The Price of War: Causal Evidence on Firms' Price Setting in Response to the War in Ukraine*

Pascal Seiler†
ETH Zurich and European Central Bank

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Abstract

This paper studies the causal effects of the Russian invasion of Ukraine in spring 2022 on firms' price-setting behavior in Switzerland. By combining qualitative survey evidence with microdata underlying the consumer and producer price indices, I find that the war increased the frequency and synchronization of price changes as well as the age of adjusted prices. This evidence supports state dependence in price setting. Diminished concerns about damaging customer relationships through price increases in the face of cost-push shocks have contributed to greater price flexibility. In contrast, sticky information, fixed contracts, and business hierarchy delayed price adjustments.

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†Contact: ETH Zurich, KOF Swiss Economic Institute, Leonhardstrasse 21, CH–8092 Zurich, Switzerland. E-mail: seiler@kof.ethz.ch. Web: https://www.pascalseiler.ch.
The views expressed in this paper are those of the author and do not necessarily reflect the views of the European Central Bank.

1 Introduction

How do large shocks affect price-setting behavior and transmit into prices? This long-standing question has gained renewed interest following the Russian invasion of Ukraine in spring 2022. With both countries taking center stage as major exporters of energy and food commodities, the economic consequences of the conflict spread quickly through supply shortages and price surges, pushing inflation across Europe to new highs after more than three decades of stable prices. To understand these inflationary dynamics and formulate appropriate policy actions, it is crucial to gain a thorough understanding of the underlying price-setting responses to this shock.

In this paper, I provide causal evidence of the effects of the Russian invasion of Ukraine on the price-setting behavior of Swiss firms. To do so, I use data from a survey that collects qualitative information on how companies set their prices and what factors influence their price adjustment decisions. The survey was conducted in spring 2022 among a sample of private Swiss companies covering all sectors of the economy, allowing for conclusions for both consumer and producer prices. The fact that some companies participated in the survey before the Russian invasion of Ukraine, while others only responded afterward, constitutes a quasi-experiment in which any difference in the responses of companies that responded before and after the outbreak of the war can be interpreted as causal.

The data collected through the survey are qualitative. To evaluate the results beyond their significance and the direction of the effects, I link micro price data underlying the Swiss Consumer Price Index (CPI) and Producer Price Index (PPI) with the survey participants at company level, calculate price-setting moments and employ an event study model to quantify some of the effects on firms' pricing decisions.

The main findings are the following. The war has increased the frequency of price reviews, translating into more frequent price adjustments. The effect on producer prices was strong and immediate. The frequency of price changes increased by 20 percentage points on impact, leading to price changes in about half of all producer prices. The effect lasted for several months before gradually diminishing half a year after the outbreak of the war. For consumer prices, on the other hand, the effect on the frequency was delayed (by one month) and smaller (increase by six percentage points) but persistent until the end of 2022. The more frequent price adjustments can be traced back to price increases almost exclusively, while the frequency of price decreases declined. In contrast to the frequency of price changes, their size shows only little reaction.

Furthermore, the war prompted changes in prices that had not been adjusted for a long time. The average age of adjusted consumer prices was 2.5 months before the war and increased to 3.6 months upon its impact. The war and ensuing surge in energy prices increased the price gap, more so for older than younger prices, triggering their corresponding adjustment. Taken together, firms' price-setting response to the war through the frequency and selection of (old) price changes provide evidence for state-dependent pricing. Beyond, when directly asked whether they change their prices in a time- or state-dependent manner, firms following the outbreak of the war said they were more likely to review the price of their main product or service in response to specific events than at regular time intervals, providing evidence that the degree of state dependence itself is time-varying.

Furthermore, firms have become more selective in changing prices across their product range. Instead of changing prices simultaneously for several products or services, the war has made them change prices for fewer products at a time, thus reducing the synchronization of price changes within stores. The opposite is true for the synchronization of price changes across firms. Firms are more inclined to interpret price changes of their competitors as a signal to adjust their prices than before the outbreak of the war. This is consistent with the finding that firms, on impact, increasingly considered the prices of their competitors for determining their own prices. This is likely related to the increased uncertainty in the first period. Companies needed time to reflect on the consequences of the new situation on price setting and wanted to avoid being the first or only to press ahead with price changes. Moreover, such wait-and-see behavior is also consistent with the delayed reaction of the frequency of price changes.

The war has also influenced the motives underlying price rigidities. The importance of some reasons why companies do not change their prices has decreased due to the war, making prices more flexible. Above all, the reason to leave prices unchanged due to unchanged cost, which indicates increased price flexibility through increased costs. This seems to indicate that while fairness considerations (Kahneman et al., 1986; Rotemberg, 2005, 2011) appear to be an important factor in explaining price stickiness in the face of demand shocks (Cavallo et al., 2014; Gagnon and López-Salido, 2020), they play a lesser role in explaining why firms keep their prices unchanged in the face of cost-push shocks.

In contrast, other reasons for not changing prices have become more important. In particular, sticky information has contributed more to price rigidity than before the war. The war has made it more costly in terms of time and money to collect all relevant information for price decisions. I find consistently positive effects on price rigidity, which

are significant in the first and third weeks. In particular, the effect in the first week could explain the delay in price changes immediately after the outbreak of war. Furthermore, fixed contracts (e.g., with suppliers) were perceived to be more restrictive towards price changes in the late aftermath of the war than before, and hierarchical delays within firms slowed down decisions to change prices.

This paper is part of an extensive literature studying the response of prices and price-setting behavior of firms to large shocks. The shocks examined in this literature cover a broad spectrum and include both more conventional economic shocks such as VAT changes (Fuest et al., 2020; Karadi and Reiff, 2019), exchange rate shocks (Auer et al., 2021; Gopinath et al., 2010), or minimum wage increases (Leung, 2021; Renkin et al., 2022), as well as more unconventional events such as earthquakes (Cavallo et al., 2014), hurricanes (Neilson, 2009; Beatty et al., 2021), or the pandemic (Cabral and Xu, 2021; Cavallo and Kryvtsov, 2023; Jaravel and O'Connell, 2020).

My contribution to this literature is threefold. First, I extend the list of shocks by instrumenting the Russian invasion of Ukraine in 2022 in a quasi-experimental framework and examine firms' pricing response to a well-identified war shock. Previous works that have examined the effects of this conflict on firm behavior have documented increased inflation expectations (Ropele and Tagliabracci, 2022; Seiler, 2022b), decreased availability of food products (Stelmasiak et al., 2023), or increased food prices (Arndt et al., 2023; Artuc et al., 2022), but have left the price-setting behavior at the firm level unexplored. Studying the effects of the war in Ukraine further provides evidence of a type of shock whose disruptions, in contrast to many of the natural disasters studied to date, were difficult to predict based on previous experiences.

Second, my results are based on a broad sample of firms covering all sectors of the Swiss economy and, therefore, largely reflect the behavior of both consumer and producer prices. Thus, they exceed the coverage of many previous contributions that have isolated the effects of shocks in specific product groups (e.g., Beatty et al. (2021) and Neilson (2009) study gasoline prices, Cabral and Xu (2021) study prices of face masks and hand sanitizers) or specific types of price setters (e.g., Renkin et al. (2022) study supermarkets, Cavallo and Kryvtsov (2023) study online retailers).

Third, and more broadly, the results presented in this paper demonstrate strong price reactions to the specificities of the investigated shock, whose economic consequences for Swiss companies are primarily transmitted through supply-side channels such as upward pressure on energy prices, potential shortages of key commodities, and increased eco-

nomic uncertainty. In doing so, they support the view emerging from the literature that price-setting behavior is particularly responsive to supply shocks (e.g., Butters et al., 2022), in contrast to (temporary) demand shocks, to which the response is comparatively small and muted (e.g., Gagnon and López-Salido, 2020).

While the characteristics and the transmission of the shock studied in this paper share some similarities with those explored in the literature, this study goes beyond analyzing price responses as revealed by micro price data. Instead, using qualitative information from survey data, it adopts a broader perspective on the entire price-setting process. It investigates how the reasoning and rationales underlying firms' pricing decisions respond to an exogenous and unanticipated aggregate shock. This is a distinctive feature of this paper. Not only are studies on the motives behind the decisions of price setters rare as such. Using qualitative research methods, Blinder et al. (1998) for the US, Fabiani et al. (2005) for the euro area, or Seiler (2022a) for Switzerland have shed light on aspects such as price rigidities and potential reasons why companies do not change their prices. This paper extends this strand of research by providing causal evidence of the responsiveness of such moments to an exogenous shock.

The paper is structured as follows. Section 2 describes the qualitative survey data on firms' pricing decisions and the quantitative micro price data underlying the Swiss CPI and PPI. Section 3 sets out the empirical strategy to identify the effect of the Russian invasion of Ukraine in February 2022 on the price-setting behavior of Swiss firms. Section 4 presents the results. Section 5 concludes.

2 Data

This study combines two datasets. The first is the Price-Setting Survey (PSS, hereafter) of the KOF Swiss Economic Institute at ETH Zurich. The second are the microdata underlying the Swiss CPI and PPI of the Swiss Federal Statistical Office (FSO).

2.1 The Price-Setting Survey

The PSS is an ad-hoc survey conducted in the spring of 2022 by the KOF Swiss Economic Institute at ETH Zurich to collect information on how companies set their prices and what factors influence their price adjustment decisions. In particular, the survey explores the different stages of the price-setting process: from price review (the stage in which

firms assess whether they want to adjust the price of their product or service) through price calculation and the information companies use to determine their prices, to actual price changes and the factors that can lead to delays in these adjustments and introduce price rigidities. The data collected through the survey are qualitative.[1]

The survey is conducted on a sample of private Swiss companies with more than two employees (in full-time equivalents) drawn from the Business and Enterprise Register of the FSO. The sample is stratified by sectors and three size classes.[3] The sectoral coverage of the sample extends across all economic sectors in Switzerland, excluding agriculture. Accordingly, the participants include manufacturing, construction, and services companies. Within the service sector, retail companies are overrepresented to enhance coverage with companies from the CPI, enabling conclusions to be drawn for both producer and consumer prices.[4]

The survey was conducted online, revealing the exact time of response of the participating companies. The survey started on 16 February and ended on 31 March 2022. The fact that some companies participated in the survey before the Russian invasion of Ukraine on 24 February, while others responded afterward, represents a quasi-experimental feature that is used to identify the war-related effects on firms' price-setting behavior, as described in Section 3 below.

In total, 5,551 companies were contacted, and 1,546 companies participated, resulting in a response rate of 28 percent. In most cases, the respondents hold senior positions within their companies, indicating that they are knowledgeable about or directly influence the company's pricing policies.

2.2 CPI and PPI microdata

The second dataset comprises product-level price data underlying the Swiss CPI and PPI from January 2010 to December 2022. The CPI includes the prices[5] of goods and

[1] Appendix A.1 contains the English version of the questionnaire[2], and Appendix A.2 provides further details on the survey design.

[3] Sectors are defined by the NACE Rev. 2 "divisions." The size classes are defined by the number of full-time equivalent employees in the companies. There are three classes: small companies (fewer than 50 employees), medium-sized companies (more than 50 but fewer than 250 employees), and large companies (more than 250 employees).

[4] Appendix A.3 provides further details on the sample design.

[5] Price quotes are transaction prices, i.e., the prices paid by consumers for a specific good or service, including indirect taxes, customs duties, environmental taxes, and subsidies.

services relevant to the consumption of private households in Switzerland.[6] The PPI measures the price[7] developments of goods and services that are produced or provided by companies operating in Switzerland and sold domestically or abroad.[8]

The classification of consumer prices follows the classification of individual consumption by purpose (COICOP). The producer prices are classified according to the sector of economic activity (NACE). To account for the relative importance of the prices in the respective indices, I use CPI weights (based on the annual expenditure of a representative household) and PPI weights (based on the production and import value of products sold by companies operating in Switzerland) to compute price-setting moments and aggregated statistics. The weights are available at the five-digit COICOP level ("expenditure items") for the CPI and the four-digit NACE level ("classes") for the PPI. These levels – uniformly referred to as "categories" across the two indices – constitute the lowest aggregation levels of the respective classification schemes for which I calculate price-setting moments.

I use these moments calculated from the micro price data to quantify the qualitative survey results. To do so, I link price spells from both price indices with participants in the PSS at the company level. Of the 1,546 companies participating in the PSS, 340 are matched with companies whose prices are included in the CPI and PPI microdata. This corresponds to 22 percent of the companies in the survey sample. Of the 340 companies, 80 are part of the CPI, and 260 are part of the PPI. The prices of the goods and services of the matched companies cover categories of the respective price indices, which cover 32 percent of the CPI and 46 percent of the PPI in terms of their respective weights.

One important consideration when determining the dynamic effects of the war is the periodicity of price collection. While both the CPI and the PPI are calculated once a month, not all prices are collected at a monthly frequency. Prices are only collected monthly for those categories whose prices are generally subject to sharp, short-term fluctuations. The other categories are collected less frequently. In our sample[9], almost all consumer prices are collected monthly (95%), while only 14% of producer prices are

[6] For a detailed description of the methodology of the CPI, see FSO (2022). Rudolf and Seiler (2022) present a recent study using Swiss CPI microdata.

[7] The companies report prices for high-turnover products or services expected to be produced or provided over a longer period. Domestic prices are ex-factory; export prices are measured free on board (FOB), excluding transportation costs, insurance costs, value-added tax, and other taxes.

[8] For a detailed description of the methodology of the PPI, see FSO (2020) and FSO (2021). Kaufmann and Renkin (2018) present a recent study using Swiss PPI microdata.

[9] Figure A.1 in the appendix shows the percentage of price observations recorded by each collection frequency in 2022.

collected monthly. More of them are collected quarterly (48%), semi-annually (20%), or yearly (18%). This implies that these categories may be slower to reflect price changes in response to the war, an aspect I will exploit in the empirical strategy.

3 Empirical strategy

To estimate the causal effects of the war on firms' price-setting behavior, I exploit a quasi-experimental feature of the PSS that saw some firms responding to the survey before the conflict started while others afterward.[10] Given the unexpected[11] nature of the conflict and the timing of survey responses, I study the effects of the war by estimating the following specification:

$$y_i = c + \sum_{j=1}^{3} T_j + \beta X_i + \gamma \Delta Oil_i + \varepsilon_i. \tag{1}$$

The dependent variable y_i is the response of firm i to a given survey question, which is regressed on a constant c, on three time dummy variables T_j with $j = \{1, 2, 3\}$ (each of which takes the value 1 if the day of response falls in the j-th period and 0 otherwise[12]), on a set of firm-specific[13] controls (X_i) and on the percentage change in the Brent crude oil price (ΔOil_i) between the outbreak of the war and the day before the questionnaire was completed.

Aside from the unpredictability of the war, the identification strategy in Equation (1) relies on the assumption that the timing of firms' participation in the survey (i.e., whether they answered the questionnaire before or after the Russian invasion on 24 February) is as good as random. I test this by estimating a logit model in which the dependent variable is a dummy variable that takes the value 1 for firms that participated in the survey after the outbreak of the war and 0 otherwise, and in which the regressors include various firms characteristics (size, sector, region, and language). Table B.1 in the appendix

[10] Figure B.1 in the appendix shows the distribution of responses to the PSS over time.

[11] Despite rumors and Russian military movements since the beginning of 2022, an invasion was considered highly unlikely. Figure B.2 in the appendix underlines this point using Google search volumes query results.

[12] I split the war period into three sub-intervals of equal length to assess whether the war has exerted time-varying effects on the outcome variables. T_1 covers the period from 24 February to 7 March, T_2 from 8 to 19 March and T_3 from 20 to 31 March. Throughout, I refer to these periods as first, second, and third weeks, respectively.

[13] The firm-specific controls in X_i cover size (three size classes), sector (NACE Rev. 2 "divisions"), and location (NUTS-3 cantons) fixed effects.

shows that none of these controls are statistically significant.

Hence, Equation (1) estimates the causal effect of the outbreak of the war on firms' price-setting behavior as reported in the PSS by comparing the responses of firms that participated in the survey before the start of the conflict with those that responded since the invasion. The dependent variables from the survey are ordered categorical variables. Therefore, I estimate ordered logistic regression models. Since the estimated coefficients of ordered response models do not allow for direct interpretation, I evaluate their results with regard to the significance and direction of the effects.

With the help of the linked micro price data and the price-setting moments calculated from them, it is nevertheless possible to quantify the effect of the war on certain aspects of firms' price-setting behavior (e.g., the frequency of price changes). For this purpose, I employ an event study model. Consider the panel of price-setting moments $m_{j,t}$ calculated for category j and month t. Denote as $Event_j$ a variable that captures the time at which the prices for a given category were collected again for the first time after the Russian invasion of Ukraine on 24 February. This corresponds to the period in which the war is adopted for the first time in the price-setting reaction of category j. Adoption time is category-dependent due to different price collection frequencies across categories. For categories that are collected at a lower than monthly frequency, the effect of the war is not captured in the first month after the Russian invasion of Ukraine (i.e., in March 2022), but may only materialize when their prices are re-collected, potentially several months after the actual outbreak of the war.

The panel event study specification can then be written as:

$$m_{j,t} = \alpha + \sum_{k=2}^{K} \beta_k D_{j,t}^k + \sum_{l=1}^{L} \beta_l D_{j,t}^l + \mu_j + \lambda_t + \varepsilon_{j,t}. \tag{2}$$

Here, μ_j and λ_t are category and month fixed effects, and $\varepsilon_{j,t}$ is an unobserved error term. The lags $D_{j,t}^k$ and leads $D_{j,t}^l$ to the event are defined as follows:

$$D_{j,t}^k = \mathbb{1}[t = Event_j - k] \text{ for } k \in \{1, \ldots, K\} \tag{3}$$

$$D_{j,t}^l = \mathbb{1}[t = Event_j + l] \text{ for } l \in \{1, \ldots, L\}. \tag{4}$$

Lags and leads are thus binary variables indicating that the given category was a given

number of months away from the outbreak of the war in the respective month. To capture the baseline difference between categories that already adopt the effect of the war and those that do not, the first lag ($j = 1$) corresponding to the last price collection before the war is omitted in Equation (2). For monthly collected prices, this is February 2022. I include $K = 11$ lags and $L = 10$ leads in the estimations to end up with a symmetric number of lags and leads around the event month.

4 Effects of the war on firms' price-setting behavior

This section presents the results. In Section 4.1, I examine the effects of the war on firms' price adjustments. In Section 4.2, I focus on price rigidity and investigate how the war affected the importance of different motives for firms not to change prices.

4.1 Effects on price flexibility

I begin by examining how the conflict has affected the frequency of firms' price reviews and price changes. To do this, I use two questions from the PSS that asked firms to indicate how often they *review* (Q1) the price of their main product or service, without necessarily changing it, and how often they actually *change* (Q2) it. Responses[14] could range from several times a day [7], over daily [6], weekly [5], monthly [4], quarterly [3], semi-annually [2], to yearly [1]. The first two columns in Table 1 present the results of estimating the two questions in Equation (1). Standard errors here and throughout are clustered at two levels: sector of economic activity and time of response.

The conflict has increased the frequency of both price reviews and price changes. The Russian invasion of Ukraine induced firms to review the price of their main product or service more frequently. Although price reviews do not necessarily lead to price changes, these more frequent reviews have indeed led to more frequent adjustments. Consistent with the estimated coefficients on price reviews, the conflict increased the frequency of price adjustment. These effects are not statistically significant until the second week, as I do not find significant effects in either the frequency of price reviews or price changes immediately after the outbreak of the war. This suggests that it may have taken some time for companies to adapt to the new situation and adjust their prices accordingly.

I use the micro price data linked to the survey participants to quantify how much more

[14] For all survey questions, the numbers in square brackets indicate how the qualitative responses on the categorical answer scales were numerically re-coded for estimating Equation (1).

frequently they changed their prices after the outbreak of war. I calculate the monthly frequency of price changes at the category level, capturing the share of category prices that change in a given month, and estimate the event study model described in Equation (2) separately for consumer and producer prices.

Figure 1 shows the resulting point estimates together with their 95% confidence intervals. They confirm the survey results by showing a significant increase in the frequency of price changes after the war for both consumer prices (in the left panel) and producer prices (in the right panel). Although less precisely estimated, the effect is much more pronounced in the PPI. On impact, the frequency of producer price changes increased by almost 20 percentage points, on average, leading to price changes in about half of all producer prices (Figure C.1 in the appendix shows the frequency of price changes in levels). The effects of the war persisted for five months before disappearing half a year after its outbreak.

In contrast to the PPI, the frequency of consumer price changes shows a smaller effect and reacts with a delay. The effect of the war is only estimated to be significant from the second month onward. It peaks at $t = 2$ at an average increase of 5.6 percentage points. This result is consistent with the findings from the PSS, which also showed a delayed response in price adjustments to the war. Furthermore, the estimates show that the war has persistently increased the frequency of price adjustments in the CPI. In the months leading up to the war, the frequency averaged 27 percent. In the ten months after its outbreak, it averaged 30 percent. From the second month onward, all coefficients are estimated to be significantly greater than zero.

The more frequent price adjustments can be traced back to price increases. Figure C.2 in the appendix shows the point estimates from the event study model estimated separately for the frequency of price increases and the frequency of price decreases. The effect of the war on the higher frequency of all price changes is almost exclusively due to a higher frequency of price increases. Conversely, the frequency of price decreases tends to be lower due to the war. For the CPI, in particular, the point estimates are significantly negative some months after the outbreak of war.

In contrast to the frequency of price changes, their size shows little reaction to the outbreak of the war. Figure C.3 in the appendix shows the size of price changes in levels, Figure C.4 and Figure C.5 show estimates of the event study model with the size of price changes, price increases and price decreases, respectively. The size of consumer price increases started to fall slightly seven months after the outbreak of the war, while

the size of producer price increases increased both on impact and one quarter later. However, the estimates are only imprecisely estimated overall.

To further illuminate firms' price adjustment decisions, I use the following survey questions on the duration hazard and synchronization of price changes in additional estimations:

Q3 *Duration hazard.* The PSS asks firms whether the probability of changing the price of their main product or service is higher if the price has been changed recently than if the price has not been changed for a long time [1], whether it is independent of the time of previous price changes [2], or whether it is higher if the price has not been changed for a long time than if the price has been changed recently [3].

Q4 *Determination of price reviews.* The PSS asks firms whether they review the price of their main product or service [without necessarily changing it] at regular time intervals [−1], both at regular time intervals but also in response to specific events [0] or in response to specific events, e.g., a considerable change in costs [1].

Q5 *Synchronization of price changes within firms.* The PSS asks firms whether, when adjusting the price of their main product or service, they change the prices of all [4], of most [3], or of some [2] other products/services at the same time, or whether they change prices for only one product or service at a time [1].

Q6 *Synchronization of price changes across firms.* The PSS asks firms whether, when their competitors change the price of their main product or service, they always [4], usually [3], or rarely [2] adjust the price of their product or service at the same time, or whether they do not change their price at the same time [1].

Columns 3 through 6 in Table 1 present the results. Duration hazard expresses the probability of price adjustment as a function of the time elapsed since the last price adjustment. The conflict has made companies assess the probability of changing their prices to be higher if they have been changed recently than if they have not been changed for a long time. This implies a decreasing slope of the duration hazard function and appears to be at odds with state-dependent pricing. In the presence of state dependence, the duration hazard function is upward-sloping because the probability of a price change increases as the optimal price drifts further away from the posted price (Karadi et al., 2023). However, there are reasons against interpreting this result as evidence against state dependence.

On the one hand, when asked directly about the determinants of their price reviews, firms were more likely to review the price of their main product or service after the outbreak of the war in response to specific events than at regular time intervals. This question directly indicates the extent of time-dependent versus state-dependent pricing. The responses suggest that pricing has shifted towards more state-dependent pricing in response to the conflict and that, in doing so, the degree of state dependence itself may vary over time.

On the other hand, micro price estimates provide evidence against firms' assessment of the duration hazard function in the PSS. The event study model allows us to analyze the impact of the outbreak of war on the selection of price changes with respect to their age. In particular, I calculate the average age of adjusted prices per category and month and estimate the model described in Equation (2) separately for consumer and producer prices.

Figure 2 shows that the war significantly increased the age of adjusted consumer prices. On impact, the adjusted prices were, on average, one month older than immediately before the war. While the average adjustment age was 2.5 months before the conflict, it was 3.6 months immediately after its outbreak (Figure C.6 in the appendix shows the age of adjusted prices in months). The effect is significant for one quarter before it flattens towards the fourth month. Conversely, for producer prices, there is no significant change in the age structure of the adjusted prices.

Thus, as a result of the war, many consumer prices were adjusted, which had not been adjusted for longer than usual. This suggests that the war has increased the probability of a price change for those prices that have not been adjusted for a long time relative to those that have been changed recently, consistent with an upward-sloping duration hazard function and in line with state dependence.

Why do companies still report a downward-sloping hazard in the survey after the outbreak of the war, according to which they are more likely to readjust those prices that they have just changed than those that they have not changed for some time? This can be reconciled with the assumption that they assessed the duration hazard for a specific subset of their prices when answering the respective survey question. Given the higher frequency of price changes in response to the war (Table 1), they may have assessed the adjustment probability precisely with regard to those prices that they have just changed and for which they already except further adjustments in view of the conflict and associated second-round effects (e.g., further expected increases in energy costs).

As a result of the conflict, companies are not only more selective when it comes to price changes with regard to their age structure but also when it comes to synchronizing price changes within their product range. This is shown by further results in Columns 5 and 6 in Table 1. Instead of changing prices simultaneously for their entire product range, companies prefer to adjust prices for fewer products at the same time since the war. The opposite is true for synchronizing price changes across firms, at least in the longer term. Here, firms are more inclined to interpret price changes of their competitors as a signal to adjust their own prices than before the outbreak of the war.[15]

4.2 Effects on price rigidity

What are the reasons underlying these more frequent price adjustments, and how has the war affected the importance of companies' motives for not changing prices? There are plenty of reasons why firms might refrain from changing the prices of their products or services, and the literature knows a wide range of explanations for sticky prices. The PSS presents firms with several of these explanations and asks them to rate these motives as to why they might decide not to change the price of their main product or service by importance on a scale ranging from very important [4], through moderately important [3], of minor importance [2] to totally unimportant [1]. The different reasons are:

Q11 *Constant costs.* We only change prices when we realize that costs changed.

Q12 *Price duration.* We do not change the price because the next price adjustment can be made only after a certain time.

Q13 *Implicit contracts.* Our customers expect a stable price, and more frequent changes could damage customer relationships.

Q14 *Explicit contracts.* We have fixed contracts that limit our ability to change prices.

Q15 *Sticky information.* It is costly in terms of time or money to gather all relevant information for pricing decisions.

Q16 *Hierarchy.* Delays within our organization slow down pricing decisions.

[15] This is also reflected by the shift in the importance of various rules for price calculation, as shown in Table C.1 in the appendix. The conflict prompted companies to consider their competitors' prices more when setting their own prices.

Table 2 presents the estimation results. I find a negative and strongly significant effect of the war on constant cost as a factor inducing price rigidity in all three estimation periods, indicating that unchanged costs have become much less important for keeping prices unchanged. Given the large cost-push shock resulting from the war, this is no surprise and illustrates that price-setting behavior has become more flexible through the cost channel.

Other factors contributing to more price flexibility were shorter price durations in the medium term (negative and significant effect in the second week) and implicit contracts in the longer term (increasingly negative and significant effect in the third week). The longer the war lasted, the more companies felt that price changes – particularly price increases – could be implemented without damaging their customer relationships. Both the need for a certain amount of time between price changes and the view that customers expect stable prices were rated as less important since the war. Hence, while fairness considerations (Kahneman et al., 1986; Rotemberg, 2005, 2011) are an important factor in explaining price stickiness in the face of demand shocks (Cavallo et al., 2014; Gagnon and López-Salido, 2020), they seem to play a lesser role in explaining why firms leave their prices unchanged in the face of cost-push shocks.

Conversely, other factors have increased price rigidity with the outbreak of the war. Fixed contracts (e.g., with suppliers) have limited firms' ability to change prices. Such explicit contracts were judged to be more restrictive in the late effects of the war (significant positive effect in the third week) than before the war. The war has also made it more costly in terms of time or money to gather all relevant information for pricing decisions. I find positive effects on price rigidity throughout, which are significant in the first and third weeks. Especially the effect in the first week could explain why there were not more price changes immediately after the outbreak of war and why the adjustment frequency only increased with a delay (see Table 1). Immediately after the outbreak of the war, there was great uncertainty and it was difficult for companies to gather all the relevant information for their price decisions, which is why price changes were delayed. In addition, hierarchical delays in the third week after the outbreak of war further delayed pricing decisions. This is likely because the war and the associated price adjustments constituted an exceptional situation that probably needed to be discussed more with upper management.

5 Conclusion

This paper provided causal evidence of the effects of the Russian invasion of Ukraine and the associated cost-push shocks on firms' price-setting behavior in Switzerland by combining qualitative survey data with microdata from the consumer and producer price indices. As a result of the war, companies changed their prices more frequently, selected older prices for changes, and synchronized price changes more with their competitors but less across their product range. Concerns about damaging their customer relationship and constant costs have become less important reasons to leave prices unchanged, contributing to the flexibilization of prices and suggesting that fairness considerations play a subordinate role in the face of large and sudden cost shocks. On the other hand, sticky information, fixed contracts, and hierarchical delays have increased price rigidity after the outbreak of the war.

These conclusions have implications for both model selection and policy. The evidence presented in the paper supports state dependence in price setting. State-dependent pricing endogenously alters the repricing rate and implies that prices become more flexible after large aggregate shocks. Under such conditions, the workhorse New Keynesian model (Galí, 2008; Woodford, 2009; Walsh, 2010), built around the assumption of a constant average frequency of price changes, falls short in adequately explaining the transmission of shocks to inflation and runs the risk of missing important aspects of inflation dynamics (Cavallo et al., 2023). Understanding the responsiveness of price setting to shocks helps to better assess inflation dynamics and formulate appropriate policy measures.

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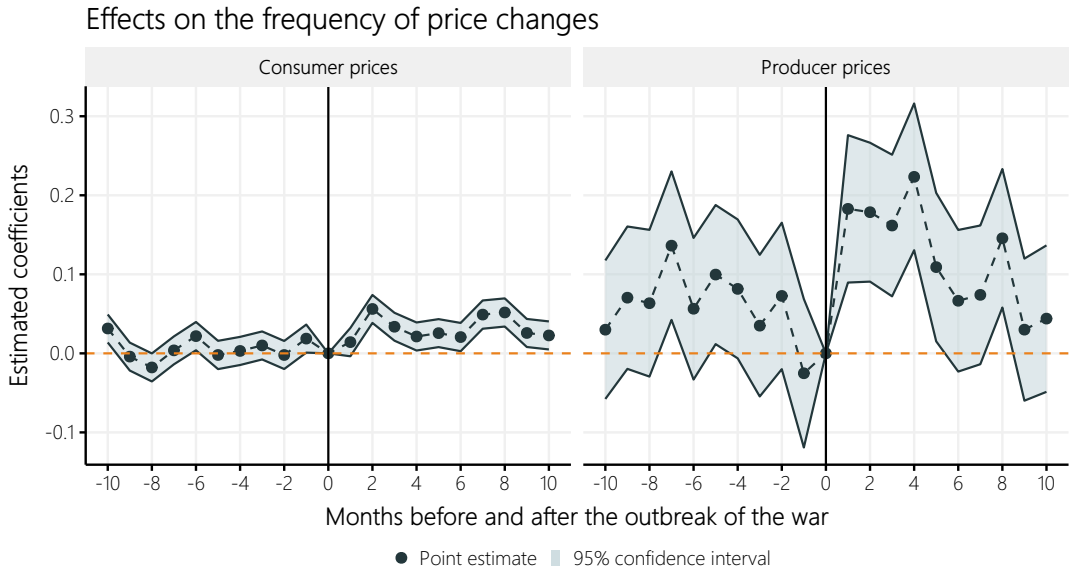

Figure 1: Effects of the outbreak of the war on the frequency of consumer (in the left panel) and producer price changes (in the right panel) estimated with the event study model described in Equation (2). The figure shows point estimates together with their 95% confidence intervals (filled area) over the event-time path. The (omitted) base period is the last price collection before the outbreak of the war (solid vertical line). For prices of monthly collected categories, this is February 2022.

Table 1: Effects of the war on firms' price adjustments

	Dependent variable:					
	Frequency of price reviews Q1	Frequency of price changes Q2	Duration hazard Q3	Review determination Q4	Synch. (within) Q5	Synch. (across) Q6
T_1	0.281	0.177	−0.529	−0.113	−0.595	0.096
	(0.247)	(0.262)	(0.196)	(0.141)	(0.321)	(0.254)
T_2	0.369	0.294	−0.359	0.103	−0.436	0.009
	(0.162)	(0.158)	(0.175)	(0.055)	(0.130)	(0.199)
T_3	0.410	0.476	−0.400	−0.067	−0.716	0.409
	(0.197)	(0.144)	(0.227)	(0.127)	(0.229)	(0.194)
γ	−1.010	−1.178	1.983	0.037	2.029	−0.641
	(0.590)	(0.591)	(0.999)	(0.236)	(1.041)	(0.772)
Size FE	Yes	Yes	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Canton FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,498	1,470	1,488	1,506	1,483	1,483

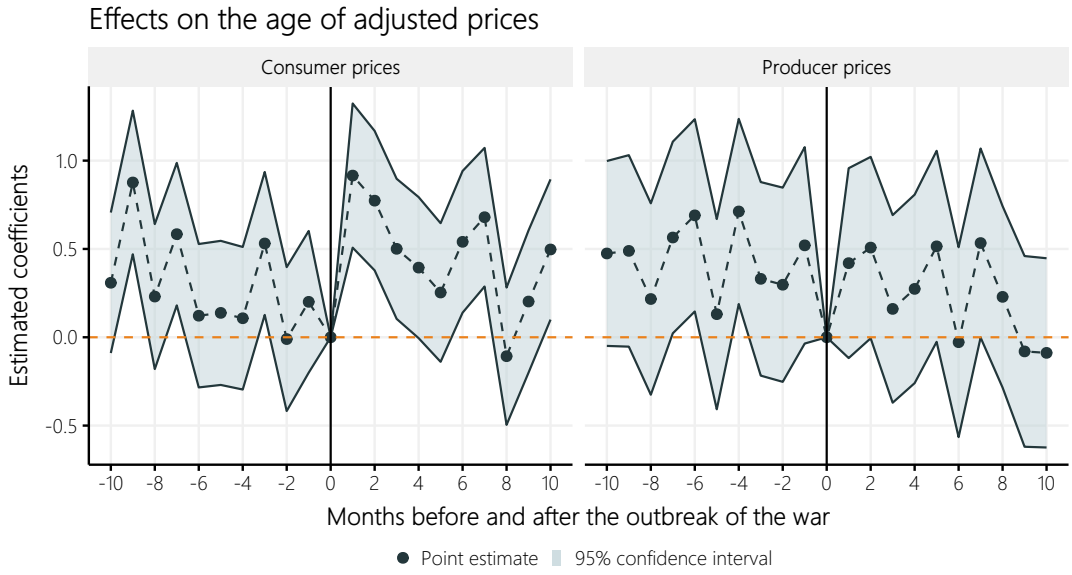

Figure 2: Effects of the outbreak of the war on the age of consumer (in the left panel) and producer price changes (in the right panel) estimated with the event study model described in Equation (2). The figure shows point estimates together with their 95% confidence intervals (filled area) over the event-time path. The (omitted) base period is the last price collection before the outbreak of the war (solid vertical line). For prices of monthly collected categories, this is February 2022.

Table 2: Effects of the war on price rigidities

	Dependent variable:					
	Const. costs Q11	Duration Q12	Impl. contracts Q13	Expl. contracts Q14	Information Q15	Hierarchy Q16
T_1	−0.292	−0.126	0.062	0.154	0.420	0.094
	(0.150)	(0.213)	(0.224)	(0.249)	(0.217)	(0.250)
T_2	−0.239	−0.207	−0.197	0.142	0.258	0.055
	(0.023)	(0.117)	(0.133)	(0.112)	(0.166)	(0.149)
T_3	−0.327	0.132	−0.296	0.335	0.535	0.445
	(0.145)	(0.132)	(0.140)	(0.152)	(0.209)	(0.253)
γ	1.961	−0.063	0.351	−1.055	−0.792	0.083
	(0.638)	(0.753)	(0.517)	(0.594)	(0.491)	(1.000)
Size FE	Yes	Yes	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Canton FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,467	1,472	1,467	1,473	1,462	1,460

Online Appendix

The Price of War: Causal Evidence on Firms' Price Setting in Response to the War in Ukraine*

Pascal Seiler†
ETH Zurich and European Central Bank

This online appendix presents additional figures, tables and analyses that are not featured in the main body of the paper. The appendices refer to the corresponding sections in the main text.

A Data

This appendix refers to Section 2 in the main body of the paper. Appendix A.1 presents the questionnaire of the Price-Setting Survey (PSS) conducted by the KOF Swiss Economic Institute at ETH Zurich. Appendix A.2 and Appendix A.3 provide further details on the survey and sample design, respectively.

A.1 Questionnaire of the Price-Setting Survey

Introduction

This survey examines how Swiss companies determine the prices for their products or services and what factors influence the price-setting process. It is divided into four sections:

- Section A asks general questions about your company and its main products and services.
- Section B collects information about how your company sets prices for its products or services.
- Section C collects information about price changes and factors that influence your decision to adjust prices.
- Section D addresses factors that may cause delays in price adjustments.

Explanation of important terms in the survey:

Price Throughout the survey, the term "price" refers to the actual transaction sales price, not the list price. Therefore, if discounts from the list price are common in your industry, refer to the after-discount price of your product or service. Final transaction prices in certain industries offering services or customized products may be largely a function of the work involved. If this applies to your firm, refer to your hourly or daily charge-out rate as the price.

Product/service Since your company probably sells many different products or services, it is difficult to generalize the answers to the questions for all products or services. For this reason, we would like you to refer to a product or service that best represents the company. Therefore, please answer the following questions for your main product or service or a typical product or service for your company. In the questionnaire, this product or service is simply referred to as "product/service."

Section A. General information

1. **What percentage of sales of your main product/service is generated in the following areas?**
   (a) Switzerland: _____ %
   (b) Euro-area countries: _____ %
   (c) Other countries: _____ %

2. **What percentage of sales of your main product/service is generated through the following channels?**
   (a) Offline: _____ %
   (b) Online: _____ %

3. **What percentage of sales of your main product/service is generated by the following customers?**
   (a) Businesses: _____ %
   (b) Private consumers: _____ %
   (c) Government: _____ %

4. **The profit margin of your main product/service over the last five years has**
   ☐ Increased
   ☐ Remained unchanged
   ☐ Decreased

5. **Are most of the customers of your main product/service regular customers, with whom you expect to do business again, or occasional customers, with whom you do not expect to be repeated customers?**
   ☐ Regular customers
   ☐ Occasional customers

6. **Do you import inputs to create your product/service or your product/service itself?**
   ☐ Yes, mostly from the euro area
   ☐ Yes, mostly from other countries
   ☐ No

7. **What is your market share[16] in your main market?**

[16]The market share is measured by sales of our main product/service as a proportion of total sales of that product/service in the market.

- □ Less than 5%
- □ Between 5% and 10%
- □ Between 10% and 25%
- □ Between 25% and 50%
- □ Over 50%

8. **How many competitors are there in the main market for your main product/service?**
   - □ None
   - □ Less than 5 competitors
   - □ Between 5 and 10 competitors
   - □ Between 10 and 20 competitors
   - □ More than 20 competitors

9. **Competition in the main market for your main product/service over the last five years has**
   - □ Increased
   - □ Remained unchanged
   - □ Decreased

Section B. Information regarding price formation

10. **Who determines the price of your main product/service?**
    - □ We determine the price ourselves.
    - □ The price is determined through negotiations/contracts with the customer.
    - □ The price is determined through negotiations/contracts with the supplier.
    - □ The parent company determines the price.
    - □ The government determines the price.

11. **What determines whether you review the price of your main product/service (*without necessarily changing it*)?**
    - □ Review in regular time intervals
    - □ Review in regular time intervals, but also in response to specific events (e.g., a considerable change in costs)
    - □ Review in response to specific events (e.g., a considerable change in costs)

12. **How often do you review the price of your main product/service (*without necessarily changing it*)?**
    - □ Several times a day

□ Daily

□ Weekly

□ Monthly

□ Quarterly

□ Semi-annually

□ Yearly

13. How applicable are the following statements to the way you price your product/service? fully applicable □—□—□—□ fully inapplicable

(a) **We determine the price using rules of thumb (e.g., indexation to the national consumer price index).**

(b) **We determine our price by adding a constant mark-up on calculated unit costs.**

(c) **We determine our price by adding a variable mark-up on calculated unit costs, depending on market conditions.**

(d) **We determine our price by considering the prices of our competitors.**

(e) **We determine our price by considering customer demand and the perceived value customers derive from purchasing our main product/service.**

(f) **We determine our price by adding a constant mark-up on calculated unit costs.**

(g) **We determine the price based on information about the *past behavior* of all variables relevant for price determination.**

(h) **We determine the price based on information about the *current behavior* of all variables relevant for price determination.**

(i) **We determine the price based on information about the *future expected behavior* of all variables relevant for price determination.**

14. The price of your product/service: Yes □—□—□ No

(a) **varies across geographical markets in Switzerland**

(b) **differs across customers ("personalized pricing")**

(c) **depends on the quantity sold**

(d) **is determined case by case**

(e) **differs whether the product/service is sold via the internet ("online") or stationary ("offline")**

(f) **depends on real-time market dynamics or the time of the day ("dynamic pricing")**

15. **To what extent are the following aspects of price formation of your main product/service automated? Here, automation means that decisions are taken without human interaction.** Yes □—□—□ No

    (a) **The price comparison with our competitors is automated.**

    (b) **The decision to review the price is automated.**

    (c) **The price calculation is automated.**

    (d) **The decision to change the price is automated.**

16. **How has the introduction of digital technologies affected the following aspects of your pricing?** Increased □—□—□ Decreased

    (a) **Ability to change prices more frequently**

    (b) **Ability to change prices compared to competitors**

    (c) **Profit margin**

    (d) **Cost of labor**

17. **What impact do you expect the introduction of digital technologies by your own company and by other parties to have on the price of your product/service in the next three years? The price of your product/service will be due to the introduction of digital technologies**
    Significantly increase □—□—□—□—□ Significantly decrease

    (a) **by your own company**

    (b) **by other parties (i.e., suppliers, customers and competitors)**

Section C. Information regarding price changes

18. **How often do you *change* the price of your main product/service?**
    - □ Several times a day
    - □ Daily
    - □ Weekly
    - □ Monthly
    - □ Quarterly
    - □ Semi-annually
    - □ Yearly

19. **To the best of your knowledge, has the frequency of price adjustments changed in the past decade?**
    - □ Yes, we change prices more frequently today.
    - □ Yes, we change prices less frequently today.

□ No, it has not changed.

20. Over the next 3 years, do you expect the frequency of price adjustments to change in your company?

□ Yes, we expect to change prices more frequently than today.

□ Yes, we expect to change prices less frequently than today.

□ No, we don't expect it to change.

21. The probability of changing the price of your product/service

□ Is higher if the price has been changed recently than if the price has not been changed for a long time.

□ Is higher if the price has not been changed for a long time than if the price has been changed recently.

□ Is independent of the time of previous price changes.

22. When you adjust the price of your product/service, do you also change the prices of other products/services at the same time?

□ Yes, we change the prices of *all* products/services at the same time.

□ Yes, we change prices for *most* products/services at the same time.

□ Yes, we change prices for *some* products/services at the same time.

□ No, we change prices for *only one* product/service at a time.

23. When your competitors adjust the price of their product/service, do you also change the price of your product/service at the same time?

□ We *always* change the price of our product/service at the same time.

□ We *usually* change the price of our product/service at the same time.

□ We *rarely* change the price of our product/service at the same time.

□ We *do not* change the price of our product/service at the same time.

24. For your main product/service, how important is each of the following factors in motivating a price *increase*?

Very important □—□—□—□ Totally unimportant

(a) **Increase in labor costs (e.g., negotiated wage increase)**

(b) **Increase in financing costs**

(c) **Increase in the cost of raw materials**

(d) **Increase in energy and fuel prices**

(e) **Increase in exchange rate**

(f) **Increase in suppliers' prices**

(g) **Decrease in our productivity**

(h) **Demand increase**

(i) **Demand increase**

(j) **Price increase by a competitor**

(k) **Product improvement (e.g., quality, design)**

(l) **The intention of gaining market share**

25. For your main product/service, how important is each of the following factors in motivating a price *decrease*?
Very important □—□—□—□ Totally unimportant

(a) **Decrease in labor costs (e.g., negotiated wage increase)**

(b) **Decrease in financing costs**

(c) **Decrease in the cost of raw materials**

(d) **Decrease in energy and fuel prices**

(e) **Decrease in exchange rate**

(f) **Decrease in suppliers' prices**

(g) **Increase in our productivity**

(h) **Demand increase**

(i) **Demand reduction**

(j) **Price reduction by a competitor**

(k) **Product improvement (e.g., quality, design)**

(l) **The intention of gaining market share**

Section D. Information regarding price rigidities

26. Sometimes companies decide not to change the price of their product/service. There are often a variety of reasons for this. Some of them are listed below. How important are the following reasons for *not* changing the price of your product/service to your company? Please neglect any special effects of the COVID-19 pandemic on your pricing policy.
Very important □—□—□—□ Totally unimportant

(a) **We are hesitant to change prices for fear that our competitors will not follow suit.**

(b) **We do not change the price because the next price adjustment can be made only after a certain period of time.**

(c) **We fear we need to revise the price in the opposite direction soon after adjusting prices.**

(d) **We have fixed contracts that limit our ability to change prices.**

(e) **Our customers expect a stable price and more frequent changes could damage customer relationships.**

(f) **We set prices at commercially attractive price points (e.g., CHF 20 or CHF 9.90) and only change them when it is convenient to move to a new attractive threshold.**

(g) **It is costly in terms of time or money to gather all relevant information for pricing decisions.**

(h) **It is costly to change prices (e.g., new catalogs, changing price tags).**

(i) **We only change prices when we realize that costs changed.**

(j) **We prefer to vary other elements of our products or services (e.g., warranty, delivery lag, customer services) rather than change prices.**

(k) **We do not reduce prices because our customers may consider this a reduction in the quality of our product or service.**

(l) **Delays within our organization slow down pricing decisions.**

(m) **Low inflation makes large price changes more noticeable.**

(n) **We are reluctant to change the price if we are uncertain about the future development of our business situation.**

(o) **We lose many customers when raising the price but gain only a few new customers when cutting it.**

(p) **Are there any important reasons other than those listed above? If yes, please specify:** _____

27. Please answer the following question with regard to any special effects of the COVID-19 pandemic on your pricing policy. How important were the following reasons for *not* changing the price of your product/service for your company *during the COVID-19 pandemic?*
Very important □—□—□—□ Totally unimportant

(a) **We are hesitant to change prices for fear that our competitors will not follow suit.**

(b) **We do not change the price because the next price adjustment can be made only after a certain period of time.**

(c) **We fear we need to revise the price in the opposite direction soon after adjusting prices.**

(d) **We have fixed contracts that limit our ability to change prices.**

(e) **Our customers expect a stable price and more frequent changes could damage customer relationships.**

(f) **We set prices at commercially attractive price points (e.g., CHF 20 or CHF 9.90) and only change them when it is convenient to move to a new attractive threshold.**

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(h) **It is costly to change prices (e.g., new catalogs, changing price tags).**

(i) **We only change prices when we realize that costs changed.**

(j) **We prefer to vary other elements of our products or services (e.g., warranty, delivery lag, customer services) rather than change prices.**

(k) **We do not reduce prices because our customers may consider this a reduction in the quality of our product or service.**

(l) **Delays within our organization slow down pricing decisions.**

(m) **Low inflation makes large price changes more noticeable.**

(n) **We are reluctant to change the price if we are uncertain about the future development of our business situation.**

(o) **We lose many customers when raising the price but gain only a few new customers when cutting it.**

A.2 Further information on the survey design

This appendix provides further information on the survey design.

The survey contains 32 questions in total. Some of these draw from earlier surveys conducted by Blinder et al. (1998) in the United States and Fabiani et al. (2005) in the euro area. Others were added to explore new aspects of how firms set the prices of their products and services.

In the context of the survey, the price of a product or service refers to the actual selling price rather than the list price. In sectors where list prices are commonly discounted, the price of the product or service refers to the after-discount price. In sectors where companies offer services or customized products, final transaction prices are often a function of the work involved. In these cases, the price refers to the hourly or daily rate charged for the labor input. Furthermore, given that most firms sell more than one product or service, respondents were asked to answer the questions with reference to their main product or service or with reference to a product or service that is representative of their company.

The questionnaire is divided into four sections reflecting the different stages of the price-setting process. The first section collects information on the price review stage, in which firms evaluate whether or not they need to adjust the price of their product or service. The second section examines price calculation, and the information firms use to set

prices. The third section examines firms' actual price adjustments. Finally, the fourth section addresses the factors that may cause delays in price adjustments. The survey was preceded with questions collecting characteristics of the firms that provide a useful profile of the firms and illustrate some of the unique features of the sample (see Table A.2 in Appendix A.3).

A.3 Further information on the sample design

This appendix provides further information on the sample design.

The survey was conducted on a sample of private Swiss companies with more than two employees (in full-time equivalents) drawn from the Business and Enterprise Register of the Swiss Federal Statistical Office. Given the dominance of small and medium-sized enterprises in Switzerland – they account for more than 99 percent of companies in the country – the sample was stratified by industries (NACE Rev. 2 division level) and three size classes (small, medium-sized, and large companies). The sectoral coverage of the sample extends across all economic sectors in Switzerland, excluding agriculture. Consequently, the participants include manufacturing, construction, and services companies. Within the service sector, companies from the retail sector have been overrepresented, so the conclusions drawn from the analysis are valid regarding both producer and consumer prices. The retailers that responded to the survey represent about 44 percent of employment in the retail sector.

The companies from the panel received an invitation letter by email and were invited to participate in the survey via the web interface for the usual business tendency surveys. Depending on the language preferences of the respondents, the questionnaire was available in German, French, Italian, and English.

The survey was conducted online from 16 February to 31 March 2022. In total, 5,551 companies were contacted, of which 1,546 companies participated. The corresponding response rate amounts to 28 percent. In most cases, respondents held senior positions in their company, suggesting that they are informed about the company's pricing policies or directly influence it.

Table A.1 shows the coverage of the sample by sector (industry level) and size (three size classes). About 30 percent of the participants are manufacturing firms, and a quarter of the firms operate in the wholesale and retail sectors. The sectoral coverage of the sample is unprecedented, as it goes beyond the manufacturing and selected services sectors, as was common in previous studies on price-setting behavior based on surveys (Blinder et al., 1998; Fabiani et al., 2005). Among all respondents, 60 percent are small firms (employing fewer than 50 employees), 28 percent are medium-sized (more than 50 but less than 250 employees), and 14 percent are large firms (more than 250 employees). Compared to the structure of the Swiss economy, small and medium-sized enterprises are underrepresented, while large companies are overrepresented. Furthermore, the share of manufacturing firms in the sample is larger than in the Swiss economy, while the share

of service providers is smaller than the corresponding population share.

Table A.1: Sectoral and size coverage

	Sample			Population	
	N	% N	% FTE	% N	% FTE
Industry segment					
Manufacturing	457	29.4	20.4	10.9	16.8
Electricity, gas and steam supply	32	2.1	1.2	0.2	0.8
Water supply	11	0.7	0.1	0.5	0.4
Construction	83	5.3	3.1	13.0	8.6
Wholesale and retail trade	394	25.4	35.0	16.8	13.7
Transportation and storage	68	4.4	11.3	2.7	5.6
Accommodation and food service act.	33	2.1	2.3	9.3	4.6
Information and communication	51	3.3	1.0	3.6	3.8
Financial and insurance act.	82	5.3	6.3	3.1	5.8
Real estate act.	13	0.8	0.3	2.2	0.9
Professional, scientific and technical act.	111	7.2	3.9	13.3	8.0
Administrative and support service act.	39	2.5	3.6	5.0	6.1
Education	20	1.3	1.0	2.0	7.6
Human health and social work act.	83	5.3	9.4	10.5	14.1
Arts, entertainment and recreation	40	2.6	0.5	1.9	1.1
Other service act.	35	2.3	0.5	5.0	2.2
Size classes					
S	847	54.6	4.8	94.6	37.1
M	516	33.2	17.3	4.6	22.1
L	189	12.2	77.9	0.9	40.9

Notes: This table presents the sectoral and size coverage of the sample by industry segments (aggregates of NACE Rev. 2 division levels) and size classes. Size "S" refers to firms with fewer than 50 employees, "M" to firms employing more than 50 but less than 250 employees, "L" to firms with more than 250 employees. "N" indicates the number of companies, "% N" the percentage of the companies in the sample (population), and "% FTE" the percentage of employees in the sample (population).

Compared to the structure of the Swiss economy, small and medium-sized enterprises are underrepresented, while large companies are overrepresented. Furthermore, the share of manufacturing firms in the sample is larger than in the Swiss economy, while the share of service providers is smaller than the corresponding population share.

The survey included questions collecting characteristics of the firms that provide a useful profile of the firms and illustrate some of the unique features of the sample (see Table A.2). The main market for the companies is domestic. On average, the respondents generate 90% of their turnover from sales of their product or service in Switzerland, 7% in the euro area, and 4% in other countries. Roughly as many participants generate the majority of sales with other companies ("business-to-business") as they do with private consumers ("business-to-consumer"), and less than 10% with government agencies. However, there are large differences between companies in all sectors regarding their main customers. Manufacturing firms generate 82% of their sales with other companies. By contrast, more than three-quarters of sales are generated by private consumers in the retail sector. The other service providers generate about half of their sales with private

consumers. Most companies do business with customers with whom they expect to do business again ("regular customers"). 12% of the participants indicate doing business with "occasional customers" whom they do not expect to be repeat customers. Customer relationships are particularly close in the manufacturing sector and less so among service providers and companies that generate more than ten percent of their sales online. The lion's share of the turnover is generated via traditional sales channels ("offline"), while an average of 11% of turnover is generated via online sales. In other service providers (12%) and retail (11%), the average online share of sales is larger than in the manufacturing sector (7%). 59% estimate that their market share is less than 10%. According to 54% of the participating companies, competition in their main market has increased in the last five years, 38% say that it has not changed, and 8% say that competition has decreased during this period. 15% say the profit margin of their main product or service has increased in the last five years, 38% say it has remained unchanged, and 47% say it has decreased during the same period.

Table A.2: Characteristics of the firms participating in the PSS

		Size			Sector			Channel		Competition	
	Total	S	M	L	Industry	Retail	Services	Online	Offline	+	−/0
Turnover by region											
Switzerland	89.6	90.5	84.5	72.6	72.5	97.2	90.9	78.7	90.9	91.2	87.5
Euro area	6.9	6.3	9.5	18.2	18.8	1.8	6.1	16.7	5.8	7.1	6.8
Other countries	3.5	3.2	5.5	9.2	8.7	0.9	3.0	4.7	3.3	1.8	5.6
Turnover by customer											
Businesses	45.2	44.2	52.6	57.0	81.7	21.9	40.5	51.1	46.0	46.4	43.7
Private consumers	44.7	46.3	34.5	25.2	11.8	75.3	49.1	40.8	45.1	43.0	47.3
Government	9.9	9.4	12.3	17.8	6.4	2.9	10.2	8.1	8.8	10.4	8.9
Customer relationship											
Regular customers	88.5	88.2	90.8	91.1	94.9	88.6	87.1	82.1	89.3	90.7	85.8
Occasional customers	11.5	11.8	9.2	8.9	5.1	11.4	12.9	17.9	10.7	9.3	14.2
Turnover by channel											
Offline	86.1	85.7	89.5	86.4	92.2	88.5	83.3	21.9	96.4	86.2	86.2
Online	10.5	10.5	9.7	12.8	7.1	11.1	12.0	78.1	3.6	12.2	8.5
Market share											
Less than 10 percent	58.5	58.9	59.6	36.6	47.3	64.3	60.5	60.2	60.0	65.0	51.0
More than 10 percent	41.5	41.1	40.4	63.4	52.7	35.7	39.5	39.8	40.0	35.0	49.0
Competition											
Increased	54.0	53.1	60.4	64.0	54.7	60.5	53.6	61.1	54.7	100.0	0.0
Unchanged	38.2	38.7	33.5	34.8	39.5	33.1	37.3	36.8	36.4	0.0	82.9
Decreased	7.9	8.2	6.1	1.2	5.9	6.4	9.2	2.1	8.9	0.0	17.1
Profit margin											
Increased	14.7	14.8	15.1	8.9	17.0	14.8	13.8	24.9	13.7	14.8	14.5
Unchanged	38.4	37.9	42.1	43.9	28.5	36.3	39.3	35.0	37.4	28.2	49.9
Decreased	46.9	47.3	42.8	47.2	54.5	48.8	46.9	40.1	48.9	57.1	35.6

Notes: This table shows firm characteristics across survey participants. The column "Total" shows the results for all survey participants. The "size" columns distinguish the results for small (2–49 employees), medium-sized (50–249 employees), and large companies (more than 250 employees). The "sector" columns classify the results according to manufacturing ("Industry"), retail, and services companies. The "channel" columns differentiate the results by companies that generate more than 50% of their sales online ("Online") and companies that generate less than 50% of their sales through e-commerce ("Offline"). The "competition" columns report the results separately for those firms that indicate that competition in the main market for their product or service has increased in the last five years ("+") and for those for which competition has not changed or decreased ("−/0") over the same period.

A.4 CPI and PPI microdata

While both the CPI and the PPI are calculated once a month, not all prices are collected at a monthly frequency. Prices are only collected monthly for those categories whose prices are generally subject to sharp, short-term fluctuations. The other categories are collected less frequently. Figure A.1 shows the percentage of price observations recorded by each collection frequency in 2022. In our sample, almost all consumer prices are collected monthly (95%), while only 14% of producer prices are collected monthly. More of them are collected quarterly (48%), semi-annually (20%), or yearly (18%).

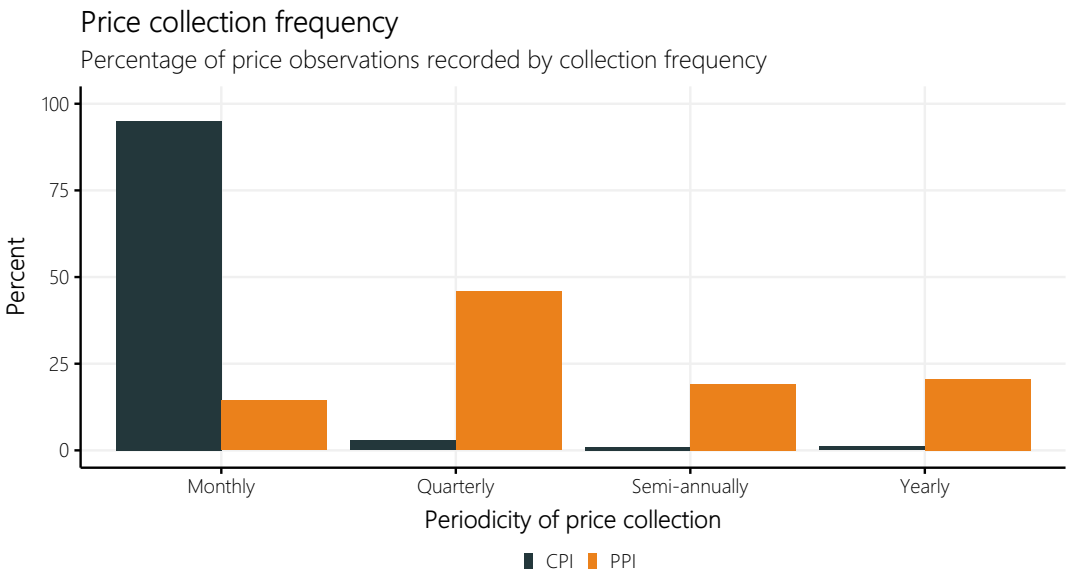

Figure A.1: Percentage of price observations recorded by collection frequency in 2022 in the linked microdata sample.

B Empirical strategy

This appendix refers to Section 3 in the main body of the paper and provides additional information on the empirical strategy.

To estimate the causal effects of the war on firms' price-setting behavior, I exploit a quasi-experimental feature of the PSS that saw some firms responding to the survey before the conflict started while others afterward. Figure B.1 shows that 43 percent of firms completed the questionnaire before Russia invaded Ukraine on 24 February 2022, while the remaining companies mainly responded in the second half of March.

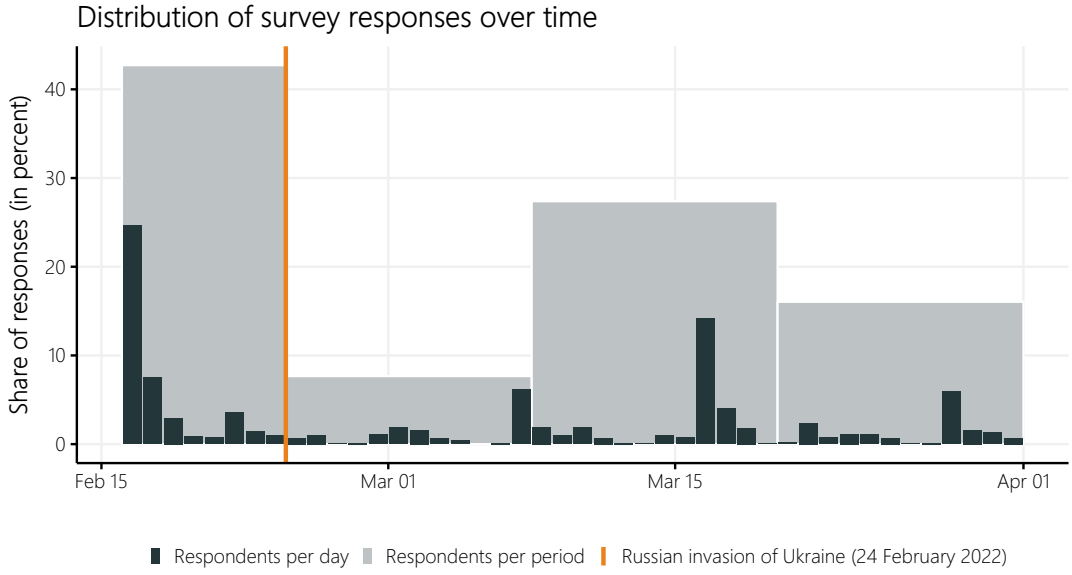

Figure B.1: Distribution of responses to the PSS (percentage of responses) over time. The survey started on 16 February and ended on 31 March 2022. The vertical line marks 24 February 2022, the day of the Russian invasion of Ukraine. The war period is divided into three sub-intervals of equal length to assess whether the war has exerted time-varying effects since its outbreak. The proportion of respondents in each period is reflected by the three vertical bars after 24 February. 43 percent of respondents completed the questionnaire before the outbreak of the war, while the remaining companies mainly responded in the second half of March.

Even though there were rumors of a possible invasion and Russian military movements were registered since the beginning of 2022 and in the lead-up to the Russian invasion of Ukraine, the start of the conflict on 24 February 2022 was an unexpected event. Figure B.2 underlines this using Google search volumes query results. It shows daily data on the intensity of internet search queries for terms related to the Russian invasion of Ukraine (invasion, Russia, Ukraine, and war) worldwide on Google from 1 January until 31 May 2022.

The increasing importance of the internet as a primary source of information makes

internet search queries indicative of people's interests and concerns (Choi and Varian, 2012). The data can be retrieved from Google's website, allowing users to query the relative popularity of search terms for selected geographical regions and periods. Notably, interest in search terms over time is reported as an index. The values indicate the search interest relative to the highest point in the diagram for the selected region in the specified period. The value 100 represents the highest popularity of the search terms. A value of 50 means that the term is half as popular, and 0 means that not enough data was available for this term.

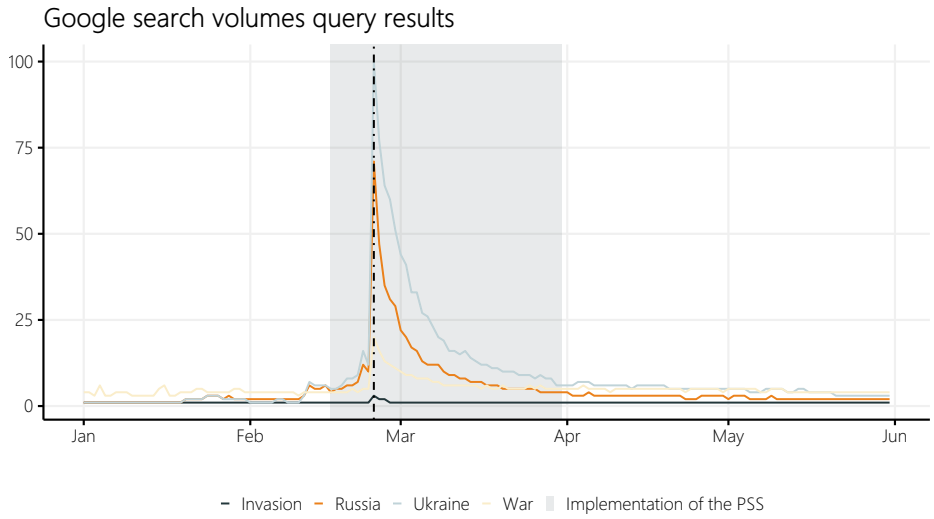

Figure B.2: Google search volumes query results for terms related to the Russian invasion of Ukraine (invasion, Russia, Ukraine, and war) worldwide from 1 January until 31 May 2022. The values indicate the search interest relative to the highest point in the diagram for the selected region in the specified period. The value 100 represents the highest popularity of the search terms. A value of 50 means that the term is half as popular, and a value of 0 means that not enough data was available for this term. The vertical line marks the Russian invasion of Ukraine on 24 February 2022. The shaded area indicates the period in which the PSS was conducted (from 16 February until 31 March 2022).

Figure B.2 displays the relative frequencies of search queries with keywords related to the war and underpins that the public did not expect the invasion before it happened on 24 February 2022. Before 24 February, virtually no search queries would hint at a war. Hence, the companies that participated in the survey before the war seem to have not foreseen the conflict and its consequences in any way.

Aside from the unpredictability of the war, the identification strategy in Equation (1) relies on the assumption that the timing of firms' participation in the survey (i.e., whether they answered the questionnaire before or after the Russian invasion on 24 February) is as good as random. This assumption is called the *ignorability* assumption. I test this by estimating a logit model in which the dependent variable is a dummy variable that takes the value 1 for firms that participated in the survey after the outbreak of the

war and 0 otherwise, and in which the regressors include various firms characteristics (size, sector, region, and language). Table B.1 shows that none of these controls are statistically significant.

Table B.1: Verification of the ignorability assumption

	Treated firms
Firm size	
Medium	0.159 (0.118)
Large	0.204 (0.173)
Sector	
Electricity, gas and steam supply	0.038 (0.379)
Water supply	0.193 (0.644)
Construction	0.125 (0.246)
Wholesale and retail trade	−0.107 (0.143)
Transportation and storage	0.213 (0.270)
Accommodation and food service act.	0.032 (0.368)
Information and communication	0.473 (0.316)
Financial and insurance act.	0.264 (0.254)
Real estate act.	1.214 (0.790)
Professional, scientific and technical act.	−0.020 (0.217)
Administrative and support service act.	−0.445 (0.343)
Education	0.830 (0.530)
Human health and social work act.	0.139 (0.249)
Arts, entertainment and recreation	0.300 (0.344)
Other service act.	−0.155 (0.354)
Region	
Espace Mittelland	0.284 (0.264)
North-West Switzerland	0.178 (0.334)
Zurich	0.142 (0.321)
Eastern Switzerland	0.113 (0.324)
Central Switzerland	−0.048 (0.336)
Ticino	0.147 (0.961)
Language	
French	0.250 (0.262)
Italian	0.483 (0.892)
Constant	−0.043 (0.319)
Observations	1,528
Log Likelihood	−1,030.151
Akaike Inf. Crit.	2,112.303
Note:	*p<0.1; **p<0.05; ***p<0.01

C Results

This appendix refers to Section 4 in the main body of the paper and provides additional results.

Figure C.1 shows the frequency of consumer and producer price changes in levels. The upper panels show the frequency of all price changes, while the lower panels distinguish between the frequency of price increases and decreases.

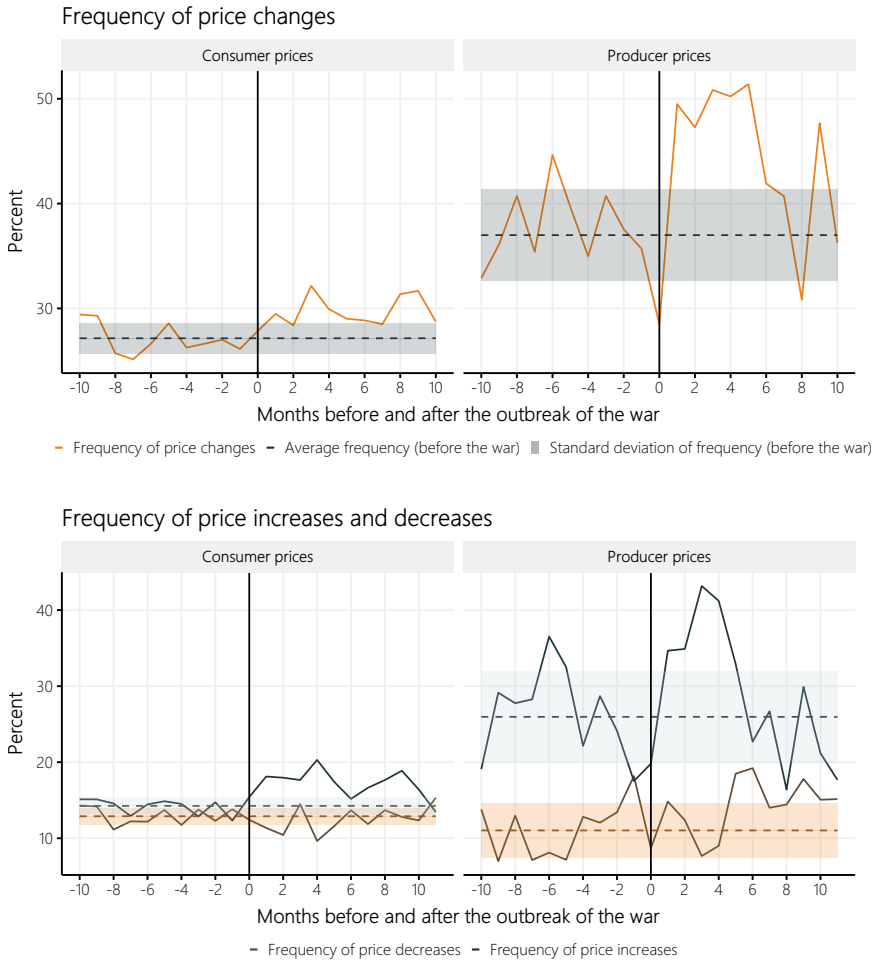

Figure C.1: Frequency of consumer (in the left panels) and producer price changes (in the right panels) in the months before and after the outbreak of the war. The upper panels show the frequency of all price changes, while the lower panels distinguish between the frequency of price increases and decreases. The figure shows the average frequency of price changes in percent (solid lines) and the average frequency of price changes in the ten months before the war (dashed lines) together with the one-standard deviation from it (filled area). The origin is the last price collection before the outbreak of the war (solid vertical line). For prices of monthly collected categories, this is February 2022.

Figure C.2 shows the point estimates from the event study model estimated separately for the frequency of price increases and the frequency of price decreases.

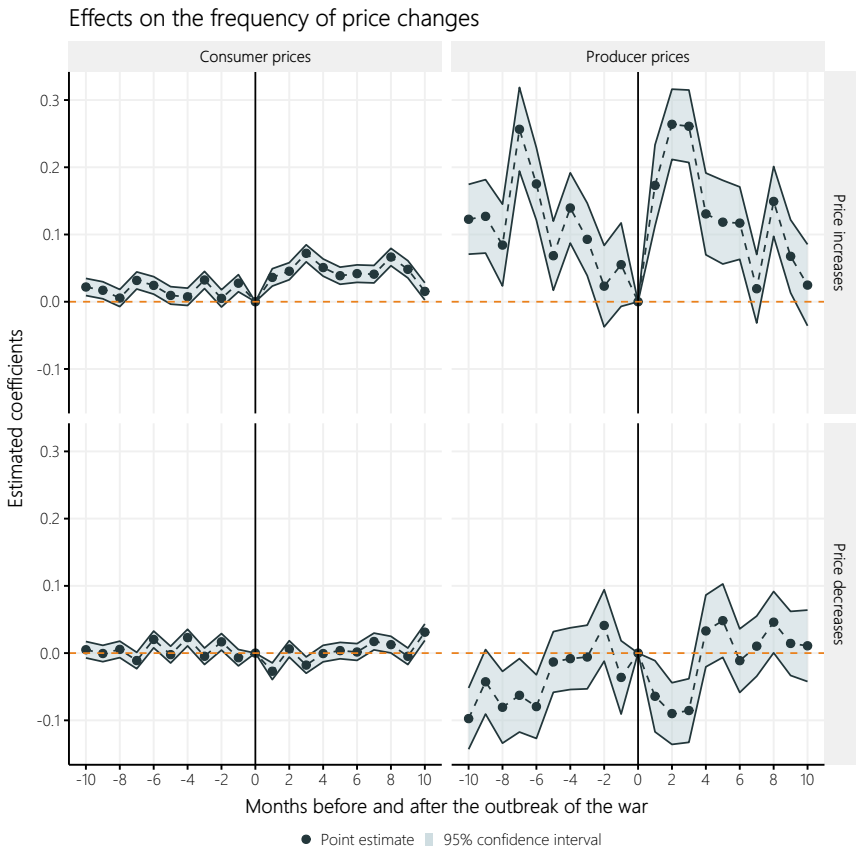

Figure C.2: Effects of the outbreak of the war on the frequency of consumer (in the left panels) and producer (in the right panels) price increases (in the upper panels) and price decreases (in the lower panels) estimated with the event study model described in Equation (2). The figure shows point estimates together with their 95% confidence intervals (filled area) over the event-time path. The (omitted) base period is the last price collection before the outbreak of the war (solid vertical line). For prices of monthly collected categories, this is February 2022.

Figure C.3 shows the size of consumer and producer price changes in levels. The upper panels show the (absolute) size of all price changes, while the lower panels distinguish between the size of price increases and the absolute size of price decreases.

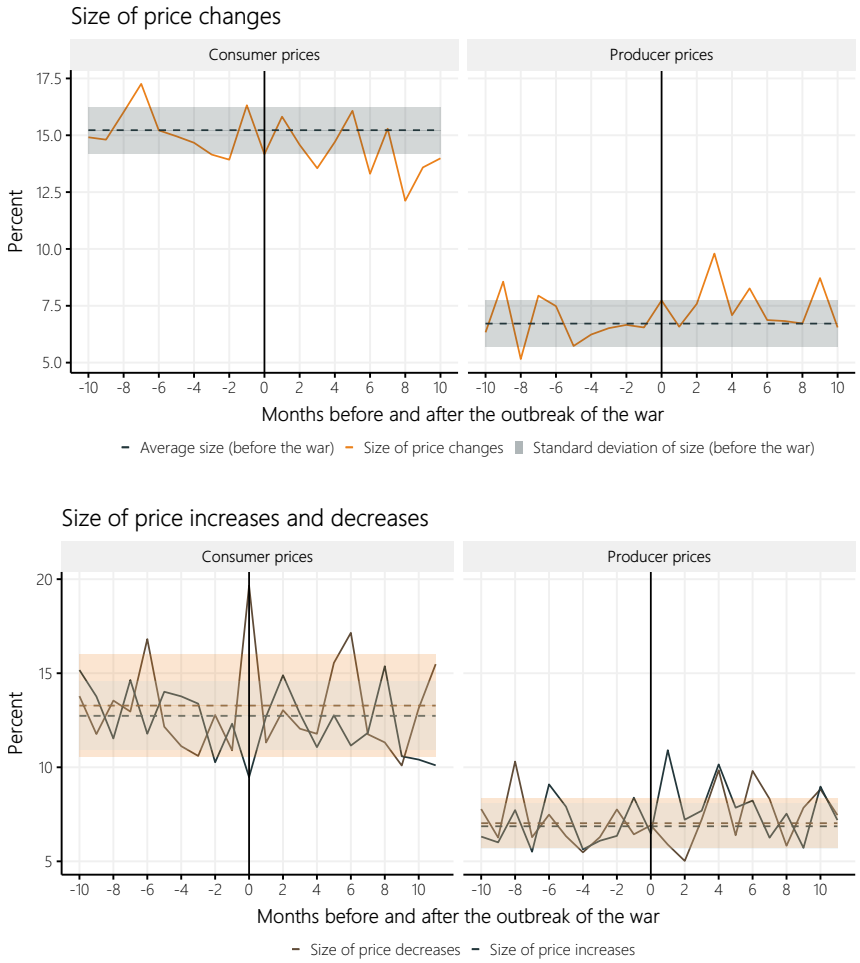

Figure C.3: Size of consumer (in the left panels) and producer price changes (in the right panels) in the months before and after the outbreak of the war. The upper panels show the (absolute) size of all price changes, while the lower panels distinguish between the size of price increases and the absolute size of price decreases. The figure shows the average size of price changes in percent (solid lines) and the average size of price changes in the ten months before the war (dashed lines) together with the one-standard deviation from it (filled area). The origin is the last price collection before the outbreak of the war (solid vertical line). For prices of monthly collected categories, this is February 2022.

Figure C.4 shows estimates from the event study model estimated with the (absolute) size of price changes.

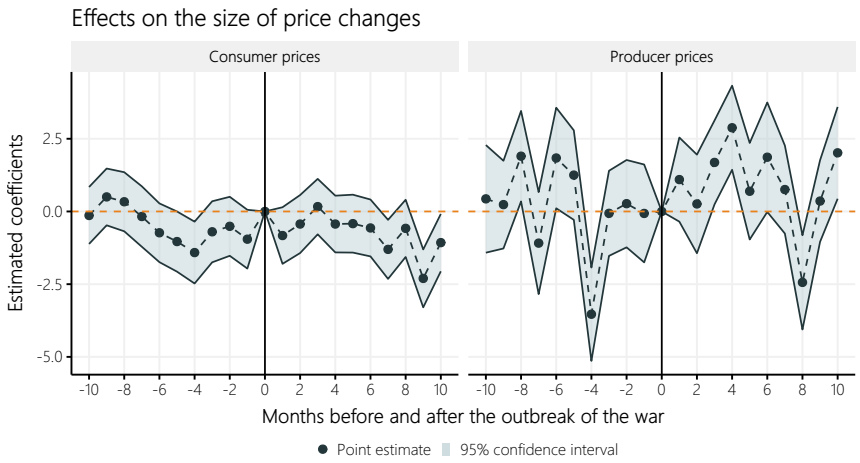

Figure C.4: Effects of the outbreak of the war on the absolute size of consumer (in the left panel) and producer price changes (in the right panel) estimated with the event study model described in Equation (2). The figure shows point estimates together with their 95% confidence intervals (filled area) over the event-time path. The (omitted) base period is the last price collection before the outbreak of the war (solid vertical line). For prices of monthly collected categories, this is February 2022.

Figure C.5 show estimates from the event study model estimated separately for the size of price increases and the (absolute) size of price decreases.

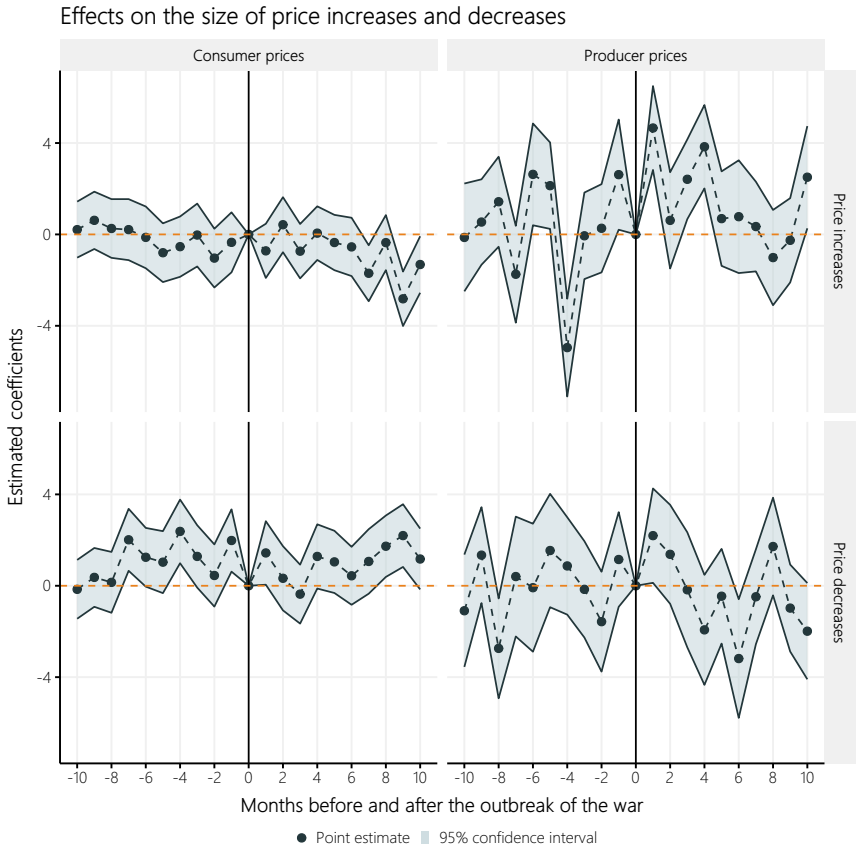

Figure C.5: Effects of the outbreak of the war on the size of consumer (in the left panels) and producer (in the right panels) price increases (in the upper panels) and absolute price decreases (in the lower panels) estimated with the event study model described in Equation (2). The figure shows point estimates together with their 95% confidence intervals (filled area) over the event-time path. The (omitted) base period is the last price collection before the outbreak of the war (solid vertical line). For prices of monthly collected categories, this is February 2022.

Figure C.6 shows the age of adjusted prices in months.

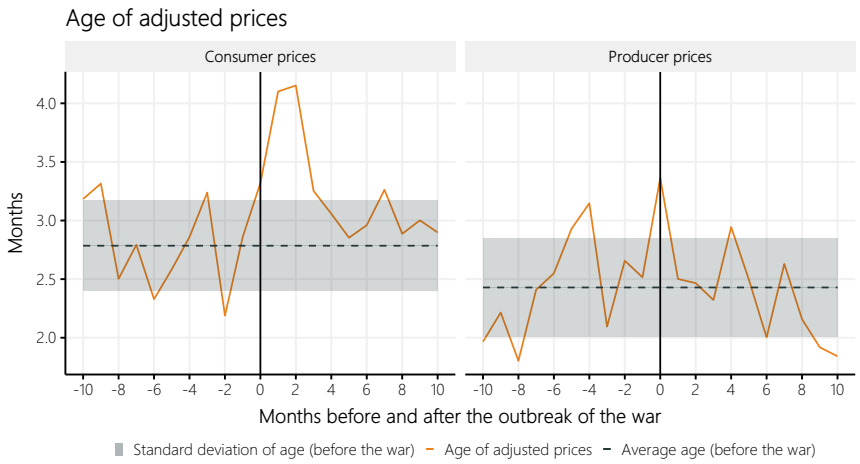

Figure C.6: Average of consumer (in the left panels) and producer prices (in the right panels) at the time of price adjustment in the months before and after the outbreak of the war. The figure shows the average age of adjusted prices in months (solid lines) and the average age in the ten months before the war (dashed lines) together with the one-standard deviation from it (filled area). The origin is the last price collection before the outbreak of the war (solid vertical line). For prices of monthly collected categories, this is February 2022.

The war shifted the importance of various rules used by firms for calculating prices. The PSS asks companies to rate each of these rules on how applicable they are to the way they price their main product or service on a scale ranging from fully applicable [2] to rather applicable [1] and rather inapplicable [-1] to fully inapplicable [-2]. The rules in question are:

Q7 *Rule of thumb.* We determine our price using rules of thumb (e.g., indexation to the national Consumer Price Index).

Q8 *Mark-up.* We determine our price by adding a constant mark-up on calculated unit costs.

Q9 *Competitors.* We determine our price by considering the prices of our competitors.

Q10 *Perceived value.* We determine our price by considering demand and the perceived value customers derive from purchasing our main product or service.

Table C.1: Effects of the war on firms' price calculation

	Dependent variable:			
	Rule of thumb Q7	Mark-up Q8	Competitors Q9	Perceived value Q10
T_1	−0.290	−0.148	0.409	0.249
	(0.131)	(0.251)	(0.194)	(0.280)
T_2	−0.103	−0.080	−0.007	−0.048
	(0.163)	(0.181)	(0.148)	(0.176)
T_3	−0.002	−0.221	0.142	−0.257
	(0.206)	(0.254)	(0.157)	(0.215)
γ	1.017	0.955	−1.785	0.267
	(0.247)	(1.078)	(0.605)	(0.707)
Size FE	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes
Canton FE	Yes	Yes	Yes	Yes
Observations	1,480	1,479	1,482	1,464

Table C.1 reports the estimation results. The conflict prompted companies to take greater account of their competitors' prices when setting their own prices. This rule is significantly more applicable to price calculation immediately after the outbreak of war, which is likely related to the increased uncertainty in this first period. Companies needed time to reflect on the consequence of the war on their prices and wanted to avoid being the first or only to rush ahead with price changes. For this reason, they may have increasingly coordinated their price changes with those of their competitors. Such *wait-and-see* behavior is also consistent with the impact of the war on the frequency of price changes, which shows an increase only from week two onward.

While the war had no significant effect on the importance of mark-up and value pricing rules, the conflict made firms less inclined to apply rule-of-thumb pricing. Their loss of

importance can be explained by the fact that companies quickly recognized that the war would affect their prices through the cost channel. Since higher costs, such as increased energy prices, are comparatively easy to quantify, companies had to rely less on rules of thumb to determine their prices.