# *Differences between Online Prices and the Consumer Prices Index During Covid-19 in Germany*

## *Rozdíly mezi cenami na internetu a indexem spotřebitelských cen v období Covid-19 v Německu*

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**Abstract**

The purpose of this paper is to examine various online price indices with the consumer price index in Germany during the Covid-19 pandemic from 2019 to 2021. This investigation refers to 9,977 items of the product category stationery and drawing supplies, whose sales prices were automatically recorded and evaluated by Amazon.de and idealo.de on a daily basis through web scraping. The official consumer price index of the German Federal Statistical Office of the 3rd Stella level is available for this product category, which makes a direct comparison possible for this study. It was found that online prices are more dynamic and volatile and react directly to external market influences than the prices of stationary trade, which are reflected in the CPI of the German Federal Statistical Office. A deviation of up to 11.7% between the calculated online price indices (OPI) and the German consumer price index (CPI) was found. Especially the value-added increase on 01.01.2021 shows a deviation effect of 9.7% to the CPI. It could be determined that the online price indices and the CPI showed the same trends, but with different characteristics. While Amazon's OPI was still in line with the CPI in 2020, deviations of over 6% were observed in 2021. The prices of other online shops already showed significant deviations from the CPI within the first lockdown in April 2021, which was imposed by the government to contain the Covid 19 pandemic in Germany and forced the stationary trade to close down across the country.

**Keywords**

inflation, online price index, consumer price index, ecommerce, online trade, statistical office, Amazon, Idealo

**JEL Codes**

G00, G10, E20

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**Abstrakt**

Cílem tohoto článku je prozkoumat různé online cenové indexy s indexem spotřebitelských cen v Německu během pandemie Covid-19 v letech 2019 až 2021. Toto šetření se týká 9 977 položek produktové kategorie psací a rýsovací potřeby, jejichž prodejní ceny

byly automaticky zaznamenávány a vyhodnocovány na denní bázi prostřednictvím web scrapingu na stránkách Amazon.de a idealo.de. Pro tuto kategorii výrobků je k dispozici oficiální index spotřebitelských cen německého Spolkového statistického úřadu 3. stupně Stella, který pro tuto studii umožňuje přímé srovnání. Bylo zjištěno, že ceny na internetu jsou dynamičtější a volatilnější a reagují přímo na vnější tržní vlivy, než ceny stacionárního obchodu, které se odrážejí v indexu spotřebitelských cen německého Spolkového statistického úřadu. Byla zjištěna odchylka až 11,7 % mezi vypočtenými indexy online cen (OPI) a německým indexem spotřebitelských cen (CPI). Zejména zvýšení přidané hodnoty k 1. 1. 2021 vykazuje odchylný vliv 9,7 % vůči indexu spotřebitelských cen. Bylo možné zjistit, že OPI a CPI vykazují stejné trendy, ale s odlišnými charakteristikami. Zatímco v roce 2020 byl OPI společnosti Amazon stále v souladu s CPI, v roce 2021 byly pozorovány odchylky přesahující 6 %. Ceny ostatních internetových obchodů vykazovaly výrazné odchylky od indexu CPI již v rámci první výluky v dubnu 2021, kterou zavedla vláda za účelem omezení pandemie Covid 19 v Německu a která si vynutila uzavření kamenných obchodů v celé zemi.

**Klíčová slova**
inflace, index online cen, index spotřebitelských cen, e-commerce, online obchodování, statistický úřad, Amazon, Idealo

# 1 Introduction

The purpose of this paper is to examine online prices in comparison with the official consumer price index of the German Federal Statistical Office and the statistical offices of the German states. This investigation is triggered by an announcement of the German Federal Statistical Office that consumer prices could not be collected in the same quality and quantity as usual during the government-imposed lockdowns at pandemic times (German Statistics Office, 2022).

After the WHO declared the pandemic on March 11, 2020, various measures were initiated in Germany to contain the Corona virus and protect the health care system (Räker et al., 2021). In addition to wearing mouth-nose protection, measures were taken primarily to limit contacts between individuals. People were urged to stay at home, companies had to close their production facilities, and service companies were no longer allowed to offer their services. Stationary trade was also closed on a large scale to protect people. Hardware stores, stationery shops, clothing stores and even hairdressers had to close their stores due to the law. Only food and beverage stores, as well as stores that satisfied people's basic needs, were allowed to open. At the end of the day, these restrictive measures became known as Lockdown and Lockdown "Light" and will probably go down in history books as such. The state repeatedly tried to loosen the lockdowns and partial lockdowns with sporadic relaxations, but then had to reinstate them when new waves of viruses appeared.

The order of the day was that everyone who could do their work from home should stay in the home office. This created an increased demand for office supplies and stationery to make private rooms and homes fit for work. Home office workers now needed paper, pens,

printers, monitors, staplers, hole punches, binders, and erasers at home. Office and stationery accounted for 1.5% of online retail, led by CE/electrical at 24.5% and fashion and accessories at 23.1%. In 2020 alone, the share of office and stationery products purchased online increased from 24.3% to 30.8% year-on-year (Trend Monitor, 2021). This means that just under one in three items in this class of goods is already purchased online.

With the area-wide closure of stationary trade, online trade received a gigantic boost. Those who had previously closed their minds to buying goods on the World Wide Web were now forced to satisfy their demand online. In 2020 alone, online trade in Germany grew by 23% to 72.8 billion euros (Online Monitor, 2021). The forecast for 2021 was already estimated at 85 billion euros, which already accounts for 18% of total consumer spending, if food is not included. This means that almost every fifth euro is already spent online by consumers. As the level of digitization in a society increases, so does the proportion of goods and services purchased online by consumers (Charbonneau et al., 2017).

For the calculation of the consumer price index, the statistical offices of the federal states manually collect prices predominantly in stationary trade with the support of up to 600 commissioned price collectors (German Statistics Office, 2022). From 650 goods classes, about 300,000 prices are normally recorded at various locations in Germany in all possible stores. These prices are then forwarded by the federal states to the German Federal Statistical Office. Only a few prices, such as rental car conditions or insurance rates, are already recorded centrally online. Although the recording of price points via scanner data and web scraping is on the rise, it has so far only been a small component in price collection. In the future, new price collection capabilities are expected to reduce and replace manual effort (Hansen, 2020a).

Online retail reacts much faster to external market influences due to modern software and AI solutions, making it more volatile but also more adaptable (Cavallo, 2015). Prices are constantly compared and adjusted by online stores and online marketplaces in an automated way. The best offer wins the customer (Chevalier and Goolsbee, 2002). The customer already has several offers for one and the same item from different sellers on marketplaces such as Idealo, Amazon and Ebay. The buyer can already decide on the cheapest offer for one and the same item on one website.

Idealo.de is a price comparison portal that compares prices of different items and different online stores. Users can use this online portal to find out in which online store they can buy their desired item at the lowest price. This circumstance basically leads to the fact that the consumer is always informed where he can obtain his products at the lowest price and the demand is channelled to the cheapest supplier. Competition in online retail is highly price-driven (Cavallo, 2018), which usually means that the cheapest provider also gets the most sales. The successes of Amazon, Ebay and Zalando are due to this effect. A large demand is served by a small number of suppliers.

## 2 Research question and hypothesis

Due to the general shift in sales from bricks-and-mortar retailing to online retailing in conjunction with dynamic pricing systems, it is hardly possible to survey the "true" inflation or determine the correct consumer price index according to traditional surveys (Hansen, 2020b). However, especially during the government restrictions due to the pandemic, respectively the lockdowns in April and December 2020, price collection could not be carried out in the usual quality and quantity, as stationary retailers were largely closed across the country.

Office and stationery stores were closed and consumer demand shifted even more to online retail. Additionally, goods class sales were driven by corporate home office arrangements. Since price collectors can hardly have been able to collect prices for certain goods classes on a stationary basis, the quality and accuracy of the consumer price index must have suffered as well. The goods class stationery and painting supplies will serve as an example for this research to determine the deviations between online prices and the consumer price index during the pandemic.

This leads to the following research question: How high is the deviation of the official consumer price index from the online prices of the goods class stationery and painting supplies? Based on the online market behaviour described above, it can be assumed that prices in online retail are more favourable than prices in stationary retail or lower than the official consumer price index (Cavallo, 2016).

However, the increased demand in online retail during the pandemic measures must in turn have led to an increase in prices in online retail. Compared to brick-and-mortar retail, the online market is occupied by only a few market participants with national to global positions. This means that there is a significant increase in demand in relation to the existing supply during the period under review. The hypothesis of the paper is that the consumer price index, collected exclusively from online prices, must be higher than the official consumer price index of the German Federal Statistical Office. Online retail demand has been strongly channelled in the 2020 and 2021 pandemic years. Thus, the availability of goods had a greater influence on supply than price.

## 3 Data and Methods

The retail giant Amazon acts as both a seller and a marketplace on its website. As a seller, Amazon buys goods from manufacturers and then resells them to consumers on its website in its own name and for its own account. Amazon determines the selling price and shipping costs for these items. However, Amazon also acts as a marketplace where other online sellers and online shops (general called sellers) can offer the same goods. In the marketplace, Amazon has no influence on the selling prices. Each seller of goods is allowed to set their own selling price. At the end of the day, most of the fast-moving consumer goods (FMGC) are offered by Amazon and a lot of other sellers or online shops. For example, the same coffee maker is offered by Amazon and by multiple sellers. When the customer gets to the Amazon detail page of the coffee maker, he sees different offers

for the coffee maker. One offer is Amazon and many more are from other sellers. The consumer is free to choose who to buy the coffee maker from. However, Amazon already puts the best offer for the consumer in the Buy Box. The Buy Box is a synonym for the best offer from price and shipping costs, moreover, the customer finally buys the item.

Thus, the Amazon offer is also always opposed by a marketplace offer from another seller. With this principle, Amazon creates competition on its own website. With the battle of all sellers for the Buy Box, the best possible offer from price and shipping costs is determined for the consumer. For this purpose, sellers as well as Amazon use modern computer-aided price adjustment systems that fully automate the battle for the Buy Box. If a seller wins the Buy Box because it has the best offer, it still has to pay Amazon a marketplace fee or a brokerage fee.

Competition among all sellers for the Buy Box determines the best offer for the consumer. Because of its market power, Amazon is also always the focus of competition regulators. However, since competitive behaviour on Amazon primarily serves the customer, Amazon escapes impending restraints. This is because dominant market positions of individual market participants generally lead to the expectation of high prices. In Amazon's case, this behaviour is rather beneficial for the consumer.

Idealo is a price comparison portal. Consumers can search for products there to find the best offer on the web. Idealo scans different online stores for the current offer and displays them on their website. The best offer from price and transportation costs presumably gets the most inquiries and sales. In the case of the coffee maker, the consumer can search for this model on Idealo. Idealo now displays all online stores including the sales price and shipping costs that sell this coffee machine. All online stores with the respective offer of the coffee maker are directly linked and easy to find for the buyer.

For our investigation, we are interested in several parameters. First, we want to determine the inflation of the Buy Box price on Amazon, since it designates the price, moreover, the consumer bought the product on Amazon. In addition, we are interested in the best price from Idealo, since this price presents the best offer on the Internet among all web stores. Third, we evaluate the best offer of a seller who uses Amazon as a marketplace.

With the help of analysis and scraping software, we can draw on 9,977 items with daily online prices in the stationery and painting supplies goods class for this study. Our sample includes items from ten different manufacturers with 17 different brands. Of these products, the best daily price was scraped daily on www.idealo.de during the period from January 01, 2019 to December 31, 2021. On www.amazon.de, the best seller price, the current Amazon price and the Buy Box price were scanned daily. For each of these prices, we create online price indices and compare them with each other and with the official consumer price index of the German Federal Statistical Office. The German Federal Statistical Office provides the consumer price index for the goods classes individually, including the stationery and painting supplies category. Thus, a direct comparison within the category is possible for this study. The prices from 2019 serve as the base year before the pandemic and the prices from 2020 and 2021 reflect the data basis within the pandemic.

**Table 1:** Data collection scheme: daily Buy Box price, daily best price on Idealo, daily best seller price.

| Products | 01.01.2019 | | | 02.01.2019 | | | ... | 31.12.2021 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Office | Idealo | Seller | Buybox | Idealo | Seller | Buybox | | Idealo | Seller | Buybox |
| Product 0001 | 8,34 € | 8,34 € | 7,12 € | 6,99 € | 8,39 € | 7,12 € | | 8,99 € | 8,77 € | 8,49 € |
| Product 0002 | 5,74 € | 5,88 € | 5,99 € | 5,77 € | 6,39 € | 5,77 € | | 5,54 € | 5,54 € | 5,55 € |
| Product 0003 | 20,32 € | 18,64 € | 19,45 € | 17,89 € | 17,89 € | 19,45 € | | 21,33 € | 23,49 € | 21,33 € |
| ... | | | | | | | | | | |
| Product 9977 | 9,99 € | 9,99 € | 10,98 € | 10,98 € | 11,55 € | 10,98 € | | 11,59 € | 11,47 € | 11,89 € |

Inflation in Germany is determined on the basis of the change in the consumer price index from month to month of the previous year. The German State Statistical Offices record prices of 650 goods classes and 300,000 articles and report them to the German Federal Statistical Office to determine inflation (German Statistics Office, 2021). In our analysis, we restrict ourselves to the goods class stationery and drawing materials of the 3rd Stellar level, SEA CPI no. 0954 (German Statistics Office, 2022).

**Table 2:** German Federal Statistical Office 3rd Stellar Level Inflation from January 2020 to December 2021 for the Goods Class Stationery and Drawing Materials (SEA CPI No. 0954).

| Jan-20 | Feb-20 | Mar-20 | Apr-20 | May-20 | Jun-20 | Jul-20 | Aug-20 | Sep-20 | Oct-20 | Nov-20 | Dec-20 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.70 | 0.80 | 1.50 | 1.90 | 2.20 | 3.00 | 1.10 | 0.50 | 0.10 | 0.10 | -0.50 | 0.50 |
| | | | | | | | | | | | |
| **Jan-21** | **Feb-21** | **Mar-21** | **Apr-21** | **May-21** | **Jun-21** | **Jul-21** | **Aug-21** | **Sep-21** | **Oct-21** | **Nov-21** | **Dec-21** |
| 1.70 | 2.50 | 1.50 | 0.80 | 0.50 | 0.10 | 2.60 | 4.10 | 4.30 | 4.00 | 3.90 | 2.40 |

For our investigation, we check whether the sample is representative. Since we do not know the size of the population for our study, we can use the simplified form of the equation for determining a representative sample size (1). In equations (2) and (3) we set $\pi = 0.5$ to ensure that the sample contains the true value even in the worst case. The π-value can range from 0% to 100% and is usually not known in advance of a sample investigation. With $\pi = 0.5$, it is ensured that the equation for determining the sample with $\pi(1 - \pi)$ obtains its maximum. With $\pi = 0$ and $\pi = 1$, the margin of error $E = 0$. To ensure a high confidence level in our sample of at least 99%, we set $z = 2.58$, as you see in equation (2) and (3). We determined the z-value using the z-value table of the standard normal distribution (Taherdoost, 2016).

$$E = z * \sqrt{\frac{\pi(1-\pi)}{n}} \qquad (1)$$

n = sample size, π = proportion of the characteristic in the population, z = width of the confidence interval, E = margin of error

In our case:

$$E = 2.58 * \sqrt{\frac{0{,}5(1-0.5)}{1{,}858}} = 0.03 \text{ (with the smallest sample size, n=1,858)} \qquad (2)$$

$$E = 2.58 * \sqrt{\frac{0.5(1-0.5)}{5{,}117}} = 0.02 \text{ (with the largest sample size, n=5,117)} \qquad (3)$$

With our smallest valid sample size of n = 1,858 in the first month of our study (January 2021), we must allow for a margin of error of E = 3%. That is, our results may differ by 3% up or down. The confidence interval decreases to 2% in our sample in the last month (December 2021) of our study with a valid sample size of n = 5,117.

$$n = \frac{z^2 * \pi(1-\pi)}{E^2} \qquad (4)$$

Confidence level: z-value from table Standard normal distribution (Kotrlik and Higgins, 2001): 90% → 1.65, 95% → 1.96, 99% → 2.58

The minimum sample size for an unknown population is calculated (5), with a maximum permissible margin of error of 3% and a confidence level of 99% (Taherdoost, 2016).

$$n = \frac{2.58^2 * 0.5(1-0.5)}{0.03^2} = 1{,}849 \qquad (5)$$

With at least 1,850 item prices per month per day, the resilience of the study is given.

We calculate the price index from all three data series, from Amazon buy box (6), from the best idealo price index (7) and from the best seller price index (8). We determine a monthly average price per article if there are at least ten daily prices of an article per month. We determine the price index per item and form the monthly average from all item indices. We use the Laspeyres index formula for the calculations of the online price index, which is also used in the calculation of the consumer price index and the Harmonized Index of Consumer Prices (Camba-Mendez et al., 2002).

Calculation Buy Box price inflation (BBI):

$$BBI = \sum_{t=0}^{t} \frac{BB_t - BB_{t-1}}{BB_{t-1}} \qquad (6)$$

Calculation best Idealo price inflation (IDI):

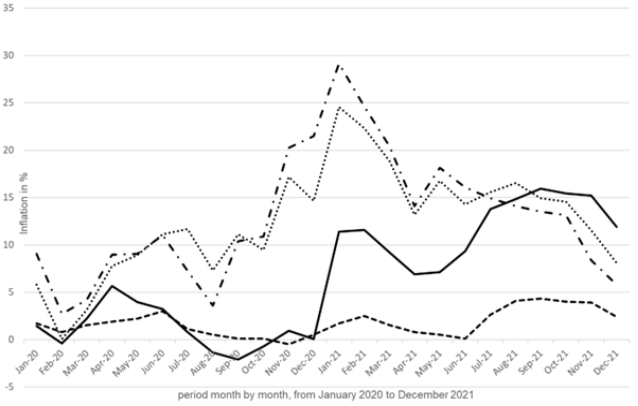
$$IDI = \sum_{t=0}^{t} \frac{ID_t - ID_{t-1}}{ID_{t-1}} \qquad (7)$$

Calculation best seller price inflation (SEI):

$$SEI = \sum_{t=0}^{t} \frac{SE_t - SE_{t-1}}{SE_{t-1}} \qquad (8)$$

t = period month, t-1 = same month, previous year, BB = buy box price, ID = best Idealo price, SE = best seller price, BBI = buy box price inflation, IDI = Idealo price inflation, SEI = seller price inflation

**Figure 1:** Comparison of German Federal Statistical Inflation with Buy Box price index, Idealo price index and best seller price index in the period January 2020 – December 2021




# 4 Results

The evaluation of the data is quite surprising, as the samples deviate strongly from the official inflation rate. In general, however, in figure (1) one can see that the indices at least show the same trend or direction. Thus, when German inflation falls, the indices in the samples also fall. Buy Box inflation, which stands for the selling price of an item on Amazon at the end of the day, still goes reasonably hand in hand with official inflation in 2020, but then diverges significantly as of January 2021.

The second half of 2020 is characterized by lockdowns and partial lockdowns (figure 1). Retail is mostly closed and consumers are forced to make their purchases online. In addition, there is an increased demand of stationery and office supplies in private households due to home office regulations. The explosion of demand in online retail, driven by more customers and more demand, explains the price increase. Since sellers can also gain the Buy Box and thus influence the Buy Box price as well. The Buy Box inflation is also influenced by the seller price. The German Federal Statistical Office collects prices for office supplies and stationery only in brick-and-mortar stores, most of which were closed, which certainly leads to the moderate inflation rate.

The rising inflation rates of the Seller and Idealo prices in the second half of 2020 are interesting. Both curves run parallel and almost on top of each other, which suggests a strong correlation. The Idealo and Seller inflation still increase significantly during the period of the VAT cut compared to the Amazon prices and peak at 29.1% in January 2021 compared to the previous year. We explain this effect with an increased demand, especially in smaller online stores. Amazon is already partially sold out of individual items, which causes prices in other online stores to rise.

While Amazon Buy Box inflation is negative in the second half of 2020 due to the temporary reduction in VAT (-3%), it jumps from 0% to 11.4% in January 2021. For the same month, the German Federal Statistical Office publishes an inflation rate of just 1.7% for this goods class. The divergence of around 10% between Buy Box inflation and official inflation will remain until the end of 2021. Traditionally, Amazon negotiates new purchasing conditions and new purchase prices with suppliers for the following year, which could indicate the jump. That Amazon is using the VAT increase to raise prices is also obvious. Extremely rising energy prices, low availability of goods due to a shortage of raw materials and an increased demand for goods are an additional explanation for the rising prices at the turn of the year. The significant increase in Buy Box inflation and official inflation in the second half of 2021 is due to the renewed VAT adjustment (+3%) on 01.01.2021.

# 5 Discussion

Online prices and offline prices are not the same (Cavallo, 2016). Online prices are highly volatile and can adapt immediately to new market conditions. This effect is again driven by computer-aided price adjustment systems, which are already used to a large extent in online retailing (Hansen, 2020b). And it is already known that online prices can have an impact on inflation (Cavallo and Rigobon, 2016).

This research was able to confirm this effect. Online prices have their own dynamics, are more adaptive and are under strong competition. This study and also previous studies suggest that online prices need to be given greater importance in the collection of CPI and inflation (Cavallo, 2016). Without the inclusion of online prices in the calculation of the CPI, an accurate determination of inflation is no longer possible. Initial prices are already collected online, but are not yet automated and computerized (Hansen, 2020a).

These studies refer exclusively to the pandemic period of 2020 and 2021 and only to the goods class "painting supplies and stationery". In January and February 2021, the indices examined were still at a similar level, only to show significant differences over the course of the next two years. In December 2021, the online indices seem to have adjusted back to the level of the official CPI. Further research will be needed to determine whether the significant deviations in the online indices over the pandemic period were temporary or whether this trend will continue. In addition, the effect in other euro area countries should be investigated. Coronavirus containment measures were similar across European countries. Stationary trade was subject to severe restrictions and online trade experienced a shock in demand, which suggests a similar increase in online prices.

One theory prior to the study was that the cargo ship "Ever Given", which ran aground in the Suez Canal at the end of March 2021 and thus brought international cargo traffic to a standstill in parts, could have had a significant influence on sales prices. This theory that this single event acutely influenced prices could not be established on the basis of this study. Nevertheless, the worldwide increase in demand for raw materials and the resulting rise in prices in Germany are certainly a driver of the relatively high inflation rates compared to the last five years in Germany.

Important macroeconomic decisions depend on the inflation rate, which makes it necessary to determine it almost exactly. If the inflation rate is not correctly determined, this can lead to incorrect or mismeasured measures on the part of the government and financial institutions. A suitable example is the key interest rate of the European Central Bank, the level of which is significantly influenced by the inflation rate of a state. In addition, the inflation rate influences a state's decisions on the deferral of interest and loans, the level of subsidies and the buying and selling of government bonds.

# 6 Conclusion

Using a sample of 9,977 items in the stationery and drawing supplies goods class, it was found that the determined online price index of Amazon Buy Bux and the best Idealo price within the pandemic in 2020 and 2021 deviated significantly from the figures of the German Federal Statistical Office. The closures of brick-and-mortar retail during the lockdowns to contain the pandemic caused demand in online retail to really explode, which caused prices for goods to rise. The effect in the stationery and painting supplies goods category was certainly reinforced by the fact that home office regulations were introduced. Private households had to equip themselves with office supplies in order to be able to do their work at home. The research was able to show that online retail prices differed by up to 11.7% from the official figures.

Moreover, it was found that Idealo prices and Seller prices do not go hand in hand as expected when compared to Amazon Buy Box price in pandemic times. While Amazon Buy Box prices still showed inflation around zero in the second half of 2020, Idealo and Seller prices already increased by 21.5% and on Idealo by 14.7% year-on-year. This effect can be explained by the fact that smaller online stores and online sellers on Amazon (Seller) are taking advantage of the increased demand to raise prices.

The shortage of raw materials and global logistics problems also make goods scarce, which in turn leads to higher prices. The Seller price increases compared to the Buy Box price because the Seller is only waiting for the situation that Amazon has no more inventory to then fill the Buy Box with a higher price. Here the seller shows patience and waits for his chance. Basically, everything sold in the pandemic years and also at almost any price. As a seller, you just had to be patient until your competitor sold his goods and then offer his goods for a higher price. The synchronous behaviour of Idealo price inflation and seller inflation points to the effect.

The German Federal Statistical Office was unable to collect prices in stationary retail as usual during the imposed lockdowns (German Statistics Office, 2022). The number of prices collected was severely limited, and in addition, prices in stationary retail are not as volatile. In addition, only supermarkets and discounters sold stationery and painting supplies as a marginal product range, whose pricing is in turn based on more competition and basically already calculates with lower margins. Supermarkets and discounters are not specialist retailers and therefore generally offer lower prices. In addition, the commissioned price collectors will not have found a suitable substitute for every article in the price survey, which distorts the official inflation rate.

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