disabil-

[3] See Osorio et al.'s (2023) study on the vulnerability of the Spanish tourism sector.

ity certificate received one additional benefit in the form of a voucher supplement, also for PLN 500. The voucher could be used to pay for hotel services or tourist events carried out only in Poland. The Polish Tourist Voucher was in the form of an electronic voucher, valid until the end of March 2022.

The Polish Ministry of Culture and National Heritage launched the "Culture Online" program during the COVID-19 pandemic. This support program aimed to help artists, creators, and institutions who, due to the ongoing epidemic, could not pursue their artistic activities in their current form. With a program budget of PLN 80 mln (USD 20 mln), this was an important initiative that helped adapt cultural activities to the new online reality. During the pandemic, the Ministry introduced several other more specialised support programs for the cultural sector: the budget of the "Film Production" program was increased to support film production in Poland; "COVID" subsidies were launched for state cultural institutions; the "Shield for writers" was created. A Cultural Support Fund was also established, an initiative aimed at supporting various fields of culture during the difficult period of the pandemic. Finally, a program was also launched to help artists learn about various solutions that support their activities on the internet.

Overall, the increases in revenues were much smaller than the decreases. The divisions that statistically significantly benefited from the pandemic were "Computer programming, consultancy and related activities" (+23.3%), and "Veterinary activities" (+19.2%). In the first case, the pandemic increased demand for computer consultancy and computer facilities management services due to remote working. The natural productivity of this division was not negatively impacted, since many IT specialists, including programmers, worked remotely prior to the pandemic. In the second case, people who were confined in their homes took greater care of their pets. Interestingly, in both cases, the return on assets did not increase to a statistically significant degree, for two different reasons. In the IT business, this was due to an increase in fixed assets (purchasing new hardware or software) because at the same time the operating profit margin improved. In the "Veterinary activities" division, the operating profit margin did not register a statistically significant change, which implies that operating costs increased at this time. The contrasting performance of operating margins between IT and veterinary services during the pandemic reflects fundamental differences in their business models and operational constraints. The IT sector's improved margins stemmed from its ability to scale services without proportional cost increases, existing remote work infrastructure, and reduced office expenses during lockdowns. In contrast, despite experiencing higher demand from increased pet ownership during lockdowns, veterinary services faced proportionally higher operating costs, owing to necessary safety protocols, protective equipment investments, and facility adaptations for social distancing. Moreover, the physical nature of veterinary work limited scalability and required continued in-person opera-

tions, preventing the cost efficiencies achieved in the IT sector. This explains why increased revenue from veterinary services was offset by higher operational costs, resulting in stable rather than improved margins. However, IT companies could leverage their digital infrastructure to improve profitability.

There are also divisions in which Revenues from Sales increased substantially. However, these increases are not statistically significant. They were "Manufacture of electrical equipment" (+20.9%), and "Repair and maintenance of computers and personal and household goods" (+19.5%). This can be explained by the fact that there were 500 and 200 enterprises registered in these divisions, respectively, but few big players were generating revenues in the PKD classes "Manufacture of domestic appliances" and "Repair and maintenance of personal and household goods" belonging to these divisions.

Since the transformation from a socialist centrally planned economy to a market economy, Poland had experienced an uninterrupted period of positive economic growth till the pandemic. Even during the great financial crisis of 2008–2010, growth in Poland remained high. However, a marked decline in real GDP growth of Poland occurred in the first year of the pandemic (2020), followed by a sharp recovery in the next two years. Figure 2 presents Poland's real GDP growth. GDP per capita in PPP terms, experienced an exponential trend (marked by a dotted line) from the beginning of the 1990s,

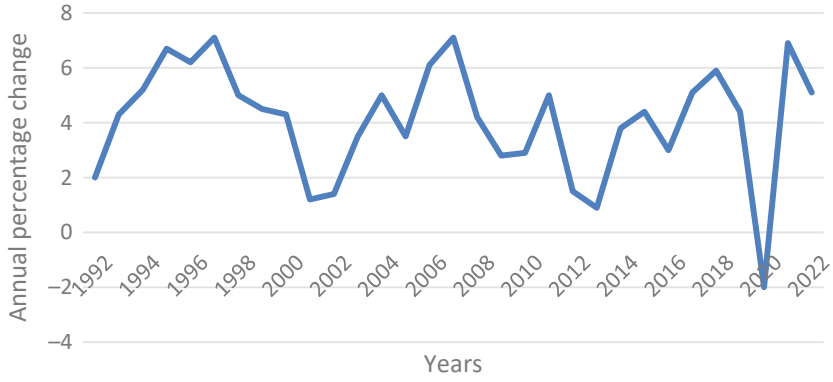

Figure 2. Real GDP growth of Poland

Source: (https://www.imf.org/external/datamapper/NGDP_RPCH@WEO/POL?zoom=POL&highlight=POL).

according to Figure 3. In just the first year of the pandemic, the economy deviated markedly from it. Over the next two years, the economy converged to or even surpassed this trend.

The above can be treated as evidence that the Polish economy quickly returned to its pre-COVID trajectory and substantial economic growth. It might implicitly prove that the fiscal programs implemented to support enterprises during the pandemic were effective. Apart from the general programs, the

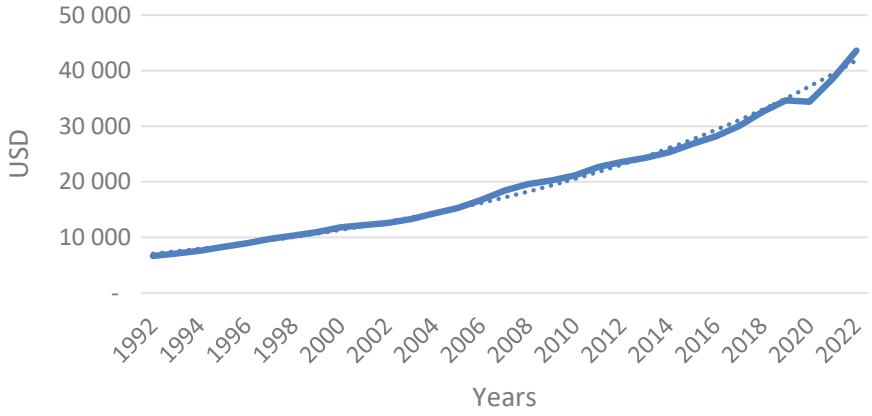

Figure 3. GDP per capita (current prices, PPP) of Poland

Source: (https://www.imf.org/external/datamapper/PPPGDP@WEO/POL?zoom=POL&highlight=POL).

specific programs were suited to the specific needs of various economic sectors, represented in this research by the PKD divisions. Of course, one could argue that this state aid was too generous, and that there were certainly enterprises which should not have received this assistance but did. However, in crisis prevention, overreaction is preferable being overcautious. Moreover, given the time pressure, doing too much with these programs was better than doing too little.

3.2. Robustness checks

To assess the statistical robustness of the above results, we use the non-parametric Mann Whitney (1947) test, in lieu of the Wilcoxon. The Mann-Whitney *U* test operates under slightly different assumptions than the Wilcoxon test. While the Wilcoxon test assumes independent differences between paired observations and symmetrical distribution of those differences between groups, the Mann-Whitney *U* test assumes independent samples and similar shapes in the underlying distributions of the two groups. Because the two observations come from the same company, and from two consecutive years, they are certainly not independent. Hence, the Wilcoxon test better fits this situation than the Mann-Whitney *U* test. However, the latter test serves as an appropriate robustness check because it tests the same null hypothesis under different assumptions (independent samples and similar distribution shapes rather than paired differences). Thus, if both tests yield similar results, it strengthens confidence in the findings' statistical validity, regardless of the underlying data structure.

Table 2. Robustness checks

Checks	RS	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
check1	48%	81%	79%	59%	72%	69%	75%	85%	83%	61%	95%
check2	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Source: own calculations.

Nevertheless, we use the second test as a robustness check. As the first check, the percentage of PKD divisions which gave the same results for both tests can be verified. The first row of Table 2 presents the results. In the second row of the table, the 2nd check is presented, which verifies the consistency of extreme results for both tests, i.e. if one test generates output 1 or 0 and the other generates output 1 or 0 too, or if one test generates output –1, 0 and the other generates output from the same range. The results of the second check and the initial output table are consistent. However, there are notable discrepancies in intermediate cases, which are particularly evident in Revenues from Sales (RS). This lower concordance rate for RS suggests that the choice of test methodology may be particularly important when analysing revenue changes. These discrepancies warrant deeper analysis for several reasons. Firstly, they may indicate cases where the underlying assumptions of each test become crucial: the Wilcoxon test's assumption of symmetrical differences versus the Mann-Whitney's assumption of similar distribution shapes. Secondly, divisions showing different results between tests might represent cases where the financial impact of COVID-19 was more ambiguous or complex. Thirdly, the varying concordance rates across different financial ratios suggest that some metrics may be more sensitive to the choice of statistical methodology than others. These variations ultimately strengthen the study's reliability by demonstrating the robustness of the main findings across different statistical approaches, while also highlighting areas where results should be interpreted with additional caution.

The above findings complement the existing literature by offering a more granular understanding of the pandemic's heterogeneous effects across 75 PKD divisions, in contrast to the global or macroeconomic focus of studies like McKibbin and Roshen (2023) and Alon et al. (2023). The current study identifies the most severely affected sectors and those that experienced growth, aligning with the findings of Kwiatkowski and Szymańska (2022) on employment reallocation shocks in Poland. The deterioration of financial ratios in most sectors is consistent with the supply chain disruptions highlighted by Kazancoglu et al. (2023). The research also emphasises the role of government liquidity injections in stabilising financial conditions, providing a detailed account of the specific measures implemented under the Anti-Crisis Shields, complementing the conclusions of McCann et al. (2023) and Guedegbe (2022) on the importance of policy responses.

The authors admit that it is difficult to distinguish between the government interventions and the possible moral hazards that these actions may lead to. Certainly, not every crisis should force government intervention to prevent moral hazards. However, in the case of the COVID-19 pandemic, which caused public isolation, world trade disruption, and medical threats, such government action was justified. We note that the Polish government was not alone in intervening, and did not permit the shutdown to further deteriorate the living standard of its population. In this regard, governments throughout the world followed the advice of John Maynard Keynes, and also of Ben S. Bernanke in the wake of the 2008–2009 global financial crisis. In future economic crises, whether due to health, natural disasters, or finance, policy makers should consider and balance the consequences of coming to the rescue when it is not justifiable.

Conclusions

COVID-19 had an enormous impact on the economies of numerous countries. This paper uses financial data from more than 150,000 Polish enterprises and explores varied effects brought by COVID-19 across multiple sectors.

The Polish government implemented a portfolio of measures under its Anti-Crisis Shields programs, providing liquidity and supporting businesses during the COVID-19 pandemic. These measures included subsidies for salaries and social security contributions, loan guarantees, direct loans, deferral of tax payments, tax exemptions, moratorium on loan repayments, and specialised additional aid for different categories. Estimates suggest that these measures amounted to more than PLN 200 bn in 2020. Clearly, such generous support by the Polish government poses a moral hazard, inducing future generations to anticipate future handouts, whether justifiable or not. This study reports that government subsidies were allocated to particular distressed sectors, thereby averting their collapse and a potential downturn in the entire Polish economy. It is true, though, that parts of these subsidies were utilised outside of targeted sectors, causing inefficiencies and unintended consequences. However, in the authors' opinions, the magnitude of the global crisis and its exponential spread justify such large-scale governmental interventions.

From the variable values for all financial ratios across all PKD divisions investigated here, it can be observed that Days Receivable Outstanding, Days Inventory Outstanding, and overall Cash Conversion Cycle deteriorated in most divisions because of delayed payment of trade receivables from enterprises. Despite these disruptions, the government's liquidity injections helped sta-

bilize financial conditions, by showing that the overall liquidity, measured by Quick Ratio and Cash Ratio, apparently increased for almost all PKD divisions.

The COVID-19 pandemic had a substantial impact on the Polish economy, with varying effects across different sectors. The government's targeted support programs, such as the substantial aid for Polskie Linie Lotnicze LOT S.A., the tourist voucher initiative, and the "Culture Online" program, were crucial in stabilizing affected industries. Sectors like retail and hospitality faced severe downturns, yet technology and veterinary services experienced growth due to increased demand for remote work solutions and pet care. The effectiveness of government interventions highlights the importance of tailored and robust policies in mitigating economic crises and fostering a resilient recovery. Continued support and strategic investments remain vital for sustained economic stability and growth.

The COVID-19 pandemic interrupted Poland's long period of economic growth, causing a significant GDP drop in 2020. However, the economy rebounded quickly, surpassing its pre-pandemic growth levels by 2022. This rapid recovery proved the efficacy of the government's fiscal support programs, indicating that these were crucial in stabilising the economy, while also stressing that during tough economic times, it is advisable to offer more government support than too little.

The robustness checks using the Mann-Whitney *U* test confirmed the reliability of the results obtained with the Wilcoxon test. The findings are validated by the consistent outcomes across both tests, which reinforces the statistical reliability of the conclusions regarding the economic impacts of COVID-19 on Polish enterprises. This approach ensures that the observed effects are credible, providing a solid foundation for the analysis presented in the paper.

Moreover, it may be of interest to compare differences among sectors, and further aggregation of industries may prove useful. An additional possibility involves adding more years as we move from 2022 and 2023 to 2024. Furthermore, one may introduce macroeconomic factors such as Gross Domestic Product, Industrial production, number of employees in each sector, etc., into the analysis to infer the different elasticities in response to government policies and sectors' characteristics, such as ease of reallocating resources in times of blockage. This will require the implementation of panel-data econometrics.

Future research might also benefit from exploring why certain financial metrics show greater sensitivity to test selection and whether this reflects underlying economic phenomena or statistical artifacts. Future research may involve comparing the measures used by the Polish Government with other Central and Eastern European countries. We live in a world of uncertainty, as the conflict between Russia and Ukraine has proven.

Appendix 1

Definitions of financial ratios

RS – Revenues from Sales
d% *RS* – percentage change of Revenues from Sales between 2020 and 2019 years.

List of financial ratios:

(1) profitability ratios:

- *R*1: Operating Profit Margin = Operating profit / Revenues from Sales,
- *R*2: Return on Assets = Net income / Total assets,

(2) liquidity ratios:

- *R*3: Quick Ratio = (Current assets – Inventories – Biological assets – Intangible assets) / Short-term liabilities,
- *R*4: Cash Ratio = Cash and cash equivalents / Current liabilities,

(3) working capital ratios:

- *R*5: Cash Conversion Cycle = (Days Receivables Outstanding + Days Inventory Outstanding) – Days Inventory Outstanding,
- *R*6: Days Receivables Outstanding = Average receivables / Sales revenue × 365 [days],
- *R*7: Days Inventory Outstanding = Average inventory / Operating expenses × 365 [days],
- *R*8: Days Payable Outstanding = Average short-term trade liabilities / Operating expenses × 365 [days],

(4) financial leverage ratios:

- *R*9: Debt Ratio = Liabilities / Total assets,
- *R*10: Interest Coverage Ratio = (Operating profit + Depreciation) / Financial costs.

Appendix 2

List of PKD 2007 codes (economic sectors) and related divisions

PKD	Full name
01	Crop and animal production, hunting, including service activities
02	Forestry and logging
03	Fishing and aquaculture
08	Other mining and quarrying
10	Manufacture of food products
11	Manufacture of beverages
13	Manufacture of textiles
14	Manufacture of wearing apparel
15	Manufacture of leather and related products
16	Manufacture of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
17	Manufacture of paper and paper products
18	Printing and reproduction of recorded media
19	Manufacture and processing of coke and refined petroleum products
20	Manufacture of chemicals and chemical products
21	Manufacture of basic pharmaceutical substances and medicines and other pharmaceutical products
22	Manufacture of rubber and plastic products
23	Manufacture of other non-metallic mineral products
24	Manufacture of metals
25	Manufacture of fabricated metal products, except machinery and equipment
26	Manufacture of computer, electronic and optical products
27	Manufacture of electrical equipment
28	Manufacture of machinery and equipment not elsewhere classified
29	Manufacture of motor vehicles, trailers and semi-trailers excluding motorcycles
30	Manufacture of other transport equipment
31	Manufacture of furniture
32	Other manufacturing
33	Repair, maintenance and installation of machinery and equipment
35	Electricity, gas, steam, hot water and air conditioning manufacturing and supply
36	Water collection, treatment and supply
37	Sewage disposal and treatment

38 Waste collection, processing and neutralizing activities; materials recovery
39 Remediation activities and other waste management services
41 Construction of buildings
42 Works related to construction of civil engineering
43 Specialised construction activities
45 Wholesale and retail trade of motor vehicles; repair of motor vehicles
46 Wholesale trade, excluding motor vehicles
47 Retail trade, except retail trade of motor vehicles
49 Land transport and transport via pipelines
50 Water transport
51 Air transport
52 Warehousing and support activities for transportation
55 Accommodation
56 Food and beverage service activities
58 Publishing activities
59 Motion picture, video and television program production, sound recording and music publishing activities
60 Public and license programmers broadcasting
61 Telecommunications
62 Computer programming, consultancy and related activities
63 Information service activities
68 Real estate activities
69 Legal, accounting, bookkeeping and auditing activities; tax consultancy
70 Activities of head offices; management consultancy activities
71 Architectural and engineering activities; technical testing and analysis
72 Scientific research and development
73 Advertising and market research
74 Other professional, scientific and technical activities
75 Veterinary activities
77 Rental and leasing activities
78 Employment activities
79 Tour operator, middlemen, agents and other reservation service and related activities
80 Security and investigation activities
81 Services to buildings and landscape activities
82 Office administrative service activities and other business support activities
84 Public administration and defence; compulsory social security
85 Education
86 Human health activities
87 Residential care activities
88 Social work activities without accommodation
90 Creative, arts and entertainment activities

91 Libraries, archives, museums and other cultural activities
93 Sports activities and amusement and recreation activities
94 Activities of membership organisations
95 Repair and maintenance of computers and personal and household goods
96 Other personal service activities

Appendix 3

The output table, all sectors

PKD	d% RS	RS	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
79	–70	–1	–1	–1	–1	0	–1	–1	0	1	–1	–1
51	–55	–1	0	0	0	1	–1	–1	0	0	0	0
90	–46	–1	–1	–1	0	0	–1	–1	0	1	–1	–1
55	–39	–1	–1	–1	–1	0	–1	–1	0	1	–1	–1
56	–24	–1	–1	–1	–1	–1	–1	–1	–1	1	–1	0
91	–18	–1	–1	–1	–1	0	–1	–1	0	0	–1	0
93	–16	–1	–1	–1	0	1	–1	–1	0	1	–1	0
15	–14	–1	0	0	1	1	–1	–1	–1	0	0	0
60	–13	0	0	0	0	1	0	0	0	0	0	0
94	–13	–1	0	0	0	1	–1	–1	0	0	0	0
29	–12	–1	0	–1	1	1	–1	–1	–1	1	0	0
08	–11	–1	–1	–1	–1	1	–1	–1	0	0	–1	0
24	–9	–1	1	1	1	1	–1	–1	–1	1	0	1
45	–8	–1	0	–1	1	1	–1	–1	–1	0	0	0
02	–8	–1	0	–1	0	0	–1	–1	0	1	–1	0
96	–7	–1	–1	–1	0	1	–1	–1	0	0	–1	0
68	–6	1	1	–1	1	1	–1	–1	0	0	–1	0
50	–6	0	0	0	0	1	0	0	0	0	0	0
78	–6	–1	–1	–1	0	1	–1	–1	0	1	–1	0
73	–5	–1	–1	–1	0	1	–1	–1	0	1	0	0
14	–5	–1	0	0	1	1	–1	–1	–1	0	0	0

PKD	d% RS	RS	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
58	–4	–1	0	0	1	1	–1	–1	0	0	0	0
28	–4	–1	0	0	1	1	–1	–1	–1	1	0	0
70	–4	0	0	–1	1	1	–1	–1	0	0	0	0
69	–3	1	1	–1	0	1	–1	–1	0	0	0	0
25	–2	–1	0	–1	1	1	–1	–1	–1	1	–1	0
85	–2	–1	0	–1	0	1	–1	–1	0	1	–1	0
18	–2	–1	0	–1	1	1	–1	–1	0	0	0	0
23	–1	0	0	–1	1	1	–1	–1	–1	0	0	0
31	–1	1	1	0	1	1	–1	–1	–1	0	–1	0
43	–1	0	–1	–1	1	1	–1	–1	0	0	–1	0
30	–1	0	0	0	0	1	–1	–1	0	0	0	0
77	–1	–1	0	–1	1	1	–1	–1	0	1	0	0
19	–1	0	0	0	0	1	0	–1	–1	0	0	1
17	–1	0	1	1	1	1	–1	–1	–1	0	0	1
82	–1	–1	–1	–1	0	1	–1	–1	0	1	0	0
49	0	0	1	1	1	1	–1	–1	0	1	1	1
13	0	0	1	1	1	1	–1	–1	–1	1	0	1
52	1	1	1	0	1	1	–1	–1	0	1	1	0
22	1	1	1	1	1	1	–1	–1	–1	0	1	1
11	2	0	0	0	0	0	–1	–1	–1	0	0	0
71	2	0	–1	–1	1	1	–1	–1	0	0	–1	0
46	2	0	1	1	1	1	–1	–1	–1	0	1	0
20	3	1	1	1	1	1	0	0	–1	0	1	1
47	3	0	1	1	1	1	–1	–1	–1	0	0	0
80	3	1	0	0	1	1	0	0	0	0	1	1
39	3	0	1	0	0	1	0	0	0	0	0	0
36	3	1	–1	–1	0	1	0	0	0	0	0	0
01	3	1	1	1	1	1	–1	–1	0	0	1	1
88	4	1	0	0	1	1	–1	–1	0	0	0	0
16	4	0	0	0	1	1	–1	–1	0	0	0	0
26	4	1	1	1	1	1	–1	0	0	0	0	1
37	4	1	0	0	0	1	0	0	0	0	0	1

PKD	d% RS	RS	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
87	4	1	0	0	1	1	0	–1	0	0	1	0
32	5	0	1	0	0	1	–1	–1	–1	0	–1	0
74	5	0	0	–1	0	1	–1	–1	0	0	0	0
61	5	1	0	0	1	1	–1	–1	0	0	1	0
10	5	0	1	1	1	1	–1	0	–1	0	0	1
86	6	1	1	–1	1	1	–1	–1	0	1	0	0
72	6	1	0	0	0	0	–1	–1	0	0	–1	0
33	6	–1	–1	–1	0	1	–1	–1	0	1	–1	0
42	7	–1	–1	–1	0	1	–1	–1	0	1	–1	0
81	7	1	0	–1	1	1	–1	–1	0	0	0	0
41	7	1	1	–1	1	1	–1	–1	0	0	–1	0
35	8	1	1	1	1	1	0	0	0	0	0	0
21	8	1	1	1	0	1	0	0	–1	0	0	0
03	8	1	0	0	1	1	0	0	0	0	1	0
63	8	1	1	0	1	1	–1	–1	0	0	0	0
59	10	–1	0	–1	0	0	–1	–1	0	1	–1	0
84	10	0	0	0	1	0	0	–1	0	1	0	0
38	17	1	1	1	1	1	–1	–1	0	0	1	1
75	19	1	0	0	1	1	–1	–1	0	0	0	0
95	20	0	0	0	0	0	–1	–1	0	0	0	0
27	21	0	1	0	0	1	–1	0	–1	1	0	1
62	23	1	1	0	1	1	–1	–1	0	0	1	0

Source: own calculations.

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