# WORKING PAPER

# Calculating inflation in Poland during the COVID-19 pandemic and aftermath of Russia's attack on Ukraine using transactional data

# Table of Contents

# Key numbers

**1.25 pp**

– actual inflation in Poland in April 2020, during the spring lockdown, may have been this much higher than the official measure

**0.34 pp**

– overestimation of the official CPI in December 2021, during the escalating energy crisis

**0.23 pp**

– inflation in December 2021 during the energy crisis hit poorer households more than wealthier ones

**0.20–0.40 pp**

– the share of spending on transport was this much higher in the bottom 20% of spenders in December 2021 and February 2022. The high inflation in this category had more of an impact on poorer households

**2.6 times more**

– amount spent by the richest households per month in 2019, compared to the poorest ones, on average

**3 main events**

affected the structure of the inflation basket: the COVID-19 pandemic, first during the spring of 2020 and then during the second wave, and the energy crisis caused by Russia's manipulation of the gas market and, more recently, its attack on Ukraine

# Key conclusions

- **The consumption basket based on Mastercard's estimates and spending data showed convergence with the official inflation basket.** The Pearson indicator shows a 99% correlation. The transactional data basket's advantage is its high frequency, which makes it possible to observe changes in consumption in real time.

- **Real inflation during the spring lockdown may have been higher than the official measure.** The difference in March of 2020 was 0.72 pp; in April, it was 1.25 pp. At the peak of the energy crisis in December 2021, the official CPI may have been overestimated by 0.34 pp. The other sudden events did not have a clear impact on the inflation index. In 2019, the official inflation was overstated, supported by theoretical underpinnings.

- **Inflation affects people unequally because of differences in the basket structure.** The energy crisis is creating more inequality than the pandemic. In December 2021, inflation affected the poor more than the rich by as much as 0.23 pp. In the first half of 2020, the price change was 0.2-0.3 pp more severe for the bottom 20% of spenders, compared to the top 20% of spenders. The pandemic reduced spending in selected groups and made shopping baskets more similar, hence the smaller difference in inflation impact.

- **The richest households spent an average of 2.6 times more per month in 2019 than the poorest.** Spending on each group of goods and services varies by income group. The greater a person's financial capabilities, the better his or her quality of life and, consequently, the share of spending on entertainment, culture or education – for the richest it was 17%, compared to less than 11% among the poorest, in 2019.

# Introduction

**For years, inflation was in many ways absent, even with the substantial loosening of monetary policy in many OECD countries.** The substantial fiscal stimulus of 2020, the supply-shock energy crisis that unfolded in 2021 and the war in Ukraine have all caused the highest inflation in a generation.

In this paper, we try to answer this question because we know that the official indicators are far from perfect. Economists have faced the challenge of designing a measure that best captures sentiment about the prices of goods and services. This indicator is important from a behavioural perspective and the impact of inflation expectations on actual statistics (Rötheli, 2020; Kantur, Özcan, 2021; Kara, 2021; Woodford, 2021).

**The aim of this paper is to present an alternative measure of inflation using high-frequency data. Statistical offices and researchers are seeking innovative, digital ways to improve consumer price index (CPI) (Cavallo, Rigobon, 2016; Reinsdorf, Schreyer, 2019; Białek et al., 2022). Estimated spending by Mastercard allows us to update the inflation basket monthly, instead of the annual changes used in official statistics. As a result, we can observe rapid changes resulting from sudden events and shocks more quickly.**

**Sudden events lead to unplanned spending changes and affect consumers' purchasing patterns.** Between 2020 and 2022, the world economy was hit by a pandemic, an energy crisis and Russia's attack on Ukraine. During the pandemic, most countries' governments imposed restrictions to save citizens' lives and create less of a burden on the healthcare system. In Poland, people were deprived of the opportunity to spend money on recreation or restaurants. Instead, the share of spending on necessities, including food and beverages, increased. Two years later, in 2022, vast increases in energy and commodities prices increased consumers' focus on necessities again. High electricity and heating bills prevented consumers from saving and buying goods, including electronics, household appliances and clothing.

**The rapid changes in the structure of spending resulted in significant deviations in the CPI.** Statistics offices update inflation baskets once a year. This means that they were unable to capture the sudden differences in the shopping basket, making it difficult to correctly interpret inflation results (Tenreyro, 2020; Lane, 2020). Two approaches use modern technologies and new data sources to improve inflation measurement: scraping goods and services prices to get up-to-date data on costs without surveying thousands of households, and using transactional data to observe consumers' spending structure.

**We used high-frequency data on estimated spending according to Mastercard.** Information on Poles' actual consumption made it possible to create an inflation basket and calculate an alternative measure of inflation, which we contrasted with statistics from Statistics Poland (*Główny Urząd Statystyczny*). Similar studies have been conducted in the United States (Cavallo, 2020) and Spain (Carvalho et al., 2020). This paper is an update of the *Consumption in the pandemic* (Miniszewski, 2021) report, where these estimates were made for the first time. Any differences in the results and narrative may be caused by methodological differences compared to the previous study. We discussed it further in the "Data, methodology and inflation basket structure" section. War is another type of crisis that influences prices and consumption (OECD, 2022), especially given Poland's proximity to the frontline in Ukraine.
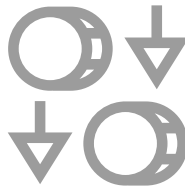
# Data and methodology

During the pandemic, statistical offices' inflation baskets were questionable due to their failure to account for the strong shifts in consumption patterns during this period (Tenreyro, 2020; Lane, 2020). To reflect the shifts in consumption patterns, researchers use additional data sources to estimate expenditure weights for the national CPI, including high-frequency household budget surveys, credit card data, scanner data, quarterly national accounts and short-term statistics for wholesale, retail trade and services, and monthly statistics for transport, tourism and energy (OECD, 2021). In this paper, we used Mastercard data on consumer spending. Mastercard is an international company and association of more than 25,000 financial institutions (Mastercard, 2022). Mastercard's estimations of transaction volumes in the paper were anonymised[1] and aggregated into shopping categories.[2] They do not reflect pure Mastercard volumes as they were scaled and adjusted by two additional coefficients reflecting:

a) Mastercard's share in the payment card market. The data on turnover is reported quarterly by the National Bank of Poland,

b) the share of payment cards in total turnover during each period, based on a continuous survey conducted by Mastercard and Minds&Roses.

Categories of goods and services were standardised for statistical purposes according to the Classification of Individual Consumption by Purpose (COICOP) developed by the United Nations (UN). We matched 94 groups of goods and services delivered by Mastercard with COICOP spending categories and made adjustments that allowed a more accurate comparison of the CSO and Mastercard spending structure. We aggregated spending in the "food and non-alcoholic beverages" category with "alcoholic beverages and tobacco", because typically purchases in both categories are made at the same shops. In addition, we excluded the categories "information and communication", "education" and "housing" from the analysis, because these spending groups are characterised by a high share of payments by bank transfer and cash. We presented these changes in Table 1.

---

[1] Anonymization was performed using various methods including but not limited to aggregation and Truata service.

[2] Estimations of total retail spending modeled based on card payments gets more representative every year. While the detailed scaling factors used in Mastercard estimations remains undisclosed from legal reasons, currently according to the European Central Bank (2022), in the eurozone card payments accounted for 49% of the total number of transactions in 2021. The share of cashless payments in the number of transactions made at retail and service outlets will reach 57%, compared to 43% of transactions using cash. Mastercard's share of the Polish payment card market is nearly 50% (NBP, 2022a).

**Table 1.  Changes in spending categories**

| COICOP categories in official statistics | Mastercard spending categories |
|---|---|
| Food and non-alcoholic beverages | Food, alcoholic and non-alcoholic beverages |
| Alcoholic beverages and tobacco | |
| Clothing and footwear | Clothing and footwear |
| Housing, water, gas, electricity and other fuels | - |
| Furnishings, household equipment and routine maintenance of the house | Furnishings and household equipment |
| Health | Health and beauty |
| Transport | Transport |
| Information and communication | - |
| Recreation and culture | Recreation and culture |
| Education | - |
| Restaurants and hotels | Restaurants and hotels |
| Other goods and services | Other goods and services |

Source: prepared by PEI based on CSO data and estimated spending data according to Mastercard.

The observed effect of changes during the energy crisis was limited due to the omission of categories of household expenses that include gas or electricity bills. At the same time, it is possible to observe nominal and percentage changes in other categories, including the process of saving money or shifting expenses.

To estimate the weight of a given category and at a specific time *t* in the new inflation basket, we divided the indicated group's share by the sum of the shares of all categories. We used a similar transformation to recalculate the official CSO measures after aggregating and omitting selected categories. In formula (1), we present a formal calculation of a category's weight in the inflation basket

$$Wk_t^i = \frac{w_t^i}{\sum_i w_t^i} * 100\% \qquad (1)$$

in which $Wk_t^i$ denotes the weight of the category, and $w_t^i$ the share of the value of the category's transactions in the entire inflation basket.

The procedure for calculating CPI consists of four steps. First, the average prices of a representative product in a region are determined, then its index is calculated as the ratio of the average prices in each month to its average in the base period. Using geometric averages of the price indexes of representative products from all regions, nationwide price indexes are obtained. Finally, at higher levels of aggregation, the Laspeyeres formula is used to determine published price indices for goods and services (Białek, 2019).
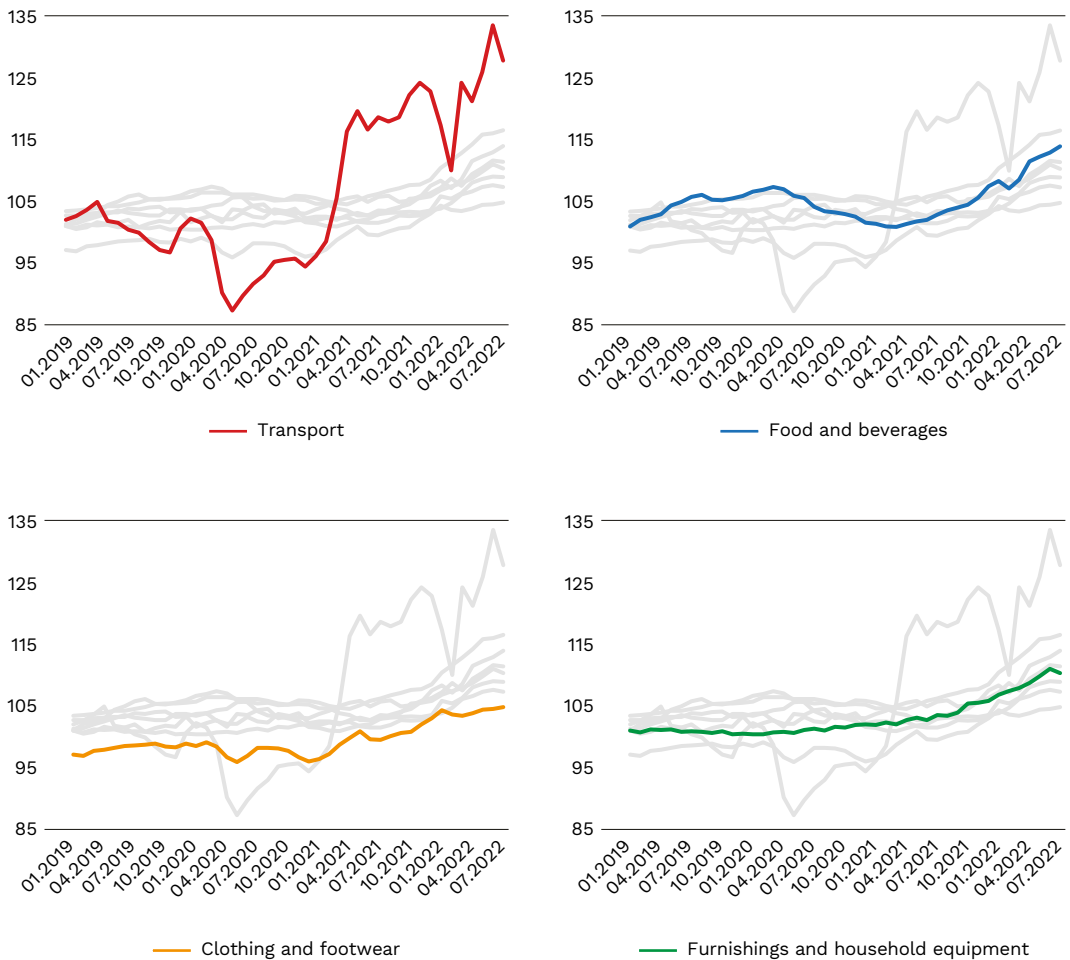
We calculated inflation during each period *t* based on estimated spending according to Mastercard using formula (2)

$$I_t = \sum_i i_t^i * w_t^i \qquad (2)$$

where $w_t^i$ is the weight of the category and $i_t^i$ is the inflation rate of the category.

Price increases using the official measure were converted to form a new inflation basket. Formula (2) was also used for this purpose, selecting indicators for selected and aggregated spending categories.

**Figure 1. Price index for goods and services in selected categories (% y/y)**



Transport

Food and beverages

Clothing and footwear

Furnishings and household equipment

Source: prepared by PEI based on CSO data.

**The pandemic was expected to led to some temporary inflation** (Baldwin, di Mauro, 2020). In Poland, it reduced the dynamics of price changes in transport and textiles. In May 2020, inflation in the transport sector was -12.8% y/y and -4.2% y/y in clothing. We observed a decrease in the dynamics of food and beverage prices between March 2020 and March 2021 (from 7.3% to 0.8% y/y) and an increase in housing spending (from 0.6% to 1.9%). Then, in 2021, inflation in all the categories started to increase. In June 2022, transport prices were more than 30% higher than the previous year. In Figure 1, we present the rate of price growth in selected spending categories.

**The price drops due to the pandemic slowdown did not last long.** Price indices for goods and services reached long-unseen levels, clearly above the NBP's inflation target (2.5% with -1/+1 pp deviation). The energy crisis and the Russian invasion of Ukraine impacted the commodities market and increased the inflation to double digits (Boone, 2022; OECD, 2022). Official statistics has to navigate these challenges. Sudden events and forecast errors are reviving the discussion about the quality of the price index measurement.

In 2020, the share of prices in the inflation basket was estimated due to the closure of the economy and the curtailing of retail and service activities. We presented the share of estimates in Figure 2. Price estimation may have affected the extent to which the actual inflation was reflected. Most estimates were made in April 2020 (almost 20%), then the share decreased, but restrictions on economic activity forced the process to continue until August 2021.

**Figure 2. Share of estimates in monthly inflation rate (%)**
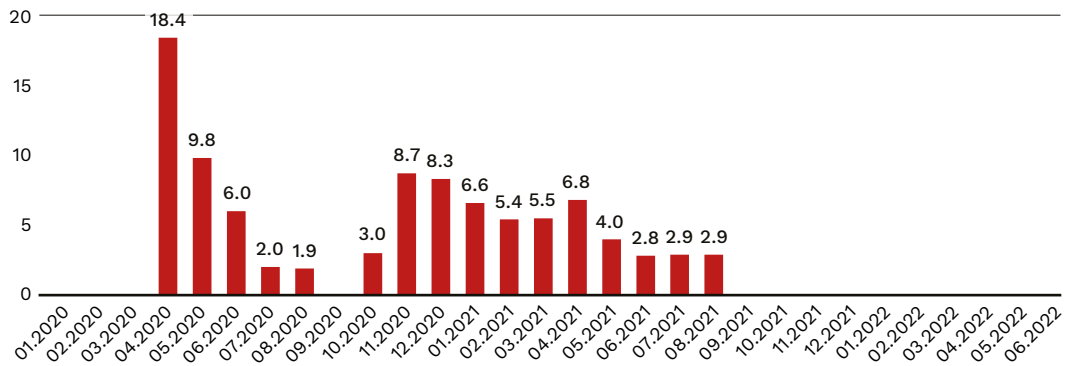


Source: prepared by PEI based on CSO data.

**The pandemic, and later the energy crisis, have reopened the discussion about the heterogeneity of inflation within spending groups** (Boone, 2022). Central banks will retain a specific value as their inflation target, but the real consequences of rising prices for society matter, too. Some economists

even describe inflation as a tax that particularly affects the poor (Hofstetter, Rosas, 2018; Akçelik, Cömert, 2017). Kakar, Daniels (2019) have argued that inflation has the character of a regressive tax that affects the growth of inequality. They already described several negative effects two decades ago (Di Tella, MacCulloch, Oswald, 2001; Wolfers, 2003). According to Mankiw (2006), poorer spending groups are more affected by inflation because they finance their purchases with money to a greater extent, the cost of which increases when prices rise. The impact of price increases according to wealth was also described by Jaravel (2019) and Argente and Munseob (2017).

For the purposes of the study, we assumed that this was a sufficient reflection of price increases in income groups. The relationship between income and consumption has been widely described in the literature (Duesenberry, 1967; Khan, Ahmad, 2014; Diacon, Maha, 2015; Eurostat, 2020). Spending increases with income, but its structure changes. The level of income does not directly correspond to the amount of consumption, as illustrated by Engel's law, among others. In addition, the level of household income is less important for spending in middle-income countries, and more important for countries with low- or high-income levels, including Poland (World Bank, 2021). The method used in this work based on payment card transactions is also applicable to other countries.

The Mastercard spending groups were determined based on two years of observation. If a person (card) was in the top 20% of spenders in 2020-2021, he or she was labelled a "premium card". The methodology changed compared to the previous study. Earlier, the top 20% of spenders were chosen yearly – the consumer only received the "premium card" label if he or she was in the top or bottom 20% in both 2019 and 2020. This is why the present analysis shows smoother differences between the spending groups. Moreover, the 2020-2021 label also concerns card activity, so the results for 2019 and 2022 could be distorted. Labeling for 2020-2021 limits the interpretation of results for other years. It is worth considering expanded "premium card" labeling methods in the future to achieve greater comparability over long time horizons. For reasons of data protection, it was not possible to provide the indicated spending threshold. The analysis was conducted on a portfolio of like-for-like cards, meaning that these were cards present in the market throughout the observation period. The Mastercard data used was anonymised independently. Personal data was not used to prepare this summary.

# Transactional data inflation

## Inflation basket structure

Cavallo (2020) proposes to create relative weights based on the official CPI measure and percentage changes in payment transactions. In Table 2, we present the share of each category in the inflation basket, both CSO and Mastercard. The outlined approach made it possible to observe differences in spending structures between 2019 and 2022, and to assess the usefulness of high-frequency data as an alternative to public statistics.

The convergence of the Mastercard and CSO inflation baskets in 2019-2022 was very high. The Pearson indicator showed a 99% correlation. The results may differ from the previous paper (Miniszewski, 2021) because of the methodology changes in mapping spending categories. It is hampered by lack of access to the full account. We were only informed which shop the money was spent at. Supermarkets are matched to the grocery categories (due to the highest share of food in sales), even though they also sell household or recreational goods. In this analysis, the groups were selected according to expert knowledge, taking into account a company's broadest field of activity and the degree of inflation matching official statistics.

Table 2. **Summary of CSO and Mastercard inflation baskets in 2019-2022 (%)**

| Inflation basket categories | CSO inflation basket | | | | Mastercard inflation basket | | | |
|---|---|---|---|---|---|---|---|---|
| | 2019 | 2020 | 2021 | 2022 | 2019 | 2020 | 2021 | 2022 |
| Food, alcoholic and non-alcoholic beverages | 41.4 | 41.5 | 46.3 | 44.1 | 42.2 | 46.9 | 44.8 | 43.4 |
| Clothing and footwear | 6.5 | 6.5 | 5.6 | 6.0 | 7.4 | 5.4 | 5.6 | 5.3 |
| Furnishings and household equipment | 7.5 | 7.6 | 7.8 | 7.7 | 7.1 | 7.3 | 6.6 | 6.0 |
| Health and beauty | 6.8 | 7.0 | 7.2 | 7.6 | 6.1 | 6.4 | 6.1 | 6.1 |
| Transport | 13.7 | 13.0 | 11.9 | 12.8 | 13.8 | 11.0 | 12.0 | 12.7 |
| Recreation and culture | 8.5 | 8.7 | 7.7 | 8.1 | 9.6 | 9.0 | 9.0 | 9.0 |
| Restaurants and hotels | 8.2 | 8.1 | 6.1 | 6.4 | 5.8 | 4.7 | 5.2 | 5.9 |
| Other goods and services | 7.4 | 7.5 | 7.4 | 7.3 | 8.2 | 9.4 | 10.7 | 11.6 |

Note: we used data from January-June 2022 to create 2022 Mastercard inflation basket.
Source: prepared by PEI based on CSO data and estimated spending data according to Mastercard.

**The decline in sales at apparel shops was greater than official statistics show.** While the official weight decreased by 0.9 pp in 2021, the share of real spending in this category already fell by 2.0 pp in 2020. Mastercard's current estimates showed dynamic changes in the consumer basket as early as 2020 (Table 3). Updates to the official inflation basket did not occur until the following year, so abrupt changes in 2020 and 2022 can only be observed using high-frequency data. We observed a deeper slump in the "transport" category (-2.8 pp in 2020, compared to -1.2 pp in 2021). In contrast, the decreases in the "recreation and culture" and "restaurants and hotels" categories were not as sharp as in the official statistics, but they occurred earlier.

**Table 3. CSO and Mastercard inflation baskets dynamics in 2019-2022 (pp)**

| Inflation basket categories | CSO inflation basket | | | Mastercard inflation basket | | |
|---|---|---|---|---|---|---|
| | 2019-2020 | 2020-2021 | 2021-2022 | 2019-2020 | 2020-2021 | 2021-2022 |
| Food and beverages | 0.1 | 4.8 | -2.2 | 4.7 | -2.1 | -1.4 |
| Clothing and footwear | 0.0 | -0.9 | 0.4 | -2.0 | 0.2 | -0.3 |
| Furnishings and household equipment | 0.1 | 0.1 | -0.1 | 0.2 | -0.7 | -0.6 |
| Health and beauty | 0.2 | 0.2 | 0.4 | 0.3 | -0.2 | 0.0 |
| Transport | -0.6 | -1.2 | 0.9 | -2.8 | 1.0 | 0.7 |
| Recreation and culture | 0.2 | -1.0 | 0.4 | -0.6 | 0.0 | 0.1 |
| Restaurants and hotels | -0.1 | -2.0 | 0.3 | -1.0 | 0.5 | 0.6 |
| Other goods and services | 0.2 | -0.2 | -0.1 | 1.2 | 1.4 | 0.9 |

Note: we used data from January-June 2022 to create 2022 Mastercard inflation basket.
Source: prepared by PEI based on CSO data and estimated spending data according to Mastercard.

Figure 3 shows the change in the composition of the consumer basket in 2019-2022. We observed three main abnormal periods: a) the first spring of the pandemic (03-05.2020), b) the second wave of the pandemic, between 2020 and 2021 (11.2020-04.2021), and c) the gas crisis and Russian invasion of Ukraine (12.2021-04.2022). Consumers mainly saved money on clothing and appliances.

**Figure 3. Inflation basket structure in 2019-2022 (%)**
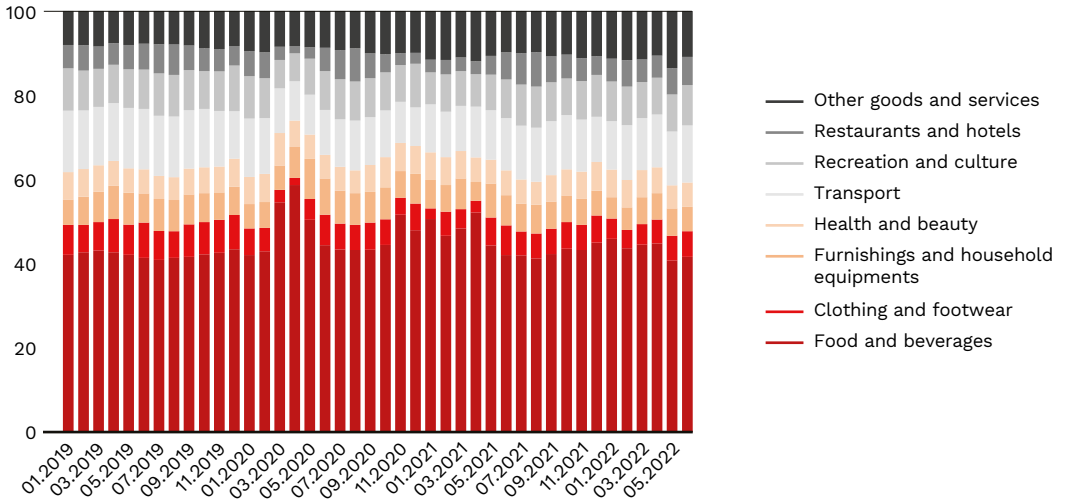


Source: prepared by PEI based on estimated spending data according to Mastercard.

During the pandemic, spending on clothing and restaurants in April 2020 fell by 85% and 75% respectively. The lockdown reduced spending on transport by more than 50%. In nominal terms, consumers spent less in all categories – the share of "food and beverages" increased from 43% in April 2019 to 59% in April 2020. During the second wave, we observed the biggest decline in the clothing (-60-65%) and restaurants (-30-50%) categories. Consumers limited their spending on transport and appliances.

The energy crisis has been one of the main causes of the surge in inflation in Europe and globally in 2021/2022, potentially lasting several years. Although we observed nominal increases in almost all the categories, the share of clothing and appliances dropped by 30% and 20% compared to the inflation basket from 2019. The decrease in transport is smoother because of the high commodity price increases – consumers could travel less, but the cost of the travel was higher.

# Estimated error of official statistics

**The perceived price increase during the spring lockdown may have been higher than the official measure.** The difference in March 2020 was 0.72 pp; in April 2020, it was 1.25 pp. Since June 2020, the discrepancy has oscillated around 0.1 pp. This shows the predominance of high-frequency data that captured changes in the composition of the shopping basket during the period being studied. Reinsdorf (2020) also showed the underestimation of inflation during the pandemic. This was caused by the unusual conditions

during the early months of the crisis, and the potential for the differences between current spending patterns and the CPI weights. In Figure 4, we present a comparison of the goods and services price index for the CSO and Mastercard inflation baskets in aggregate categories. Since we cannot identify unit goods in Mastercard spending, the values indicated are approximate and based on the overall price indexes for goods and services according to the COICOP classification and inflation baskets in each month.

**Figure 4. Comparison of monthly price indices of goods and services for the CSO and Mastercard inflation basket (%)**
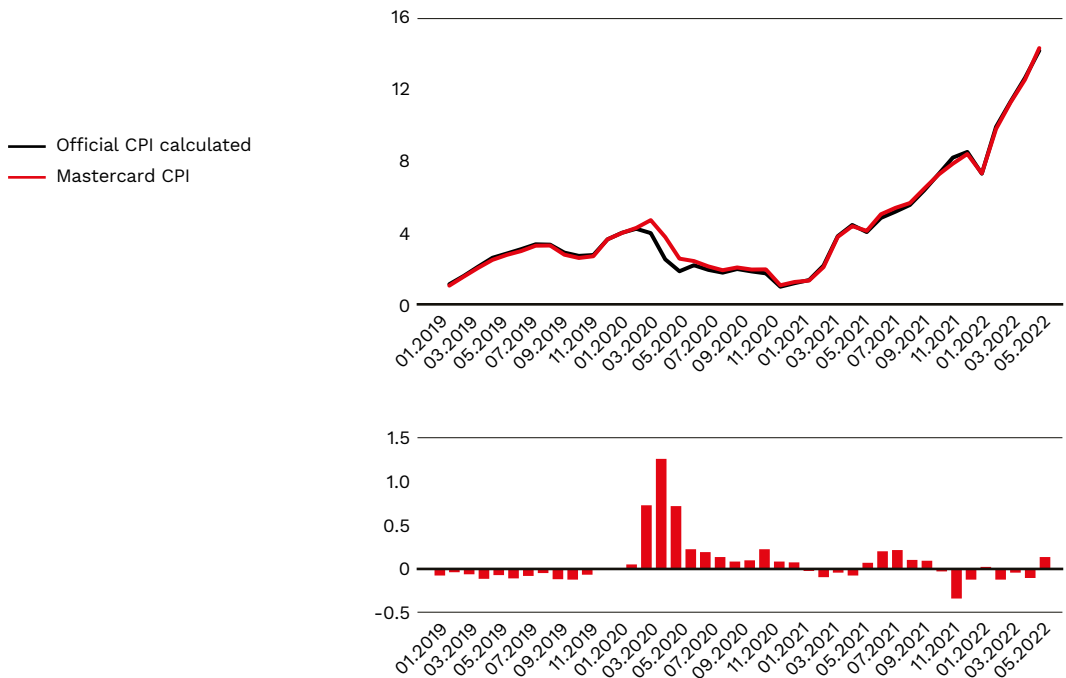


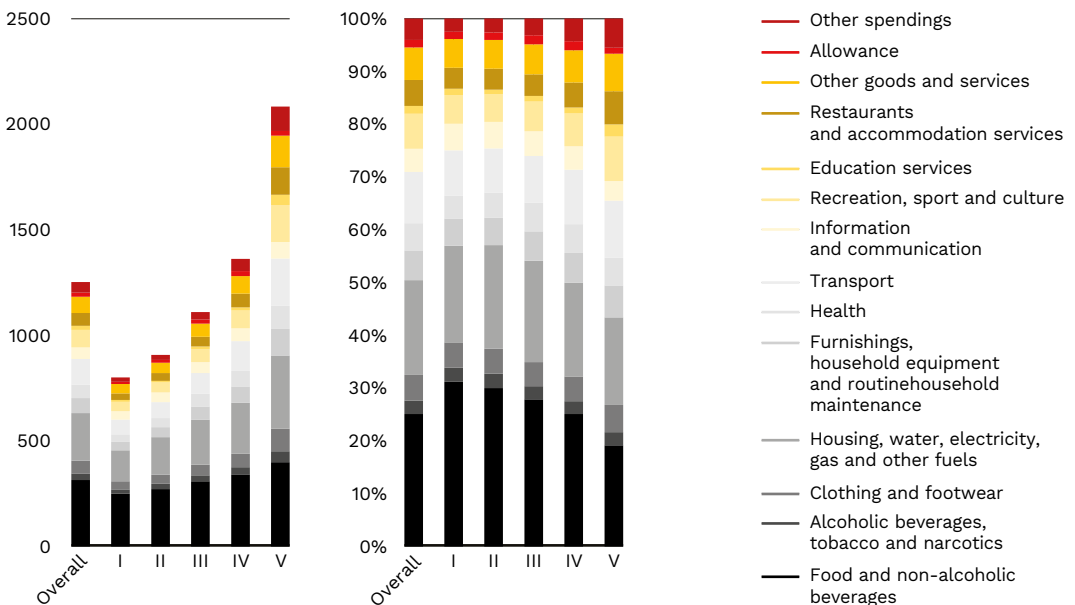Source: prepared by PEI based on CSO data and estimated spending data according to Mastercard.

**Actual inflation in December 2021, during the energy crisis, may have been lower than the official CSO measure.** The official CPI may have been overestimated by 0.34 pp. The main reason is the lower share of transport spending in the inflation basket. In the official structure, transport had a share of 11.9%; transactional data showed that it was 1.2 pp lower. CPI in transport was then at its maximum: 22.7%. The energy crisis made people save money, so they reduced travel and fuel purchases. Consumers postponed major purchase decisions like buying a new car to save money or for external reasons – the long wait for a vehicle at the showroom. Similarly, less new furniture was purchased in December 2021 (5.9%, compared to 7.8% in the official inflation basket). In addition, December is a month in which we see

an increase in the purchase of holiday-related gifts: clothing and jewelry. Actual spending in the categories of clothing and footwear and other goods was therefore higher than reported by the statistics office. In mid-2021, it became apparent to many central bankers that the inflation might not be transitionary; since then, the CPI observed by the CSO and the Mastercard estimate has increased far beyond the central bank's target, leading to monetary interventions (which are not covered in this paper). In 2019, the official inflation was overstated, supported by theoretical underpinnings, including instantaneous consumer reactions to price changes, the problem of comparability of substitutes and the income effect. Anomalies observed during the summer holidays in 2021 may have been caused by spending on recreation and trips.

# Inflation heterogeneity

**Spending on groups of goods and services varies by income group.** The richest households spent on average 2.6 times more per month in 2019 than the poorest ones (Figure 5). With greater financial capabilities, the quality of life rises, and the share of spending on entertainment, culture and education increases – among the richest, it was 17%, compared to less than 11% among the poorest. At the same time, 20% of the lowest earners spent every third złoty on food. Among the rich, this category accounted for one-fifth of total spending.

**Figure 5. Average spending per person by quintile group in 2019 (% and nominal terms in PLN)**
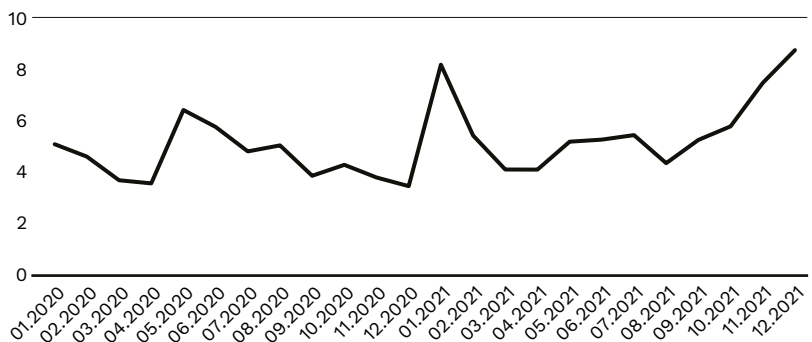


Source: prepared by PEI based on CSO data.

**People consume different baskets of goods and prices rise heterogeneously, which makes individual inflation rates diverge.** There is a growing body of literature on inflation inequality (Jaravel, 2021; Altunbaş, Thornton, 2022). Cavallo (2020) used data from payment transactions to show that real inflation in the US during the pandemic was higher than indicated by the official measure. According to his study, households in the bottom income quintile were more affected by price increases. Cardoso et al. (2022) quantified the overall effect of the different channels through which inflation affects households' wealth. The authors showed that old people (>65), especially low-income ones, are the most affected by inflation. Using Mastercard's estimates, we examined whether, in the face of the pandemic and the energy crisis, the CPI placed less of a burden on wealthier people.

**An increase in inflation affects poorer people more,** as their spending structure is focused on essential products, whereas the top spenders do not have to save that much money and, during certain periods, have very different consumption patterns. In Figure 6, we showed the differentiation in the baskets due to the population's wealth. During the lockdowns, this measure decreased due to the limited spending opportunities. Both the top 20% and the bottom 20% spenders had a bigger share of food and a smaller share of restaurants and hotels in their inflation baskets. Rising CPI since mid-2021 has also increased inflation heterogeneity within spending groups. We observed a huge difference during the energy crisis in November-December 2021 due to "food and beverages" and "furnishings" spending. In 2022 the high prices impact both inflation baskets. Consumers spent more on transport and less on clothing and furnishing. In May 2022 the difference could increase due to the wealthier e-commerce spending on other goods and services, which may be caused by an increase in promotional activities organized by financial (cryptocurrency) market players.

**Figure 6. Differences in the inflation basket of the top 20% and the bottom 20% spenders in 2020-2022**



Note: we used the average square of the Euclidean distance as a measure of differentiation. The lower the value, the more similar the purchase structure.

Source: prepared by PEI based on estimated spending data according to Mastercard.

We are facing an unusual crisis and it is difficult to say how much of the spending on second or even third necessity goods disappeared from the wallets of affluent individuals, not because of an intentional reduction in purchases, but because they could not buy them due to the lockdowns and broken supply chains (Figure 7). In the group with the highest spending, foreign travel, services and beauty treatments were restricted, and jewelry shops tended to be in enclosed shopping malls (the share of e-commerce in this industry was not high). In the data, we observe the bottom 20% of spenders' clear focus on essential goods, in the form of food or medicine. They did not shift their spending from transport or recreation to furniture purchases, but rather saved money. A similar process occurred during the second, winter wave of the pandemic, but on a smaller scale due to the more limited restrictions. During the energy crisis, in the face of rising inflation, there have not been any clear changes in the structure of purchases them-selves – spending on transport is rising due to rising fuel prices. Spending on categories of other goods and services is temporarily increasing. The share of spending on food and beverages has fallen to average pre-pandemic levels.

**Figure 7.  Inflation basket in the top 20% and bottom 20% spending group in 2019-2022 (%)**
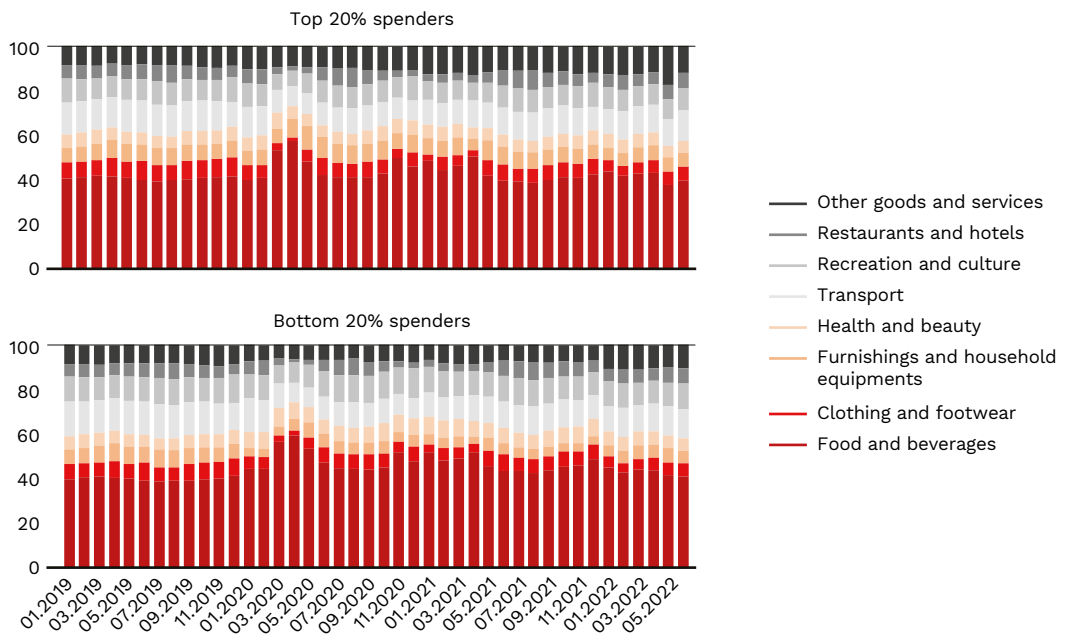


Source: prepared by PEI based on estimated spending data according to Mastercard.

**The share of spending on transport was 0.2-0.4 pp higher within the bottom 20% of spenders in December 2021 and February 2022.** The high inflation in this category affected poorer households more. A larger share of their total spending represented fuel, which was necessary. Transactional data indicates the significant impact of the energy crisis in Poland and Europe. Poorer households tend to respond more quickly to price increases by reducing mobility, which causes the higher share of "transport" spending in the inflation basket of the wealthier. Meanwhile, in December-February 2021 and May 2022, transportation remained a larger share of spending among the poorest. We observed a bigger share of spending on transport among the wealthier during the waves of the pandemic and in early energy crisis. Top 20% of spenders did not travel less, but they may have postponed the purchase of vehicles.

**Figure 8. Difference in the transport share between the top 20% and bottom 20% of spenders (pp)**
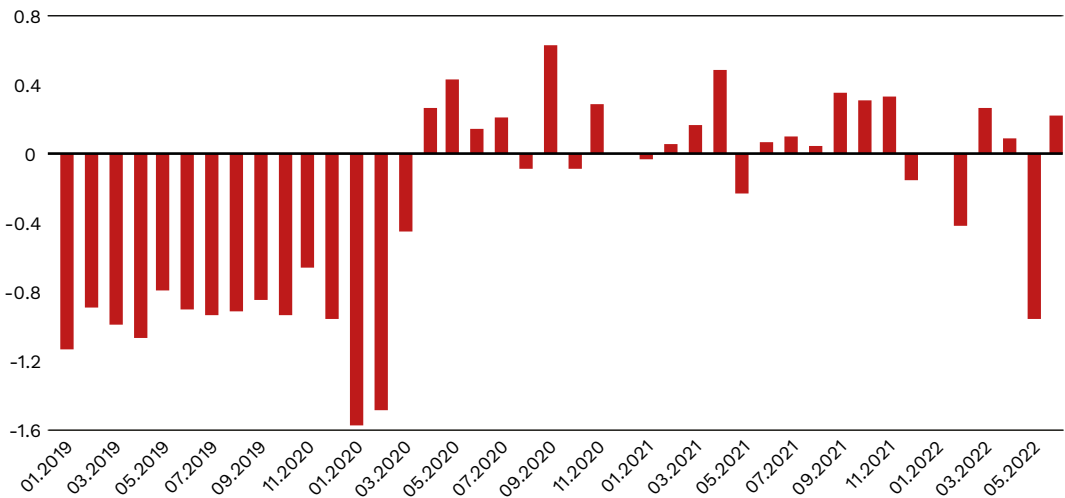


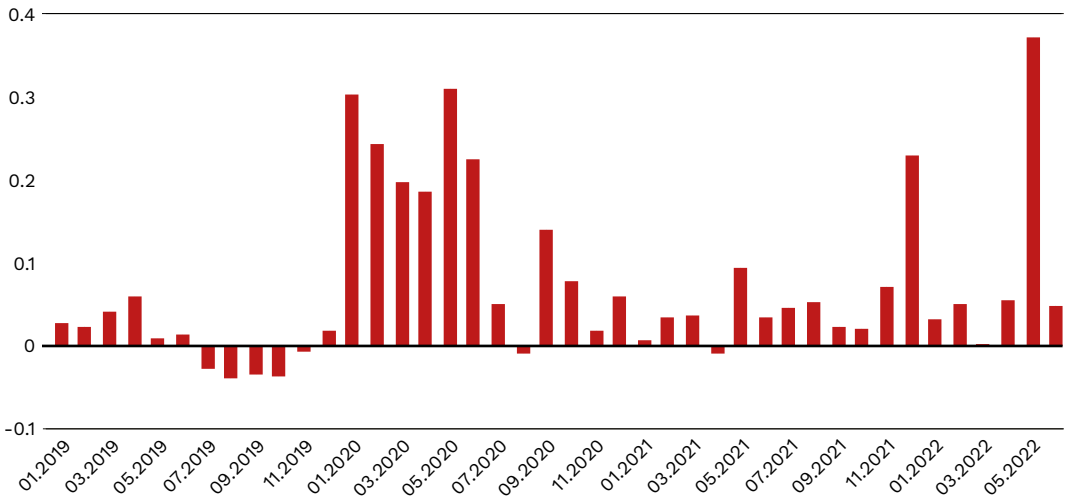Note: positive values indicate a higher share of transport among the wealthier households.
Source: prepared by PEI based on estimated spending data according to Mastercard.

**In the first half of 2020, the price change was more severe – by as much as 0.2-0.3 pp – for the bottom 20% of spenders than the 20% top spenders.** In April-May, the difference was smaller due to the more similar shopping basket (limited spending in leisure, dining and travel). In the first half of 2020, the difference in inflation impact was 4-6 times bigger than the previous year. During the summer of 2020, CPI was similar between the spending groups. In August, the inflation was more of a burden on wealthier households due to higher holiday spending on travels, recreation, restaurants and hotels with a higher CPI value in these months. The first wave of the pandemic had an impact on inequality, but we found that the energy crisis has had a huge impact on it, too.

**In December 2021, inflation affected the poor more than the rich – by as much as 0.23 pp.** This was due to the high food and beverages inflation while preparing for Christmas. The wealthier households had a lower share of transport spending. We also observed a big change in the structure of the 2022 inflation basket. The share of food has been dropping because of the high cumulative prices and savings by households. The prices of services highly dependent on energy are increasing, changing the basket. These are the repercussions of the Russian invasion of Ukraine. Since mid-2021, we observed higher CPI impact on bottom 20% of spenders. In May 2022, the difference in the inflation burden was 0.37 pp, a consequence of the higher financial product spending within the wealthiest and sharp increases in food and fuel prices caused by rising commodity prices. Data for 2022 may be distorted due to the labeling of spending groups in 2020-2021.

**Figure 9. Difference in the inflation burden on the top 20% and bottom 20% of spenders (pp)**



Note: positive values indicate inflation that weighs more heavily on poorer households.
Source: prepared by PEI based on estimated spending data according to Mastercard.

The inflation basket does not include financial assets, purchased housing, agricultural and construction land, or works of art. This means that we did not consider the difference in savings and investments, which has a greater impact on the fact that richer consumers are better able to cope during a crisis. Falling food price dynamics and the inability to spend money in selected categories of goods and services had a limited effect on price changes. In line with the theoretical basis discussed in the literature, we observed that inflation affects poorer people more.

# Discussion

High-frequency data provides a more dynamic view of the current economic situation. Using estimated spending according to Mastercard, we showed that the official measure of inflation during the spring lockdown of 2020 may have been underestimated. At the end of 2021, inflation could have been overestimated due to the shifting pattern of consumption in Poland. The energy crisis has had a different, yet smaller, effect on consumption so far. In line with previous research, we can confirm that poorer households are more affected by the rise in consumer prices that the most affluent ones.

The method used in this working paper is not perfect due to the lack of accurate data on the amount of goods and services purchased by specific consumers. We rely on the value of transactions, which can be assigned to only one category. Another obstacle is the inability to accurately match transactions to COICOP spending categories. Based on in-store payments, we are unable to identify the specific types of products purchased. The method presented here was used to check the measurement of inflation by increasing the frequency of the inflation basket. This is not an independent method for measuring inflation. To create an alternative CPI, data on prices from the Internet could be used[3], but in case of Poland the insufficient number of Internet users might be still an obstacle when interpreting the data.

Future surveys should consider the choice of methodology, including the choice of labels for spending quintiles, to allow for uniform analysis across the survey horizon. In addition, they should consider how the highest and lowest spending groups are selected: are they in this group year after year, or rather characteristic of the entire period combined?

It is also worth considering conducting a survey on income quintiles, rather than just creating spending groups to illustrate the financial situation of consumers. This information carries valuable knowledge for policymakers when assessing the current economic situation and, most importantly, the real burden of inflation on citizens. This method is applicable not only in Poland, but also in other countries. The available data also makes it possible to examine inflation at the regional level; in the case of Poland, in individual voivodships. This study seeks to encourage other researchers to make further use of high-frequency data to supplement public statistics.

Ultimately, this study also shows that we have more information on consumption at our fingertips and that, with the development of electronic transactions, we can measure economic indicators such as consumption and CPI more accurately. Major developments using this kind of data lie ahead.

---

[3] There is an online CASE CPI, an innovative index measuring consumer price dynamics in the Polish market based entirely on data from the Internet (CASE, 2015).

# Bibliography

Akçelik, F., Cömert, H. (2017), *Does Inflation Vary across Income Groups? Evidence from an Emerging Market*, Salerno Universitesi Seminer Serisi, https://open.metu.edu.tr/handle/11511/72785 [accessed: 12.09.2022].

Argente, D., Munseob, L. (2017), *Cost of Living Inequality during the Great Recession*, SSRN Scholary Paper ID 2567357, Social Science Research Network, Rochester.

Baldwin, R., di Mauro, B.W. (2020), *Economics in the Time of COVID-19*, A VoxEU.org Book, CEPR Press.

Bank Światowy (2021), *World Bank Country and Lending Groups*, https://datahelpdesk.worldbank.org/knowledgebase/articles/906519 [accessed: 12.09.2022].

Białek, J. (2019), *Metodologia pomiaru inflacji: stan obecny i wyzwania*, Uniwersytet Łódzki, Główny Urząd Statystyczny, Łódź, Warszawa.

Białek, J., Kłopotek, M., Panek, T. (2022), *Nowoczesne technologie i nowe źródła danych w pomiarze inflacji*, Biblioteka Wiadomości Statystycznych, t. 70, Statistics Office, Warsaw.

Boone, L. (2022), *Editorial: The price of war*, OECD Economic Outlook, Vol. 2022, Iss. 1.

Cardoso, M., Ferreira, C., Leiva, J.M., Nuño, G., Ortiz, A., Rodrigo, T., Vazquez, S. (2022), *The Heterogeneous Impact of Inflation on Households' Balance Sheets*, https://www.galonuno.com/uploads/1/3/4/6/134687692/bbva_bde_september_2022_v1.pdf [accessed: 12.09.2022].

Carvalho, V.M., Garcia, J.R., Hansen, S., Ortiz, Á., Rodrigo, T., Rodríguez Mora, J.V., Ruiz, J. (2020), *Tracking the COVID-19 Crisis with High-Resolution Transactional data*, BBVA Research, Working Paper, No. 20/06.

CASE (2015), *Online CASE CPI*, Centre for Social and Economic Research, https://www.case-research.eu/pl/online-case-cpi [accessed: 12.09.2022].

Cavallo, A., Rigobon, R. (2016), *The Billion prices project: Using online prices for measurement and research*, "The Journal of Economic Perspectives", Vol. 30/2, http://www.jstor.org/stable/43783711.

Cavallo, A. (2020), *Inflation with covid consumption baskets*, National Bureau of Economic Research, Working Paper, No. 27352, http://www.nber.org/papers/w27352 [accessed: 12.09.2022].

Diacon, P.-E., Maha, L.-G. (2015), *The Relationship between Income, Consumption and GDP: A Time Series, Cross-Country Analysis*, "Procedia Economics and Finance", No. 23, https://doi.org/10.1016/S2212-5671(15)00374-3.

Di Tella, R., MacCulloch, R.J., Oswald, A.J. (2001), *Preferences over Inflation and Unemployment: Evidence from Surveys of Happiness*, "The American Economic Review", No. 91(1).

Duesenberry, J. (1967), *Income, saving and the theory of consumer behavior*, "Oxford University Press", Oxford.

ECB (2022), *Payment statistics: 2021*, The European Central Bank, https://www.ecb.europa.eu/press/pr/stats/paysec/html/ecb.pis2021~956efe1ee6.en.html [accessed: 12.09.2022].

Eurostat (2020), *Interaction of household income, consumption and wealth - statistics on main results*, https://ec.europa.eu/eurostat/statistics-explained/index.php/Interaction_of_household_income,_consumption_and_wealth_-_statistics_on_main_results#Interplay_between_indicators [accessed: 12.09.2022].

Goolsbee, A., Klenow, P.J. (2018), *Internet rising, prices falling: Measuring inflation in a world of ecommerce*, NBER Working Paper, No. 24649, www.nber.org/papers/w24649.

Hofstetter, M., Rosas, J. (2018), *The Poor and the Rich: Preferences Over Inflation and Unemployment*, "Documento CEDE", No. 2018-05, http://dx.doi.org/10.2139/ssrn.3116899.

ILO et al. (2004), *Consumer Price Index Manual: Theory and Practice*, http://www.ilo.org/wcmsp5/groups/public/---dgreports/---stat/documents/presentation/wcms_331153.pdf [accessed: 12.09.2022].

Jaravel, X. (2019), *The Unequal Gains from Product Innovations: Evidence from the U.S. Retail Sector*, "The Quarterly Journal of Economics", No. 134(2).

Kakar, V., Daniels, G.E. (2019), *Role of cash and costs of inflation for different income groups in the U.S.*, "Economic Modelling", No. 80, https://doi.org/10.1016/j.econmod.2018.11.016.

Kantur, Z., Özcan, G. (2021), *What pandemic inflation tells: Old habits die hard*, "Economics Letters", No. 204.

Kara, H. (2021), *Policy Performance and the Behavior of Inflation Expectations*, "International Journal of Central Banking", Issue. 70.

Khan, A.-u.-d., Ahmad, I. (2014), *An Empirical Study into the Relation of Income and Consumption Using Cross-Sectional Data*, "ASEE 2014 Zone I Conference", University of Bridgeport, Bridgeport.

Konüs, A.A. (1939), *The problem of the true index of the cost of living*, Econometrica, Vol. 7.

Lane, T. (2020), *Policies for the Great Global Shutdown and Beyond*, Bank of Canada, https://www.bankofcanada.ca/2020/05/policies-great-global-shutdown-and-beyond/ [accessed: 12.09.2022].

Mankiw, G. (2006), *The Inflation Tax*, http://gregmankiw.blogspot.com/2006/05/inflation-tax.html [accessed: 12.09.2022].

Mastercard (2022), *Who we are*, https://www.mastercard.us/en-us/vision/who-we-are.html [accessed: 12.09.2022].

NBP (2022), *Metodyka obliczania miar inflacji bazowej publikowanych przez Narodowy Bank Polski (spraw. tech.)*, Narodowy Bank Polski, Warszawa, https://www.nbp.pl/statystyka/bazowa/metodyka.pdf [accessed: 12.09.2022].

NBP (2022a), *Informacja o kartach płatniczych I kwartał 2022 r.*, Departament Systemu Płatniczego, Narodowy Bank Polski, Warszawa.

OECD (2021), *Statistical Insights: Consumption shifts and inflation measurement during COVID-19*, The Organisation for Economic Co-operation and Development, https://www.oecd.org/fr/sdd/prix-ppa/statistical-insights-consumption-shifts-and-inflation-measurement-during-covid-19.htm [accessed: 12.09.2022].

OECD (2022), *OECD Economic Outlook, Interim Report March 2022: Economic and Social Impacts and Policy Implications of the War in Ukraine*, OECD Publishing, Paris, https://dx.doi.org/10.1787/4181d61b-en.

Reinsdorf, M., Schreyer, P. (2019), *Measuring consumer inflation in a digital economy*, OECD Statistics Working Papers, No. 01, OECD Publishing, Paris, https://doi.org/10.1787/1d002364-en [accessed: 12.09.2022].

Reinsdorf, M. (2020), *COVID-19 and the CPI: Is Inflation Underestimated?*, IMF Working Paper, No. 20/224.

Rötheli, T.F. (2020), *The Behavioral Economics of Inflation Expectations: Macroeconomics Meets Psychology*, Cambridge.

Tenreyro, S. (2020), *Monetary Policy during Pandemics: Inflation before, during, and after Covid-19*, Bank of England.

Woodford, M. (2021), *Behavioral Macroeconomics and Finance: Implications for Central Bankers* (Conference Paper), Columbia University, Bank of Canada Annual Conference.

Wolfers, J. (2003), *Is Business Cycle Volatility Costly? Evidence from Surveys of Subjective Well-Being*, "International Finance", No. 6(1).

# Appendix 1

The Mastercard and Kantar survey covers the largest shopping categories. It is conducted by telephone, continuously, with a daily frequency (6 days a week) on a representative sample of Poles, which makes it possible to estimate even short-term changes in the share of a given means of payment. The coefficient (b) considers the scale of the partial displacement of cash that took place during the first lockdown. The data presented in the statement is not a representation of Mastercard's financial results. Due to the need to protect information on Mastercard's raw transaction volumes, the scaling factors cannot be made public.

"Legal disclaimer: The information/data contained in this report/work product provided by Mastercard in no way: a) contains, reflects, indicates or relates to Mastercard's actual performance or b) constitutes or includes Mastercard data. The information/data contained in this report/work product represents Mastercard's estimate of the overall market only. The information/data, including any forecasts, projections and indications of financial opportunities are provided to you as they exist ("as is") and may be used at your own risk. Mastercard is not responsible for any of your actions taken in reliance on this report/work product or any inaccuracies, inconsistencies, formatting errors or omissions contained herein. Mastercard makes no representations or warranties, express or implied, as to the accuracy or completeness of the information/data contained herein and assumes no liability to you or any other person arising from the use of such information/data by you or your agents."

# List of figures and tables

## The Polish Economic Institute

The Polish Economic Institute is a public economic think tank dating back to 1928. Its research primarily spans macroeconomics, energy and climate, foreign trade, economic foresight, the digital economy and behavioural economics. The Institute provides reports, analyses and recommendations for key areas of the economy and social life in Poland, taking into account the international situation.

Polish
Economic
Institute