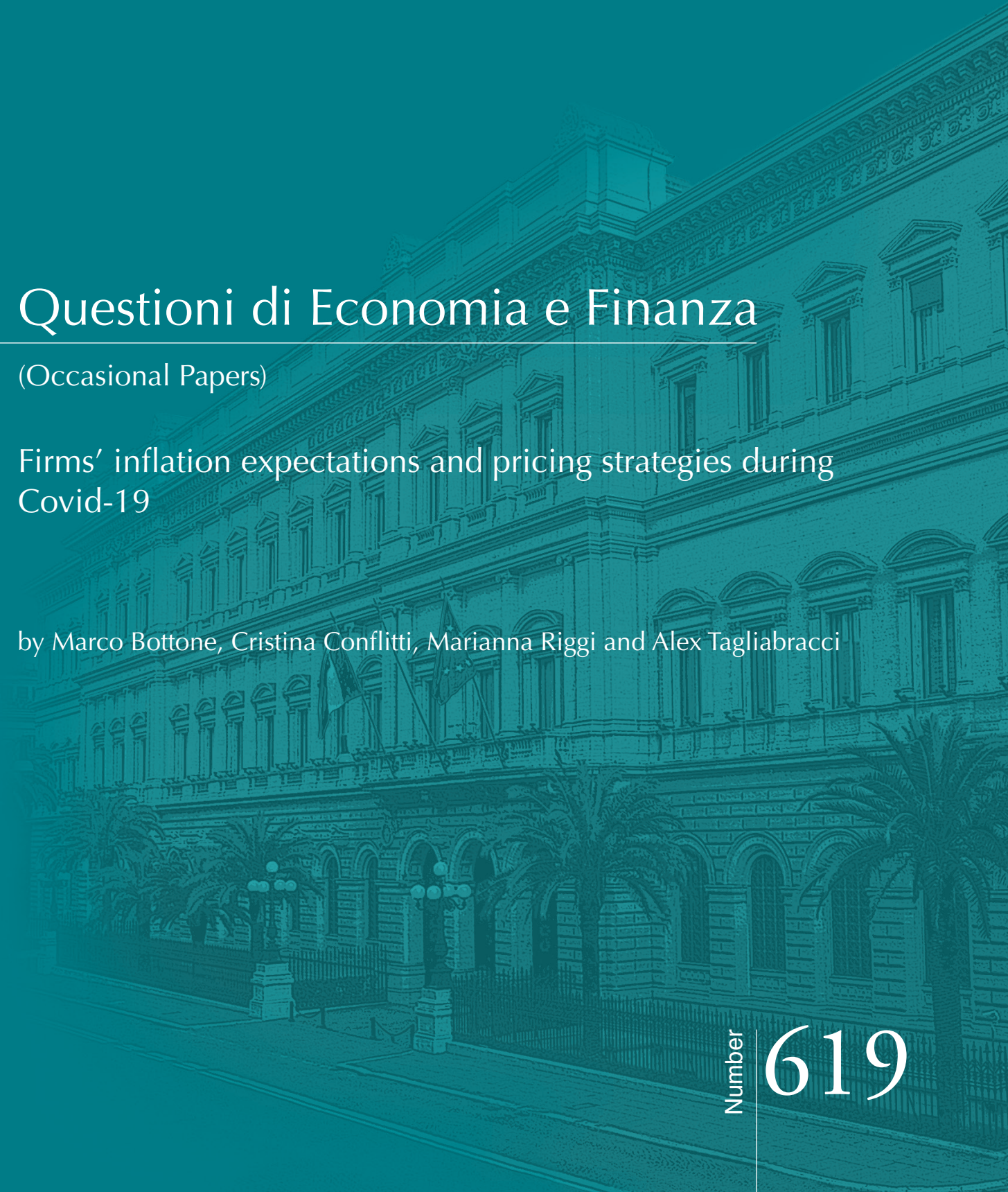
BANCA D'ITALIA
EUROSISTEMA

# Questioni di Economia e Finanza

(Occasional Papers)

## Firms' inflation expectations and pricing strategies during Covid-19

by Marco Bottone, Cristina Conflitti, Marianna Riggi and Alex Tagliabracci



June 2021

Number 619

BANCA D'ITALIA
EUROSISTEMA

# Questioni di Economia e Finanza

(Occasional Papers)

## Firms' inflation expectations and pricing strategies during Covid-19

by Marco Bottone, Cristina Conflitti, Marianna Riggi and Alex Tagliabracci

Number 619 – June 2021

*The series* Occasional Papers *presents studies and documents on issues pertaining to the institutional tasks of the Bank of Italy and the Eurosystem. The* Occasional Papers *appear alongside the* Working Papers *series which are specifically aimed at providing original contributions to economic research.*

*The* Occasional Papers *include studies conducted within the Bank of Italy, sometimes in cooperation with the Eurosystem or other institutions. The views expressed in the studies are those of the authors and do not involve the responsibility of the institutions to which they belong.*

*The series is available online at www.bancaditalia.it .*

ISSN 1972-6627 (print)
ISSN 1972-6643 (online)

*Printed by the Printing and Publishing Division of the Bank of Italy*

# FIRMS' INFLATION EXPECTATIONS AND PRICING STRATEGIES DURING COVID-19

by Marco Bottone*, Cristina Conflitti*, Marianna Riggi* and Alex Tagliabracci*

**Abstract**

We use the Bank of Italy's Survey on Inflation and Growth Expectations to explore how the COVID-19 shock affects firms' pricing policies and their inflation expectations. We find that the longer the time deemed necessary to return to their normal business levels and the greater the attention they pay to their competitors' pricing policies, the more likely firms are to reduce their own product prices. Moreover, firms' inflation expectations react to the expected persistence of the macroeconomic effects of the shock. We rationalize this evidence through the lens of a general equilibrium model.

**JEL Classification**: E2, E31, E32, I10.
**Keywords**: Covid-19, firms' inflation expectations, firms' pricing strategies, survey data.
**DOI:** 10.32057/0.QEF.2021.619

## Contents



* Bank of Italy, Directorate General for Economics, Statistics and Research.

# 1 Introduction

The Covid-19 shock is unprecedented in origin and impact. Seen through the lens of macroeconomics, the spread of the epidemic and the measures adopted to counter it have determined an unusual and simultaneous sharp fall in both supply and demand. Scholars have debated extensively about the impact of this shock on firms' pricing behaviour, which is difficult to predict for the reasons outlined above, yet of utmost importance as Covid-19 struck the economy in a persistently low inflation environment.

So far this debate has focused on the prevalence of the demand versus supply channels or on the ties between them (Baqaee and Farhi, 2020, Bekaert et al., 2020 Brinca et al., 2020, del Rio-Chanona et al., 2020). A theory of Keynesian supply shocks has emerged (Guerrieri et al., 2020), where temporary supply shortages trigger changes in aggregate demand that are larger than the shocks themselves. Empirical evidence to gauge directly how firms perceived this type of shock and its immediate impact on their expectations and pricing policies is scarce, reflecting the lack of data on firms' behaviour and expectations. Two exceptions are Balleer et al., 2020 on German firm-level survey data and Balduzzi et al., 2020 on Italian firms.[1]

In this paper we provide a full characterization of the impact of the Covid-19 shock on firms' pricing behaviour by using a unique dataset based on ad hoc questions included in the quarterly Bank of Italy's Survey on Inflation and Growth Expectations (SIGE hereafter) starting with the wave carried out in March 2020.[2] Firms were asked to identify the main channels, operating from demand or supply sides, through which the spread of the coronavirus affected their outlook. Moreover, a direct measure of the perceived persistence of the Covid-19 shock on firms' own activity is also available, as firms were asked how many months would be needed to return to their pre-epidemic business levels. Finally, the survey collated in December 2020 included a measure of the expected aggregate persistence of the shock, proxied by the number of months deemed necessary for the general economic situation to return to normality. In order to explore the drivers of firms' inflation expectations and pricing policies, we combine these answers with the broad array of SIGE standard questions, which include, among others, the importance

*The views expressed in this article are those of the authors alone and do not necessarily represent the positions of the Bank of Italy or of the Eurosystem.* We would like to thank Silvia Fabiani, Andrea Neri, Stefano Neri, Alfonso Rosolia, Sergio Santoro, Giordano Zevi and Roberta Zizza for their useful comments at different stages of this work. All the remaining errors are ours.

[1] Balduzzi et al., 2020 exploit survey data collected between March and April 2020 on Italian firms in the manufacturing and production service sectors, as a special supplement to the Monitoraggio Economia e Territorio (MET) survey, which was completed by mid-January 2020. See Section 5.1 for further details.

[2] As we clarify in Section 2, the survey addresses firms in industry, non-financial private services and construction (since 2013) with 50 or more workers, for a total of more than 1,000 firms.

placed by firms on their competitors' strategies for setting their own prices.

A number of interesting results emerge. The demand-supply narrative is not that relevant for firms' inflation expectations and pricing strategies. The great majority of firms perceive Covid-19 as a demand shock: fewer than 10 per cent see it as a supply shock across different survey rounds. However, these different perspectives on the downturn do not significantly affect firms' inflation expectations, nor do they influence expected changes in firms own product prices. Instead, two other factors shape the direction of planned price changes. First, it is the expected duration of the downturn on firms' own business activity that is the key driver of their pricing decisions: both supply- and demand-affected firms are more likely to plan a decrease in their own prices when the time needed to return to normality gets longer. Second, competitive pressures, measured by the importance given to pricing policies of competitors for setting firms' own prices, are the other crucial determinant of firms' pricing plans. Regardless of other factors, the more firms pay attention to the pricing policies of their competitors, the more likely they are to lower their prices.

Concerning firms' expectations on consumer inflation, none of these cited factors end up guiding them to a significant extent, at any horizon. This 'non-result' suggests that firms do not consider themselves as pivotal for inflation dynamics: factors that instead affect - very significantly - their own pricing policies are considered as completely uninfluential for future inflation developments. Indeed, unlike what happened during the Great Recession and the sovereign debt crisis, after the pandemic crisis firms did not change their inflation expectations in the same direction: in our sample, half of the firms revised their inflation expectations upwards and half downwards.[3] This suggests that, faced with the outbreak of the pandemic, firms were feeling as uncertain as academics, markets and analysts as to whether the coronavirus would end up being deflationary or inflationary. To many market observers, the investment community had never seemed so divided, grappling with the risks of both deflation and high inflation and paying up to protect against extreme scenarios at both ends of the spectrum. Our findings suggest that the same 'inflation confusion' pervaded entrepreneurs' views as well.[4] The information treatment, i.e. the information about recent inflation figures given to a randomly chosen subset of firms, is the most significant determinant of firms' inflation expectations.[5] On

[3]In Section 5 we exploit the length of the survey to compare the responses to the three recent large crises from the perspective of firms' inflation expectations, showing that the latter were revised negatively in 2008 and positively in 2011.

[4]For instance, on 24th August 2020 the Financial Times carried an article titled "*Divided investors caught in inflation confusion*", see `https://www.ft.com/content/672e69b7-d069-4c97-b86c-6e1ba36ece87`.

[5]This is a robust result of the literature based on SIGE, see Bartiloro et al., 2019, Conflitti and Zizza, 2020 and Coibion et al., 2020.

top of that, the aggregate persistence of the Covid-19 crisis (measured as the expected number of months needed for the general economic situation to return to pre-epidemic levels) has a negative impact on firms' inflation expectations.

We rationalize our empirical findings through a general equilibrium model. Our goal is to build the simplest model able to shed light on the rationale behind the key forces identified in our empirical analysis and to show the aggregate impact of these drivers on inflation dynamics.With this aim, the model has the following features.

First, we consider an economy on a balanced growth path hit by an unexpected shock that renders some of its capital stock unproductive. We see the assumption of an exogenous stochastic capital depreciation rate as particularly suited to stylize the current crisis in a macroeconomic model, embracing the reading that Ambler and Paquet, 1994 gave to this disturbance. They were the first to study its business cycle properties[6], arguing that it could represent natural disasters, or more generally weather conditions, with an impact on the stock of productive capital: this shock interrupts the process by which investment goods become productive capital.[7] To study the role of the expected duration of the Covid-induced downturn, we analyse the reaction to this shock conditional on different degrees of its persistence. At one more favourable extreme, the shock is a white noise, as is typically assumed in the literature on rare disasters (Ambler and Paquet, 1994 and Barro, 2006, 2009, Cantelmo, 2020): it renders part of the capital stock unproductive, but it is a one-off event such that the economy thereafter returns to a balanced growth path. In the case of a persistent shock, all the resources devoted to capital formation persistently prove to be unproductive at a higher rate than usual.[8]

Second, we model the relevance of competitive pressures by resorting to 'deep-habit' formation (Ravn et al., 2006): agents form habits from the consumption of individual goods, rather than from their overall consumption levels as in more standard models. Put simply, consumers' choices between different brands of goods (differentiated goods) are affected positively by past brand choices. This is akin to assuming 'customer-market', where depending on relative prices there is a gradual substitution between differentiated goods rather than discrete switches among suppliers. A higher degree of 'deep-habit' means a high relevance of the price-inelastic component of consumers' demand function and, hence, less importance given by firms to their competitors' prices. This allows us to study the implications of one of our key findings i.e. the extent to which firms pay

[6]Ambler and Paquet, 1994 introduce stochastic depreciation shocks into a real business cycle model. As a consequence they cannot study the implications for inflation, while focusing on the correlation between hours and productivity conditional on these types of shocks.

[7]See Section 4 for a discussion on the rationale behind using this shock to stylize the current crisis.

[8]Furlanetto and Seneca, 2014 state that it is difficult to interpret 'capital depreciation shocks' as natural disasters when they are modelled as persistent disturbances. Yet epidemic shocks are peculiar in this respect, as they have a certain degree of intrinsic persistence.

attention to competitors' pricing policies matters for their pricing response to the Covid-shock.

Third, to capture the dependence of firms' inflation expectations on past inflation that we find in the empirical analysis, we depart from fully-forward-looking expectations and allow expectations to depend, to a certain extent, on lagged inflation. At one extreme, we have rational, forward-looking, expectations. At the other extreme, the model collapses to adaptive expectations. This allows us to trace the implications of alternative expectations' formation mechanisms.

In an economy with these characteristics, a capital depreciation shock entails a sizeable decrease in consumption that goes hand-in-hand with a sharp drop in GDP and investment. Yet, the sign of firms' pricing policies crucially depends on the weight firms place on their competitors' prices and on the expected persistence of the shock, in accordance with our empirical findings. The reason is that the interplay between these two features – persistence and competitive pressures - affects the trade-off between the benefit and cost of raising prices. Following a contractionary shock, the benefit to firms of a unit increase in their price is given by the increase in revenue stemming from selling all intra-marginal units at the higher price. The cost is the decline in demand that the price rise induces and that, given deep habit, also has an inter-temporal effect, as a decline in the current demand for a firm's goods reduces the customer base in the future as well. The higher the share of demand that does not depend on how a firm's prices compares to those of its competitors (as it is just inherited by the firm from its past sales) the larger the increase in current revenue stemming from selling at the higher prices, the more likely it is that firms will increase their prices. Yet, if the contractionary shock hits persistently, it exogenously erodes the customer base in a sharper and more persistent way and hence the current benefit of higher prices, leading symmetrically to a larger increase in the value of future demand. Indeed, further into the future the expected recovery in the productive capital stock is, the sharper the contraction in investment, consumption and GDP in the initial periods as well. Hence, when the recession is expected to be very persistent, firms resolve the trade-off between the cost of throwing away current and future demand and the benefit of increasing prices - exploiting its own customer base - in favour of the former, even when the price-inelastic component of consumers' demand is high.[9] The inflation

[9]This result might be read as being in contrast with the findings in Duca et al., 2018 that in the face of a drop in demand, the likelihood of increasing markups is higher when a low state of demand is expected to persist. The reason for this difference is that in Duca et al., 2018 the shock's persistence does not change the magnitude of the current decrease in demand, since there is a two periods model where in each period the realization of demand can be exogenously high or low, and does not depend on agents' behaviour and expectations. This framework is indeed useful for studying the role of liquidity constraints for a firm's likelihood to survive. Here, instead, the longer the shock is expected to persist, the larger the contraction in demand in the initial periods as well, since ours is a general equilibrium model where forward-looking households smooth their consumption patterns.

response depends crucially on these two features. Moreover, the more firms' inflation expectations depend on recent inflation realizations, rather than being forward looking, the more persistent the response will be.

Our paper is organized as follows. Section 2 provides a descriptive overview of our dataset. Section 3 presents our empirical results. Section 4 interprets these findings through the lens of a theoretical model. Section 5 offers additional results on the role of liquidity and financial conditions and compares the effects of the Covid-19 pandemics to those associated with previous recession episodes. Section 6 concludes.

**Related literature.** Our paper contributes to the recent studies on firms' pricing behaviour amidst the Covid-19 shock and, on a broader perspective, it fits in the literature on firms' inflation expectations and pricing policies. As mentioned above, two papers provide empirical evidence based on micro data on how firms' prices react to the spread of the epidemic. With German firm-level survey data, Balleer et al., 2020 argue that supply and demand forces coexist, but demand shortages dominate in the short run, as a reported negative impact of Covid-19 on current business is associated with a rise in the probability to decrease prices up to eleven percentage points. On this respect, the main advantage of our questionnaire is that we directly ask firms whether channels operating from the demand or supply sides mainly affect them.

Balduzzi et al., 2020 exploit a special supplement to the Italian Monitoraggio Economia e Territorio (MET) survey, collected two weeks after the implementation of the first lockdown policies. They argue that credit constraints play a key role in the transmission mechanism of the Covid-shock. They draw this conclusion because most firms revised downward their expectations for sales, employment, and investment, while prices are expected to increase at a faster rate, with credit-constrained firms expecting to charge higher prices, relative to unconstrained firms. The importance of liquidity constraints was one of the main arguments put forward in the literature to explain the missing disinflation puzzle during the great financial crisis (see e.g. Gilchrist et al., 2017 and Duca et al., 2018). Financial constraints would lead firms to raise prices in response to adverse shocks, reflecting the need to preserve internal liquidity and avoid accessing external finance. In turn, this would attenuate the response of inflation to fluctuations in output. Our results suggest that this time is very different: as a robustness check we test whether liquidity constraints affect firms' planned prices and their inflation expectations during the epidemic and we find no effects. This suggests that the unprecedented fiscal and monetary measures were likely effective in providing the adequate support during the current crisis: as the pandemic unfolds liquidity and financial conditions have not been a

major concern thanks to the massive stimuli implemented.[10]

Survey-based measures of firms' inflation expectations are very scarce, despite their importance in driving firms' pricing strategies and thus the forward component of the Phillips curve. In this context SIGE stands out as a unique firm-level dataset. Previous research based on SIGE suggests that firms' expectations are influenced by the monetary policy stance (Bottone and Rosolia, 2019), by news about current inflation (Bartiloro et al., 2019 and Conflitti and Zizza, 2020 among others), by wage increases set by contract renewals and by the prices of raw materials (Conflitti and Zizza, 2020). The evidence based on SIGE on the role of firms' inflation expectations in driving agents' economic choices is more controversial. Coibion et al., 2020 conclude that Italian firms with higher inflation expectations raise prices and reduce employment and capital more than those with lower expectations.[11] These findings support a stagflationary view of inflation (as in Candia et al., 2020). By contrast, using a period-by-period analysis rather than a panel regression, Rosolia, 2020 does not find a significant causal effect of inflation expectations on price decisions. Cecchetti et al., 2021 provide a comprehensive review of the literature based on SIGE data.

# 2 Survey design and Covid-19 special questions

## 2.1 SIGE in the Italian epidemic context

The Survey on Inflation and Growth Expectations (SIGE) is a business survey run by the Bank of Italy since 1999 on a quarterly basis (in March, June, September and December), on a sample of industrial and non-financial private services firms, with at least 50 employees and administrative headquarters in Italy.[12] The sample is stratified by sector of economic activity (industry, non-financial private services and construction), geographical area (North-west, North-east, Center, and South and Islands), and number of employees (50–199, 200–999, 1,000 and over), reaching, in recent years, a total of about 1,200 sampled firms per wave (on average 500 in industry excluding construction, 500 in

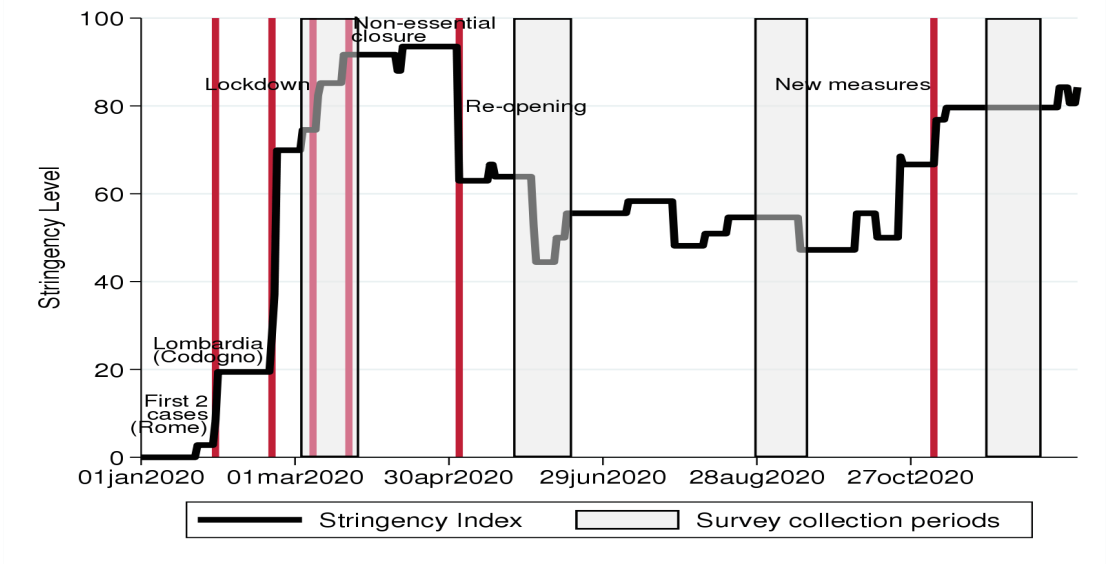
[10] De Socio et al., 2020 analyse more in details the financial conditions of Italian firms during 2020. They show that the main support measures enacted by the Italian Government between March and August were effective for Italian businesses since they avoided liquidity shortfall and guaranteed more direct access to new loans, including those with public guarantees.

[11] Focusing solely on the period of effective lower bound (ELB) on policy interest rates, following the start of the Great Recession, the effects of inflation expectations on prices and credit utilization are stronger, while those on employment and capital disappear. This is consistent with firms perceiving a stronger demand-side channel of inflation at the ELB, in line with the predictions of New Keynesian models at the ELB.

[12] The following categories are excluded from the survey: financial intermediaries and insurance companies, general government and the educational and healthcare sectors as well as other community, social and personal services.

non-financial private services, and 200 in construction).[13]

**Figure 1:** Level of government restrictions in Italy during 2020




*Source*: Oxford Covid-19 Government Response Tracker, `https://covidtracker.bsg.ox.ac.uk/`.

Our analysis is based on the surveys conducted in March, June, September and December 2020, which collected the assessments and the expectations of firms during different moments along the development of the pandemic in Italy. Figure 1 shows the fields of the survey together with an index of the government measures taken to deal with the emergency. The March wave was conducted immediately after the outbreak of the Covid-19 epidemic in Italy and the adoption of the restrictive measures to contain the contagion, while the June and September waves were conducted in a period of relative improvement in the epidemic conditions and reopening of productive activities.

The constraints imposed by the pandemic led to a lower participation in the survey, especially in the March 2020 wave, when the ratio between contacted and participants (i.e. the response rate) almost halved compared to the average of March/December 2019 (Table 1). The response rate recovered significantly thereafter, reaching a level only marginally lower than the average of the previous years. However, it is worth noting that the Covid-19 epidemic was not reflected in a significant drop in the number of units interviewed. Indeed compared to the average of the previous year, the total number of interviewed firms decreased only slightly in March, while it increased in the following waves, thanks to the decision (taken before the outbreak of the epidemic) of extending the sample size since March 2020. Moreover, the lower response rate between March and December 2020 was not systematic, meaning that the distribution of firms within the sample strata remained homogeneous. All in all, during the epidemic the survey continued to cover all the strata

[13]Full details about the survey can be found in Bank of Italy, 2017.

**Table 1:** Response rate, sample size and distribution within strata (per cent)

| | Response rates | | | | | Universe and Sample size | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mar-Dec19 | Mar | Jun | Sep | Dec | Univ. | Mar-Dec19 | Mar | Jun | Sep | Dec |
| **Number of employees** | | | | | | | | | | | |
| 50-199 | 47.2 | 25.3 | 41.2 | 43.0 | 33.2 | 81.4 | 58.2 | 56.3 | 58.9 | 59.4 | 62.4 |
| 200-999 | 54.7 | 31.7 | 46.0 | 46.7 | 43.8 | 16.0 | 30.0 | 32.7 | 30.7 | 30.1 | 29.0 |
| Over 999 | 61.1 | 36.1 | 51.8 | 53.7 | 53.6 | 2.5 | 11.8 | 11.1 | 10.4 | 10.5 | 8.6 |
| **Sector** | | | | | | | | | | | |
| Industry | 51.2 | 30.1 | 42.7 | 45.9 | 37.5 | 45.4 | 39.9 | 45.2 | 41.5 | 42.8 | 43.0 |
| Services | 49.9 | 26.6 | 43.1 | 43.3 | 35.3 | 49.3 | 42.9 | 41.7 | 43.6 | 42.5 | 44.7 |
| Construction | 51.9 | 26.8 | 47.3 | 48.1 | 42.6 | 5.3 | 17.2 | 13.1 | 15.0 | 14.7 | 12.3 |
| **Geographical area** | | | | | | | | | | | |
| North West | 46.3 | 23.4 | 42.9 | 44.4 | 33.1 | 38.5 | 27.8 | 23.6 | 28.1 | 28.3 | 31.6 |
| North East | 53.5 | 29.8 | 45.3 | 47.8 | 38.8 | 27.4 | 28.5 | 28.8 | 28.5 | 28.7 | 28.2 |
| Centre | 53.4 | 31.0 | 43.9 | 45.2 | 40.4 | 18.6 | 21.5 | 23.1 | 21.0 | 21.3 | 20.6 |
| South and Islands | 50.8 | 29.3 | 41.8 | 42.5 | 38.4 | 15.5 | 22.2 | 24.4 | 22.4 | 21.7 | 19.6 |
| **Total** | **50.7** | **28.1** | **43.5** | **45.0** | **37.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |
| **N** | | | | | | **23579** | **1093** | **787** | **1223** | **1260** | **1550** |

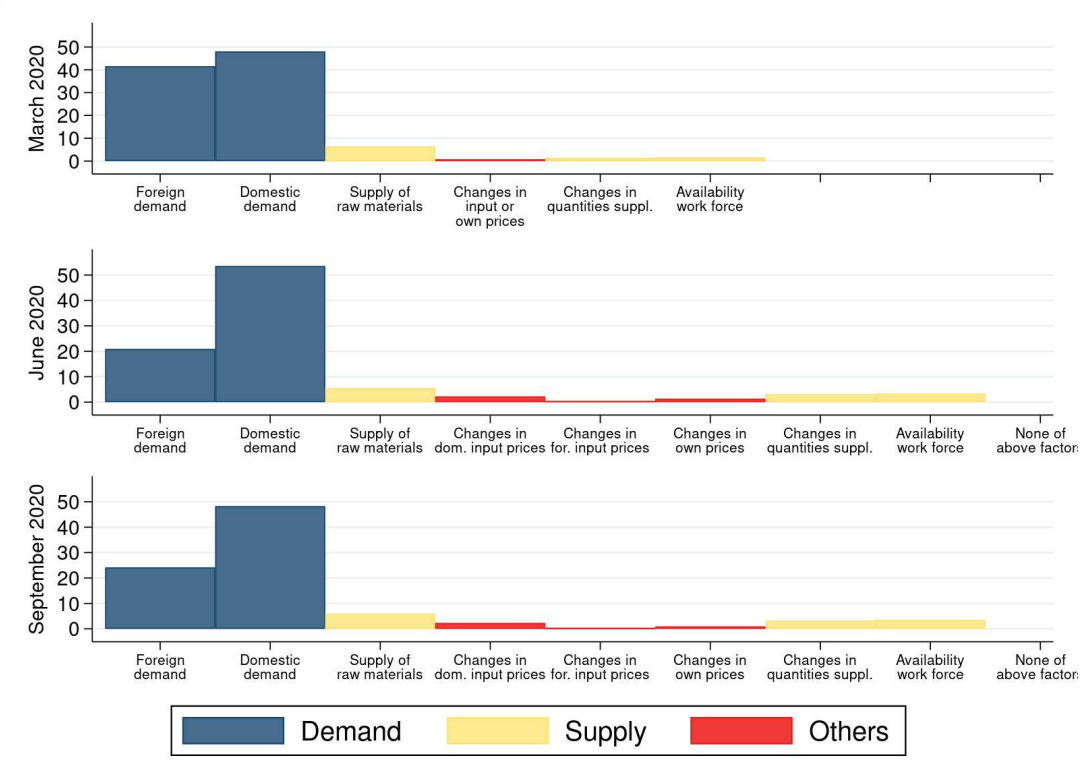
*Source*: Authors' calculations on SIGE data. *Note*: The first five columns indicate the response rate (i.e. the ratio between firms who accept to fill in the questionnaire and those contacted) in the average of the previous year (first column) and during the Covid-19 pandemic (columns 2-5). The last six columns show, for the same periods, the share and number of firms in the reference population (sixth column) and those that took part to the survey (columns 7-11).

with a sufficiently high number of firms, remaining representative of the entire target population without significantly affecting the precision of the estimates.

## 2.2 Covid-19 special questions

The SIGE questionnaire is made up of two parts, a structural one (common across surveys and amounting to about 80% of the questionnaire) and a monographic section that varies in each wave. The structural section hosts quantitative measures of firms' expected own price changes over the next twelve months and of their HICP inflation expectations over several time horizons in Italy. It also gathers qualitative opinions and expectations referred to the general economic situation and to own specific conditions. Since March 2020, the monographic part aimed at analysing the impact of the Covid-19 pandemic on Italian firms, delving into its transmission channels, the actions taken to address it and its expected duration or estimated time to return to normality (see the Appendix for a complete list of all Covid-related questions). In March, June and September 2020 firms were asked about the channels through which the epidemic affects their activity. Figure 2 shows a clear-cut result: since the very beginning of the epidemic, the majority of firms perceived it as a demand shock. This evidence remains strong over time as also shown by the June and September surveys, in which additional response options were included. Specifically, for about 50% of companies, Covid-19 has been transmitted to their business mainly through the domestic demand channel; foreign demand also played an important role, especially in the early stages of the epidemic. Finally, the share of firms perceiving

**Figure 2:** Main transmission channels for Covid-19



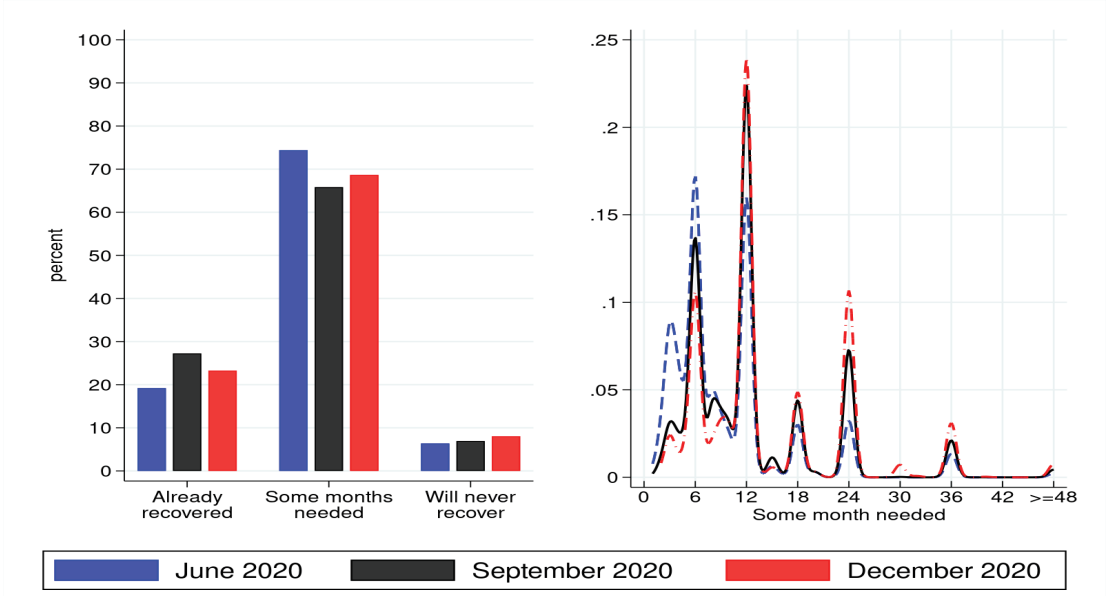

*Source*: SIGE data. Each bar represents the share of respondents for each option. Each participant could choose only one option, so the sum of the bars in each quarter adds to 100. This question was not included in the December 2020 wave.

the Covid-19 as a supply or financial shock represents only about 20% of the sample.

To shed light on the relationship between the selected transmission channel and firms' characteristics, we use a probit model where the dependent variable is constructed as a dummy that takes value 1 if the firm answered "Foreign demand" or "Domestic demand" and 0 if it answered "Supply of raw materials", "Changes in the quantities supplied" or "Availability of work force", controlling for sector, size, geography and exposure to foreign demand feature in the right-hand side. We found that the choice of "demand" as the main transmission channel is mainly relevant for industrial and service firms, while for construction firms the probability of choosing this channel drops by about 20 percentage points. This evidence could be partly affected by the composition of our sample which, as mentioned above, is made up of firms with at least 50 employees, hence disregarding small service firms such as bars, restaurants and small hotels, which could potentially have indicated "supply" as the main transmission mechanism. Also firms' size and geographical area seem not to play a crucial role, while the exposure to foreign demand slightly contributes to increase the probability of choosing the demand channel. It is worth emphasizing that these results are substantially stable over the different waves. Besides the

percentage of firms choosing demand as the main channel is similar among those whose activity could remained open and those who were forced to be closed.[14]

**Figure 3:** Perceived shock persistence




*Source*: SIGE data. Left panel shows the distribution of responses to the qualitative question on time needed to return to normality. Right panel shows the kernel distributions of the exact number of months indicated by firms answering "some months needed".

Starting with the June 2020 wave, firms have been asked the number of months they think it will take for them to return to their pre-epidemic business levels. This allows to gather a measure of expected persistence of the Covid shock on firms' own activity. Figure 3 shows that the large majority of firms perceived the Covid-19 as having persistent effects on their activity and that the average time needed to recover lengthened somewhat over time. Only a minor percentage of businesses perceived the Covid shock as having permanent effects on their own activity.

Finally, the December 2020 wave also gathered information on the persistence of the aggregate effects of the crisis on the economy, by asking firms the expected number of months needed for the general economic situation to return to its pre-epidemic levels.

[14]This phenomenon was directly measured in the June 2020 survey by means of a specific question. The results showed that in our sample about a quarter of companies were forced to be closed due to the government restrictions during the pandemic. Importantly, conditioning to this variable, the perception of the transmission channel does not vary significantly between companies, remaining the "demand channel" for more than the 80% of firms.

# 3 Empirical results

In order to identify the drivers of firms' pricing policies and inflation expectations during the pandemic, we estimate the following model for the period 2020Q1-2020Q3:

$$F_i = \alpha_i + \beta_1 D_{demand} + \beta_2 D_{infl.tr.} + \beta_3 D_{EconCond} + \beta_4 D_{Competitor} + \beta_i \mathbf{X}_i + u_i \qquad (1)$$

where $F_i$ refers to one of the following variables:

- $\pi_i^h$, the level of each firm's inflation expectations (specified for the Italian headline inflation) at horizon $h = \{6, 12, 24, 48\}$ months;
- $p_i^{12}$, the expected own price variation at a 12 month-horizon;
- $D_{inv}$, a dummy variable that takes value 1 for firms expecting an increase in the investment expenditure in the next six months;
- $D_{occ}$, a dummy variable that takes value 1 for firms expecting an increase in the employment in the next three months.

We use standard linear regression technique when the dependent variable is a price indicator and a probit regression model in the last two cases. Concerning the covariates, $D_{infl.tr.}$, $D_{EconCond}$ and $D_{Competitor}$ are dummies that respectively control for the inflation treatment received, the assessment on the general economic conditions compared to the previous quarter and the price pressure from competitors (firms are asked to indicate the direction and the intensity of the pricing policies of their main competitors in affecting their own pricing strategies over the next twelve months[15]). $\mathbf{X}_i$ includes a set of fixed effects, such as size, sector and geographical area to control for possible differences in the economic effects of the epidemics across firms' characteristics. $D_{demand}$ consists of a dummy equal to 1 if a firm answers "Foreign demand" or "Domestic demand" to indicate the channels through which the Covid-19 has affected its own outlook.[16] A priori one would expect the sign of the coefficient on $D_{demand}$ to be negative, consistently with a downward adjustment of prices and inflation expectations by firms hit by a negative demand shock. Table 2 reports our first set of findings.

First, while - as expected - the sign of the coefficient on $D_{demand}$ is negative in the regression of firms' investment and hiring decisions (pointing to a reduction in the probability to increase investment of about 13% and to augment employment of 5%), suffering Covid-19 as a demand rather than a supply shock does not exert any significant impact on firms' pricing strategies, nor on their inflation expectations.

[15] See the questionnaire reported in the Appendix for the exact wording of the questions.

[16] The same dummy equals 0 if the answer is "Supply of raw materials", "Changes in quantities suppl." or "Availability work force".

**Table 2:** Transmission channels, inflation expectations and firms strategies

| | Effect on Inflation expectations | | | | Effect on firm decision | | |
|---|---|---|---|---|---|---|---|
| | (1) $\pi^6$ | (2) $\pi^{12}$ | (3) $\pi^{24}$ | (4) $\pi^{48}$ | (5) $p^{12}$ | (6) *D_inv* | (7) *D_occ* |
| Demand channel | -0.033 | -0.013 | 0.013 | 0.075 | -0.352 | -0.127*** | -0.050* |
| | (0.78) | (0.89) | (0.87) | (0.36) | (0.16) | (0.00) | (0.03) |
| Downward pressure from competitors | -0.211* | -0.104 | 0.002 | 0.100 | -1.276*** | -0.070** | -0.038 |
| | (0.01) | (0.09) | (0.97) | (0.13) | (0.00) | (0.00) | (0.06) |
| Upward pressure from competitors | -0.170 | -0.148 | 0.008 | 0.133 | 1.581*** | -0.061 | -0.055 |
| | (0.40) | (0.25) | (0.93) | (0.27) | (0.00) | (0.14) | (0.14) |
| Worse econ. sit. | 0.147 | 0.118 | 0.090 | 0.037 | -0.186 | -0.135*** | -0.062** |
| | (0.07) | (0.14) | (0.29) | (0.64) | (0.40) | (0.00) | (0.01) |
| Better econ. sit. | -0.000 | 0.040 | 0.043 | 0.166 | 0.147 | -0.002 | 0.043 |
| | (1.00) | (0.56) | (0.59) | (0.09) | (0.64) | (0.96) | (0.08) |
| North-West | -0.219* | -0.129 | -0.130 | -0.058 | -0.506 | 0.000 | 0.008 |
| | (0.01) | (0.09) | (0.09) | (0.50) | (0.11) | (0.99) | (0.71) |
| North-East | -0.175* | -0.083 | -0.058 | -0.018 | -0.401 | 0.007 | -0.023 |
| | (0.04) | (0.33) | (0.53) | (0.84) | (0.22) | (0.79) | (0.32) |
| Central | -0.109 | -0.056 | -0.052 | -0.021 | -1.011* | 0.004 | -0.014 |
| | (0.23) | (0.52) | (0.57) | (0.83) | (0.02) | (0.89) | (0.55) |
| Inflation treatment | -0.162* | -0.259*** | -0.292*** | -0.312*** | -0.080 | -0.019 | 0.004 |
| | (0.04) | (0.00) | (0.00) | (0.00) | (0.67) | (0.31) | (0.81) |
| Constant | 0.892*** | 1.083*** | 1.018*** | 0.997*** | 0.209 | | |
| | (0.00) | (0.00) | (0.00) | (0.00) | (0.83) | | |
| Sector FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Size FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Time FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| R2 | 0.02 | 0.02 | 0.02 | 0.03 | 0.04 | 0.04 | 0.02 |
| N | 2297 | 2297 | 2297 | 2297 | 2614 | 2587 | 2604 |

P-values in parentheses. $*p < 0.05, **p < 0.01, ***p < 0.001$. *Note*: Demand channel is a dummy equal to 1 if a firm answers "Foreign demand" or "Domestic demand" to indicate the channels through which the Covid-19 has affected its own outlook. The same dummy equals 0 if the answer is "Supply of raw materials", "Changes in quantities suppl." or "Availability work force".

Second, competitive pressures (as measured by the attention to competitors' policies) come out to be the only significant driver of firms' planned price changes.

Third, when we look at inflation expectations, apart from a mildly significant negative effect on short term expectations (six months ahead) of being located in the North of Italy (where the Covid-19 hit the hardest) and of downward pressures from competitors, the only significant driver of firms' expected inflation one-year, two-year and four-year ahead is the inflation treatment, i.e. being provided with information about the most recent inflation realization. This reduces significantly inflation expectations at almost all the horizons, leaving no room for the other factors.

Starting with June 2020, firms have been asked: '*In how many months do you think your firm will be able to return to pre-epidemic business levels?*'. In order to assess whether and in which direction the expected persistence of the Covid crisis on firms' activity affects their pricing policies and inflation expectations, we estimate the model (1) replacing the dummy $D_{demand}$ with the variable "firm return to norm".[17] The exclusion of the $D_{demand}$

[17]Firms can indicate the number of months or respond that they have already returned to pre-crisis levels or believe they will never return. To use all the information, we have set the number of months

in this regression was made to make the best use of all the information available in the data. In fact, since the two questions were asked in a partially staggered manner over the year, the simultaneous use of both variables would result in a total loss of half of the observations (March and December) compared to the single regressions. However, it is important to underline that the analysis (not showed here for convenience) carried out on the portion of the year containing both variables, including their interaction, gives qualitatively and quantitatively comparable results. Furthermore, their significance is only partially reduced, probably due to the lower number of observations.

Table 3 shows the estimated coefficients. The expected persistence of the shock on

**Table 3:** Shock persistence, inflation expectations and firms strategies

| | Effect on Inflation expectations | | | | Effect on firm decision | | |
|---|---|---|---|---|---|---|---|
| | (1) $\pi^6$ | (2) $\pi^{12}$ | (3) $\pi^{24}$ | (4) $\pi^{48}$ | (5) $p^{12}$ | (6) $D\_inv$ | (7) $D\_occ$ |
| Firm ret.to norm. | -0.001 | -0.001 | -0.000 | -0.001 | -0.039*** | -0.004*** | -0.004*** |
| | (0.73) | (0.49) | (0.91) | (0.53) | (0.00) | (0.00) | (0.00) |
| Downward pressure from competitors | -0.082 | -0.057 | 0.057 | 0.067 | -0.720** | -0.086*** | -0.051** |
| | (0.20) | (0.35) | (0.35) | (0.31) | (0.00) | (0.00) | (0.00) |
| Upward pressure from competitors | -0.243 | -0.284 | -0.034 | 0.064 | 0.949 | -0.042 | -0.054* |
| | (0.14) | (0.05) | (0.69) | (0.54) | (0.17) | (0.15) | (0.03) |
| Worse econ. sit. | 0.000 | -0.009 | -0.057 | -0.061 | -0.095 | -0.085*** | -0.056*** |
| | (1.00) | (0.87) | (0.32) | (0.29) | (0.70) | (0.00) | (0.00) |
| Better econ. sit. | 0.217*** | 0.063 | 0.060 | 0.180* | 0.215 | 0.008 | 0.005 |
| | (0.00) | (0.37) | (0.38) | (0.04) | (0.43) | (0.73) | (0.81) |
| North-West | -0.096 | -0.078 | -0.078 | -0.015 | -1.022*** | 0.006 | -0.016 |
| | (0.20) | (0.28) | (0.28) | (0.85) | (0.00) | (0.75) | (0.34) |
| North-East | -0.068 | -0.016 | -0.031 | 0.068 | -0.726** | 0.007 | -0.019 |
| | (0.39) | (0.83) | (0.69) | (0.42) | (0.01) | (0.73) | (0.27) |
| Central | 0.125 | 0.107 | 0.088 | 0.117 | -0.870** | 0.012 | -0.006 |
| | (0.17) | (0.22) | (0.31) | (0.19) | (0.01) | (0.58) | (0.75) |
| Inflation treatment | -0.379*** | -0.377*** | -0.356*** | -0.349*** | -0.148 | 0.006 | 0.008 |
| | (0.00) | (0.00) | (0.00) | (0.00) | (0.45) | (0.69) | (0.49) |
| Constant | 0.793*** | 0.821*** | 0.911*** | 0.873** | -0.053 | | |
| | (0.00) | (0.00) | (0.00) | (0.00) | (0.95) | | |
| Sector FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Size FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Time FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| R2 | 0.03 | 0.07 | 0.05 | 0.03 | 0.03 | 0.06 | 0.08 |
| N | 3426 | 3426 | 3426 | 3426 | 3922 | 3889 | 3911 |

P-values in parentheses. $*p < 0.05, **p < 0.01, ***p < 0.001$.

firms' own activity comes out to be a relevant driver of firms' planned price changes: each additional month deemed as necessary to return to normality has a negative impact on the expected variation of firms' own prices. We estimate that each additional year leads to a about a 0.5 p.p. reduction in firms' own price changes over the next twelve months $(-0.039 * 12)$.[18] Importantly, downward pressures coming from competitors are confirmed as a relevant and significant driver of firms' own pricing strategies. Again, being

of those who have already returned to pre-crisis levels to be zero, while we have added one year to the maximum value observed for those who claim to never be able to return.

[18]We test for non-linear effects by including also the square of the variable "firm return to norm". The squared coefficient is not significant, suggesting that linearity is a good approximation.

informed on the last developments of inflation affects firms' inflation expectations. Note that the persistence of the negative effects of Covid-19 on firms' own business activity has a negative impact on investment and hiring policies.

The December 2020 survey introduced a question aimed at measuring the expected duration of the aggregate effect of the Covid-19 epidemic, as opposed to the expected persistence on firms' own activity. Table 4 reports the results obtained by estimating the model (1), for inflation expectations and own prices, using both measures of the shock persistence (i.e. the expected duration of the effects on firm's own activity and on the general economic situation) other then all the other variables already used in the previous regressions except from $D_{demand}$, which was not included in the December survey. The results show that while the persistence of the shock at firm level correlates with an expected decrease in firms' own product prices, the one referred to the economy as a whole correlates with a reduction, albeit less marked, in inflation expectations over all time horizons except the shorter one.

**Table 4:** Effect of firm specific and general persistence of the shock

| | (1) $\pi^6$ | (2) $\pi^{12}$ | (3) $\pi^{24}$ | (4) $\pi^{48}$ | (5) $p^{12}$ |
|---|---|---|---|---|---|
| Gen. ret.to norm. | -0.002 | -0.005* | -0.004* | -0.007** | 0.018 |
| | (0.39) | (0.04) | (0.05) | (0.01) | (0.59) |
| Firm ret.to norm. | -0.001 | -0.003 | -0.002 | -0.002 | -0.085* |
| | (0.61) | (0.24) | (0.44) | (0.31) | (0.04) |
| Constant | 0.476 | 0.334 | 0.583 | 1.026* | -3.738 |
| | (0.18) | (0.38) | (0.12) | (0.02) | (0.13) |
| Sector | Yes | Yes | Yes | Yes | Yes |
| Size | Yes | Yes | Yes | Yes | Yes |
| Geographical Area | Yes | Yes | Yes | Yes | Yes |
| Infl. treatment | Yes | Yes | Yes | Yes | Yes |
| R2 | 0.08 | 0.07 | 0.06 | 0.04 | 0.05 |
| N | 1311 | 1311 | 1311 | 1311 | 1311 |

P-values in parentheses. $*p < 0.05, **p < 0.01, ***p < 0.001$. Each regression also contains all the covariates described in equation (1) except from $D_{demand}$ which was not investigated in December 2020.

All in all, our empirical results could be summarized as follows. First, perceiving Covid-19 as a demand or supply shock has no significant impact on firms' pricing strategies nor on their inflation expectations. The significant drivers of firms' planned price changes are the persistence (rather than the demand or supply nature) of the Covid-19 impact on firms' own business activity and the strength of competitive pressures when firms' set their own pricing policies. Inflation expectations, instead, react significantly only to the inflation treatment, i.e. the information provided on the recent inflation realization and to the expected duration of the Covid downward effect on the general economic situation. We now turn to shape these mechanisms through a general equilibrium model.

# 4 A theoretical model

Consider an economy with utility maximizing households and profit maximizing firms, which grows along a balanced growth path. Households consume a bundle of consumption goods and form habits from the consumption of individual goods as in Ravn et al., 2006, rather than from aggregate consumption levels as is more standard in the literature. Each variety of goods is produced by a monopolistically competitive firm, which uses labour and capital as inputs in the production process. Firms set their prices subject to a downward sloping demand curve, derived from household preferences, and are subject to quadratic costs of adjusting nominal prices. Monetary policy sets the nominal interest rate, responding to the aggregate inflation rate.

As discussed in the Introduction, we model the recession by resorting to a capital depreciation shock. A caveat is in order. A macroeconomic model is an extreme stylized representation of the economic relationships and the shock used to represent the unfolding of a recession is functional to the aspects of the crisis that one wants to highlight more. Here, by taking capital depreciation as the detonator of the economic downturn during the pandemic, we are implicitly assuming that the crisis entails a depreciation of values that prevents them from later renewing as productive capital on the same scale. While this might appear a severe reading of the current juncture, it aims at capturing the lasting scars of the Covid-19 crisis that economists and policymakers have strongly emphasized. Transitory economic conditions can negatively affect the long-run level of output in different ways and, according to many, the interruption in the process of capital accumulation strikes as one of the most relevant during the Covid crisis. In particular, the ECB, 2020 stresses that "*capital depreciation is likely to have increased as a result of Covid-19, especially in capital-intensive sectors hit by the crisis such as the airline industry, where parts of the capital stock could become obsolete, as well as in other sectors that are struggling as a result of the demand shock*".[19] Overall, the ECB, 2020 compares the persistent effects on capital stock associated to the pandemic to the ones observed in recessions following financial crises. "*While the negative impact on total factor productivity and labour input starts to subside after approximately three years, there are adverse and persistent effects on the capital stock, which is the main source of the long-term scarring effects of financial*

[19] One may argue that two opposite forces might affect capital scrapping and depreciation at the macro level. On the one hand, liquidations imply that some of the capital assets are scrapped before the end of their service life. On this respect, the ECB, 2020 estimates that the potential costs of firm exit in terms of capital destruction can be large, as the sectors most affected by the decline in activity are also those that contribute the most to changes in the euro area productive capital stock. On the other hand, the less intensive utilization may extend the lifespan of existing assets if they were shut down during the lockdown. Yet, the experience of the great financial crisis suggests that the former effect largely predominates, leading at the macroeconomic level to an increase in the average scrapping rate of capital asset over severe crises.

*crises*". Our shock is consistent with this reading.

## 4.1 Households

The representative household $j$ derives utility from the consumption of a basket $X_t^j$ of differentiated goods $C_{it}^j$, $i \in [0,1]$ and disutility from supplying labour $H_t^j$. As Ravn et al., 2006, households are subject to good-specific habits: the marginal utility of the consumption of individual goods varieties is subject to a consumption externality specified as catching up with the Joneses good-by-good. Preferences are given by:

$$V_0^j = \mathbb{E}\sum_{t=0}^{\infty}\beta^t\xi_t\left[\log X_t^j - \frac{\gamma}{1+k}\left(H_t^j\right)^{1+k}\right] \tag{2}$$

$$X_t^j = [\int_0^1 \left(C_{it}^j - \theta^d C_{it-1}\right)^{1-\frac{1}{\varepsilon}} di]^{\frac{1}{1-\frac{1}{\varepsilon}}} \tag{3}$$

where $\beta \in (0,1)$ is the discount factor, $1/k > 0$ is the Frisch elasticity of labour supply, $\gamma$ is a preference weight and $C_{it-1} \equiv \int_0^1 C_{it-1}^j dj$ denotes the cross-sectional average level of consumption of variety $i$ in period $t-1$, which the household $j$ takes as exogenously given, with the parameter $0 \leq \theta^d < 1$ measuring the importance of habit. According to (3), the habit relating to the consumption of variety $i$ is given by the past aggregate consumption of this variety and $\varepsilon > 0$ denotes the intra-temporal elasticity of substitution of habit-adjusted consumption across different varieties. The household decides how to allocate its consumption expenditures among the different goods, by solving $\min_{C_{it}^j} \int_0^1 P_{it}C_{it}^j di$, where $P_{it}$ is the nominal price of variety $i$, subject to (3). The demand functions that solve this problem are:

$$C_{it}^j = \left(\frac{P_{it}}{P_t}\right)^{-\varepsilon} X_t^j + \theta^d C_{it-1} \tag{4}$$

where $P_t \equiv [\int_0^1 P_{it}^{1-\varepsilon} di]^{\frac{1}{1-\varepsilon}}$ is an aggregate price index. The household maximizes (2), subject to the budget constraint and the capital accumulation. The former takes this form:

$$\int_0^1 P_{it}c_{it}^j di + B_t^j + P_t I_t^j = R_{t-1}B_{t-1}^j + W_t H_t^j + R_t^k K_t^j + \Phi_t^j \tag{5}$$

where $W_t$ is the nominal wage, $I_t^j$ indicates investment expenditures, $K_t^j$ denotes capital holdings rent to the firms at the nominal rental cost $R_t^k$ and $\Phi_t^j$ are dividends from ownership of firms. Households have also access to a risk free one-period nominal bond $B_t$ that pays a gross interest rate of $R_t$. The capital accumulation equation reads as follows:

$$K_{t+1} = (1-\delta_t)K_t + \varphi(\frac{I_t}{K_t})K_t \tag{6}$$

where $\varphi(\frac{I_t}{K_t})K_t$ captures capital adjustment costs and determines the change in the capital stock induced by investment spending and $\delta_t$ is a stochastic variable which denotes the time-varying depreciation rate of capital $\delta_t = \overline{\delta}^{1-\rho_\delta}\delta_{t-1}^{\rho_\delta}e^{v_t}$, where $v_t$ is a zero-mean independent and identically distributed (i.i.d.) random variable and $\overline{\delta}$ is the mean depreciation rate.[20] As discussed before, this shock makes unproductive, in that it destroys, part of the existing capital. Rearranging the first order conditions, the behaviour of households is described by the Euler equation (7), the labour supply decision (8) and the the (real) shadow value of capital in place, i.e. Tobin's Q (9) $Q_t = \frac{1}{\varphi'(\frac{I_t}{K_t})}$.

$$\beta R_t \frac{X_t^j}{X_{t+1}^j} = \frac{P_{t+1}}{P_t} \tag{7}$$

$$\frac{W_t}{P_t} = \gamma H_t^{jk} X_t^j \tag{8}$$

$$Q_t = \beta \frac{R_{t+1}^k X_t^j}{P_{t+1} X_{t+1}^j} + \beta \frac{X_t^j}{X_{t+1}^j}\left[\varphi(\frac{I_{t+1}}{K_{t+1}})Q_{t+1} - \frac{I_{t+1}}{K_{t+1}} + (1-\delta_{t+1})Q_{t+1}\right] \tag{9}$$

## 4.2 Firms

There is a continuum of monopolistically competitive firms indexed by $i$, producing differentiated goods and facing downward-sloping demand schedule for their product, obtained by aggregating (4) across consumers. Firms select their optimal price being subject to quadratic costs of nominal price adjustment, à la Rotemberg, 1982: $\frac{\varsigma}{2}\left(\frac{P_{it+k}}{P_{it+k-1}} - 1\right)^2 Y_{t+k}$. Each firm $i$ produces with the following technology:

$$Y_{it+k} = a^{\alpha t+k} H_{it+k}^{\alpha} K_{it+k}^{1-\alpha} \tag{10}$$

where $a$ is the growth rate, capturing trend productivity growth. Firm $i$ maximizes its value:

$$\max E_0 \sum_{k=0}^{\infty} \beta^k \frac{X_t}{X_{t+k}}\left[\frac{P_{it+k}}{P_{t+k}} Y_{it+k} - \frac{W_{t+k}}{P_{t+k}} H_{it+k} - \frac{\varsigma}{2}\left(\frac{P_{it+k}}{P_{it+k-1}} - \overline{\pi}_{t+k}\right)^2 Y_{t+k} - \frac{R_{t+k}^k}{P_{t+k}} K_{it+k}\right]$$

[20] We assume $\varphi' > 0$, and $\varphi'' \leq 0$, with $\varphi'(\frac{\widetilde{I}}{\widetilde{K}}) = 1$ and $\varphi(\frac{\widetilde{I}}{\widetilde{K}}) = \frac{\widetilde{I}}{\widetilde{K}}$, where $\frac{\widetilde{I}}{\widetilde{K}}$ is the steady state investment to capital ratio (as in Galí et al., 2007 and consistently with Hayashi, 1982).

subject to the demand schedule and technology, where $\beta^k \frac{X_t}{X_{t+k}}$ is the stochastic discount factor. The first order conditions are:

$$\Psi_t = \frac{\frac{W_t}{P_t}}{\alpha a^{\alpha t} H_{it}^{\alpha-1} K_{it}^{1-\alpha}} \tag{11}$$

$$\Psi_t = \frac{\frac{R_t^k}{P_t}}{(1-\alpha)\, a^{\alpha t} H_{it}^{\alpha} K_{it}^{-\alpha}} \tag{12}$$

$$\Omega_t = \frac{P_{it}}{P_t} - \Psi_t + \beta\theta^d \frac{X_t}{X_{t+1}} \Omega_{t+1} \tag{13}$$

$$\frac{\varsigma}{P_{it-1}}\left(\frac{P_{it}}{P_{it-1}} - \overline{\pi}_t\right) Y_t + \varepsilon\Omega_t \left(\frac{P_{it}}{P_t}\right)^{-\varepsilon-1} \frac{X_t}{P_t} = \frac{Y_{it}}{P_t} + \beta \frac{X_t}{X_{t+1}} \varsigma \frac{P_{it+1}}{P_{it}^2}\left(\frac{P_{it+1}}{P_{it}} - \overline{\pi}_{t+1}\right) Y_{t+1} \tag{14}$$

where $\Psi_t$ denotes the multiplier on the production function, i.e. marginal costs, while $\Omega_t$ is the multiplier on the demand function, i.e. the shadow value of selling an extra unit of good $i$ in period $t$. Equation (13) says that the latter is given by the short-run profit of a sale $\left(\frac{P_{it}}{P_t} - \Psi_t\right)$ plus the future expected profits associated with selling an extra unit of good $i$ in the current period (Ravn et al., 2006), coming from the fact that a unit increase in sales in the current period leads, because of deep habit, to additional sales in the amount of $\theta^d$ additional units of sales in the next period, whose present discounted value is $\beta\theta^d \frac{X_t}{X_{t+1}} \Omega_{t+1}$.

In order to derive the aggregate New Keynesian Phillips curve, we impose a symmetric equilibrium. Also, to obtain the stationary representation of the model, all the non-stationary variables are rescaled by the level of technology: denoting with $Z_t$ a generic non stationary variables, $\widetilde{Z}_t = \frac{Z_t}{a^t}$ is the corresponding stationary ratio (see e.g. Smets and Wouters, 2007). Denoting with lower case letters log-deviations from the stationarized steady state, the Phillips curve associated with this economy reads as follows:

$$\pi_t = \beta \mathbb{E}_t \pi_{t+1} + \Gamma_1 \psi_t + \Gamma_2 \left(\widetilde{y}_{t+1} - \widetilde{y}_t\right) - \Gamma_3 \left(\widetilde{y}_t - \widetilde{y}_{t-1}\right) - \Gamma_4 \left(\omega_{t+1}\right) \tag{15}$$

where $\Gamma_1$, $\Gamma_2$, $\Gamma_3$ and $\Gamma_4$ are convolution of deep parameters: $\Psi_1 \equiv \frac{1}{\varsigma}\left[\varepsilon\left(1 - \frac{\theta^d}{a}\right) - \left(1 - \frac{\beta\theta^d}{a}\right)\right]$; $\Psi_2 \equiv \frac{\beta\theta^d}{a} \frac{1}{\left(1-\frac{\theta^d}{a}\right)} \frac{1}{\varsigma}$; $\Psi_3 \equiv \frac{\frac{\theta^d}{a}}{\varsigma\left(1-\frac{\theta^d}{a}\right)}\left(1 + \beta\frac{\theta^d}{a}\right)$ and $\Psi_4 \equiv \frac{1}{\varsigma}\frac{\beta\theta^d}{a}$.

## 4.3 Aggregate resource constraint and monetary policy

Monetary policy obeys the following rule satisfying the Taylor principle for stability: $\frac{R_t}{\overline{R}} = \left(\frac{P_t}{P_{t-1}}\right)^{\phi_\pi}$, where $\overline{R}$ is the steady state nominal gross rate. Finally, the aggregate

resource constraint reads as follows: $Y_t = C_t + I_t$.

In what follows we show that the expected persistence of the shock (which is measured by $\rho_\delta$) and the extent to which firms care about their competitors' prices (which is inversely related to $\theta^d$) shape the sign of the inflation response. Moreover, to capture the strong dependence of firms' inflation expectations on past inflation that we find in the empirical analysis, we report the impulse response functions (IRFs) under both rational expectations as well as potentially non-rational inflation expectations as in Blanchard and Riggi, 2013 and Del Negro et al., 2020, allowing expectations of agents to depend directly on past inflation $\pi^e_{t+1} = \gamma \mathbb{E}\pi_{t+1} + (1-\gamma)\pi_{t-1}$.

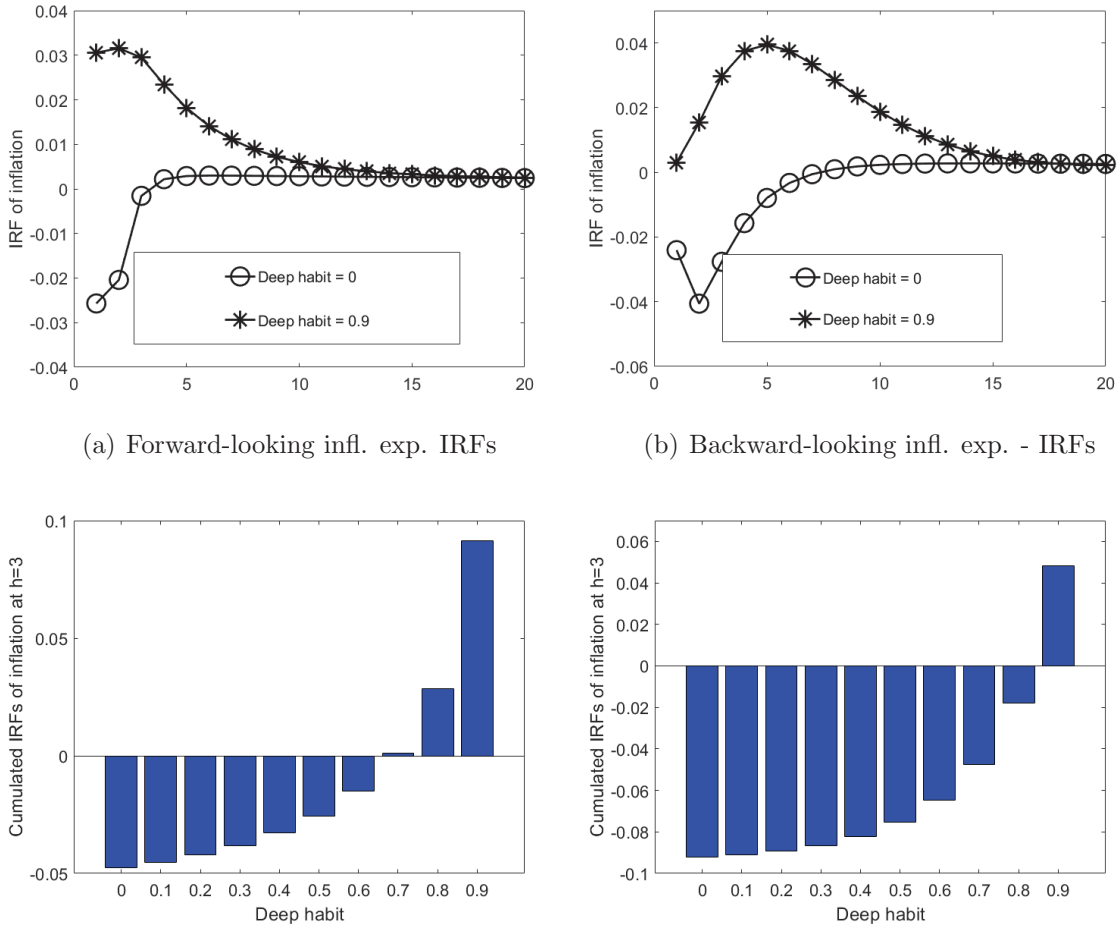
## 4.4 Competitors' prices, shock's persistence and firms' pricing strategies

Figures 4 and 5 show how the behaviour of inflation depends on $\theta$ (how much firms care of their competitors' prices) and $\rho_\delta$ (shock's persistence), respectively. To simulate the model we choose a standard calibration for the other structural parameters. In particular, following the business cycle literature we set the discount factor $\beta$ to 0.99, the inverse of Frisch elasticity $k$ to 1 and the elasticity of substitution of habit adjusted consumption across different varieties $\varepsilon$ to 6. We consider a standard labour share $\alpha = 0.6$. We assume a standard calibration for the mean capital depreciation rate $\overline{\delta}$ =0.025 (see for instance King and Watson, 1996 and Galí et al., 2007). Nominal rigidities, captured by the adjustment cost parameter, are set so as to get $\Psi_1$=0.05 in line with Riggi and Santoro, 2015, and we calibrate the Taylor coefficient $\phi_\pi$ to 1.2, a standard calibration consistent with the Taylor principle. Appendix B shows the robustness of our results to alternative monetary policy coefficients. Finally, we fix $a = 1.004$, consistent with a steady state value for productivity growth of 0.4% on a quarterly basis.

Panels A in Figures 4 and 5 show the IRFs of inflation for high and low degrees of $\theta$ and $\rho_\delta$, respectively. Panels C report the cumulated IRFs of inflation three periods after the shock ($\sum_{i=0}^{3} IRF\pi(i)$), for different degrees of $\theta$ (Figure 4) and $\rho_\delta$ (Figure 5). When we study the role of habit (Figure 4) the shock's persistence $\rho_\delta$ is calibrated at 0.2, while to study the role of the shock's persistence we fix $\theta$ at 0.85.

One key empirical finding in Section 3 is that inflation expectations depend on past inflation level. To capture this findings, we simulate the model relaxing the hypothesis of rational forward looking expectations, assuming $\pi^e = \tau \mathbb{E}_t \pi_{t+1} + (1-\tau)\pi_{t-1}$ as in Blanchard and Riggi, 2013 and Del Negro et al., 2020. Panels b and d of Figures 4 and 5 replicate the evidence assuming backward lookingness of inflation expectations ($\tau = 0.5$). While this amplifies the persistence of the inflation response, the role played by $\theta$ and $\rho_\delta$ remains robust.

**Figure 4:** Deep habit and the inflation response




(a) Forward-looking infl. exp. IRFs

(b) Backward-looking infl. exp. - IRFs

(c) Forward-looking infl. exp. - Cumulated IRFs

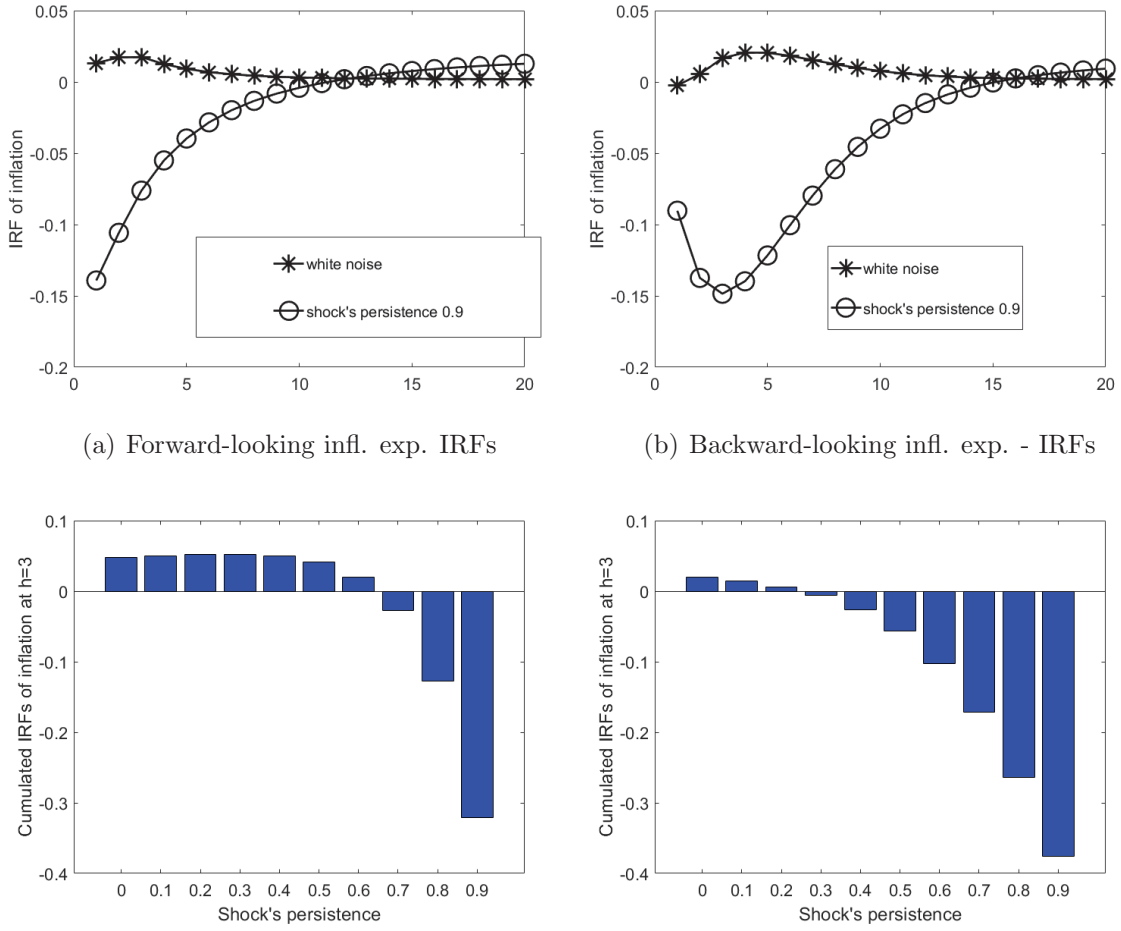
(d) Backward-looking infl. exp. - Cumulated IRFs

*Notes*: The top panels (a) and (b) report the IRFs for inflation to a 3 standard deviation shock to $\delta_t$, under different degrees of deep habit. The bottom panels (c) and (d) report the cumulated IRFs for inflation 3 periods after the shock. IRFs shown in (a) and (c) are obtained under the assumption of forward looking inflation expectations ($\gamma = 1$), while those reported in (b) and (d) are obtained assuming $\gamma = 0.5$. The shock persistence $\rho_\delta$ is set equal to 0.2. The other parameters are calibrated as indicated in the main text.

When an unexpected shock makes a part of the capital stock unproductive, consumption, investment and GDP go down unambiguously. Yet, consistently with the empirical findings, the sign of the response of prices depends on the shock's duration and on competitive pressures (how much firms care of their competitors' prices), which varies in the model with the deepness of consumption habit.

To see the intuition, let us start by assuming that there is no habit in consumption ($\theta^d = 0$). In this case, the Phillips curve (15) reduces to the standard New Keynesian relationship between inflation and marginal costs. As the latter unambiguously decrease, price dynamics go down. Things can go very differently when consumers' habits are deeply

**Figure 5:** Shock's persistence and inflation response




(a) Forward-looking infl. exp. IRFs

(b) Backward-looking infl. exp. - IRFs

(c) Forward-looking infl. exp. - Cumulated IRFs

(d) Backward-looking infl. exp. - Cumulated IRFs

*Notes*: The top panels (a) and (b) report the IRFs of inflation to a 3 standard deviation shock to $\delta_t$, under different degrees of the shock persistence $\rho_\delta$. The bottom panels (c) and (d) report the cumulated IRFs of inflation 3 periods after the shock. IRFs shown in (a) and (c) are obtained under the assumption of forward looking inflation expectations ($\gamma = 1$), while those reported in (b) and (d) are obtained assuming $\gamma = 0.5$. Deep habit $\theta$ is set to 0.85. The other parameters are calibrated as previously indicated in the text.

rooted ($\theta^d > 0$). In this case the demand function of good $i$, $C_{i,t} = \left(\frac{P_{it}}{P_t}\right)^{-\varepsilon} \left(C_t - \theta^d C_{t-1}\right) + \theta^d C_{i,t-1}$, is composed of two terms: the first one, $\left(\frac{P_{it}}{P_t}\right)^{-\varepsilon} \left(C_t - \theta^d C_{t-1}\right)$, displays a price elasticity of $\varepsilon$. The second one, instead, is perfectly price inelastic $\theta^d C_{i,t-1}$ as it originates from the consumers' habitual demand of good $i$, i.e. from the fact that firm's current demand depends, to the extent $\theta^d > 0$, on its past sales rather than on firm's relative price. This is akin to assuming "customer-market," where depending on relative prices there is gradual substitution between differentiated goods rather than discrete switches among suppliers. A higher degree of "deep-habit" means a higher weight of the price-inelastic component of consumers' demand function and, hence, less importance given by

firms to prices of their competitors. Overall, the relative-price elasticity of the demand for good $i$ is a weighted average of $\varepsilon$ and 0, with the weight on $\varepsilon$ given by the share of the price-elastic term in total demand.

Two effects are at play when a firm decides in which direction to move its price following such contractionary shock. First, the benefit of a unit increase in the relative price is given by an increase in revenue in the amount of $C_{i,t}$ stemming from selling all intra-marginal units at a higher price. Second, the cost is the decline in demand that the price increase induces. Such decline has an inter-temporal effect as, given habit at the level of individual goods, a decline in the current demand for firm's good reduces the customer base in the future as well.

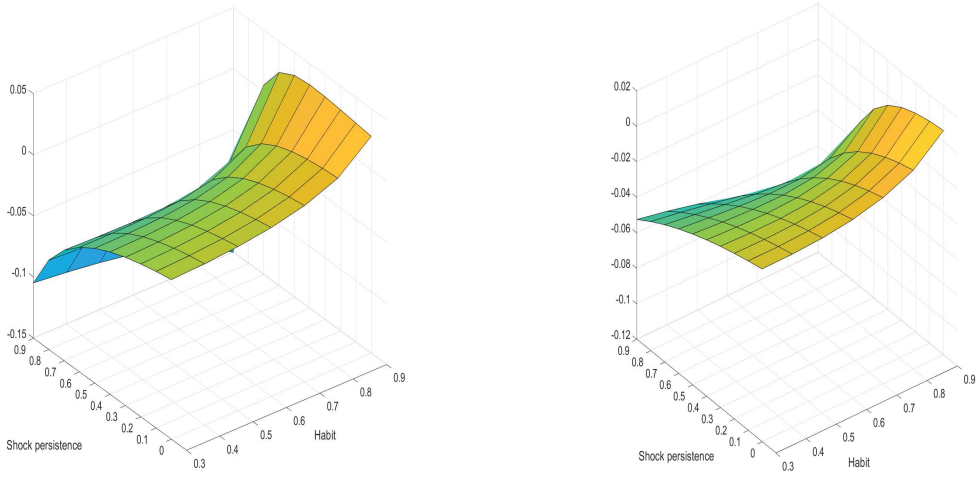
The interplay between deep habit in consumption $\theta$ (how relevant is the price-inelastic component of consumers' demand) and the shock's persistence $\rho_\delta$ (for how long a part of the capital stock will exogenously depreciate, becoming unproductive at a faster rate than usual) is key for the sign of the response of prices. That a high degree of deep habit is needed to have a positive response of prices is straightforward: the strength of the first effect is higher, the higher is the share of demand that the firm inherits from its past sales, which does not depend on how its price compares to those of its competitors. Yet, when the recession is expected to be very persistent, prices go down, even when consumers' habit is high. The reason is that when the contractionary shock hits persistently, it exogenously erodes in a larger and more persistent way the customer base ($\theta C_{i,t-1}$) and symmetrically leads to a larger increase in the marginal value of future demand: firms resolve the trade-off between the benefit of increasing prices exploiting its own customer base and the cost of throwing away current and future demand in favour of the second one.

Note that in this analysis we have disregarded the role that monetary policy might play in shaping the responses to the shock, as we stick to a simple Taylor rule that guarantees equilibrium determinacy.[21] While the study of the optimal policy response is outside the scope of our paper, in Appendix B we illustrate the stabilizing role of monetary policy by simulating the model under alternative values of the Taylor coefficient. In line with standard intuition, a stronger reaction of the interest rate would lead to a more muted movement in inflation. Yet, the overall predictions concerning the role of competitive pressures and the persistence of the crisis hold true.

Figures 6 and 7 show the impact response of inflation and one year ahead inflation expectations, respectively, by varying together the two key parameters $\theta$ and $\rho_\delta$. They illustrate that, as explained above, to get a positive reaction of inflation and inflation

[21] Inflation target uncertainty might also play a role in the transmission of the shock: Neri and Ropele, 2019 show that when the central bank's inflation target is not perfectly observed favourable supply shocks might turn contractionary as agents erroneously perceive a temporary reduction in the target.

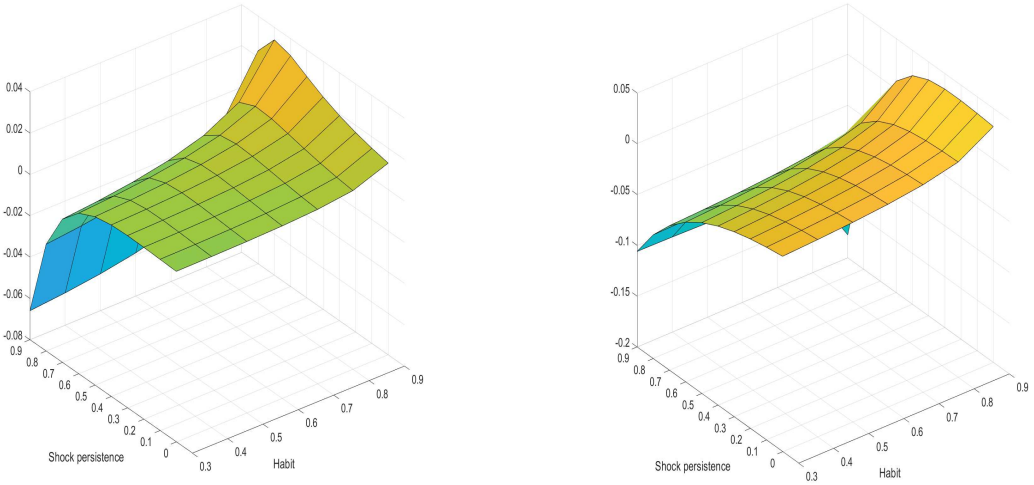
**Figure 6:** Impact response of inflation




(a) Forward-looking expectations (b) Backward-looking expectations

*Notes*: The figure reports the impact response of inflation to a 3 standard deviation shock to $\delta_t$, under different degrees of shock persistence $\rho_\delta$ and deep habit $\theta$. The other parameters of the model are calibrated as specified in the text. Impact responses shown in (a) are obtained under the assumption of forward looking inflation expectations ($\gamma = 1$), while those reported in (b) are obtained assuming backward looking inflation expectations, with $\gamma = 0.5$.

**Figure 7:** Impact response of one-year ahead inflation expectations




(a) Forward-looking expectations (b) Backward-looking expectations

*Notes*: The figure reports the impact response of one-year ahead inflation expectations to a 3 standard deviation shock to $\delta_t$, under different degrees of shock persistence $\rho_\delta$ and deep habit $\theta$. The other parameters of the model are calibrated as specified in the text. Impact responses shown in (a) are obtained under the assumption of forward looking inflation expectations ($\gamma = 1$), while those reported in (b) are obtained assuming backward looking inflation expectations, with $\gamma = 0.5$.

expectations, the share of price-inelastic demand should be high. Besides, for any degree of $\theta$, the response becomes negative the longer is shock's duration. Our theoretical framework

aims at providing a rationale for the two main drivers put forward by our empirical analysis and a precise quantification of the response of prices is clearly outside the goal of this stylized macro model. Yet, it is worth stressing that a high degree of habit (around 0.6-0.85) is in line with empirical evidence for the euro area.[22] According to our analysis, this means that the expected duration of the effects' of Covid-19 is pivotal for the sign of the inflation and inflation expectations responses.

# 5 Additional empirical results

In this section we complement our previous empirical analyses. First we investigate the role of liquidity and financial conditions for firms' pricing strategies in the context of the Covid-19 period. We test this hypothesis motivated by the evidence presented by Balduzzi et al., 2020 who argue that financial constraints play a key role in the transmission mechanism of the Covid-shock, as they find credit-constrained firms expecting to charge higher prices, relative to unconstrained ones. Our results do not support the relevance of this channel: we show that firms declared appropriate liquidity and financial conditions and, more importantly, these factors did not impact their price decisions during the pandemic.

Then, we exploit the long history of the SIGE survey to provide a more general overview of how the response to the Covid-19 shock compares with previous recession episodes. Differently from the 2008-09 global financial crisis and the 2011 sovereign debt crisis, the response of inflation expectations to the Covid-19 shock was relatively muted, pointing toward the idea that the complexity of this shock led firms to perceive with uncertainty its inflationary implications and, as a consequence, to revise inflation expectations only to a limited extent.

## 5.1 The role of liquidity and financial conditions

The literature emerged after the 2008-09 global financial crisis has shown that financial conditions can play an important role in driving business cycle fluctuations, also in terms of price dynamics. The seminal paper by Gilchrist et al., 2017 documents that liquidity-constrained firms were more likely to increase prices than their unconstrained counterparts. This mechanism was also relevant in the euro area after the sovereign debt crisis: Duca et al., 2018 find that financially-constrained firms tend to charge higher

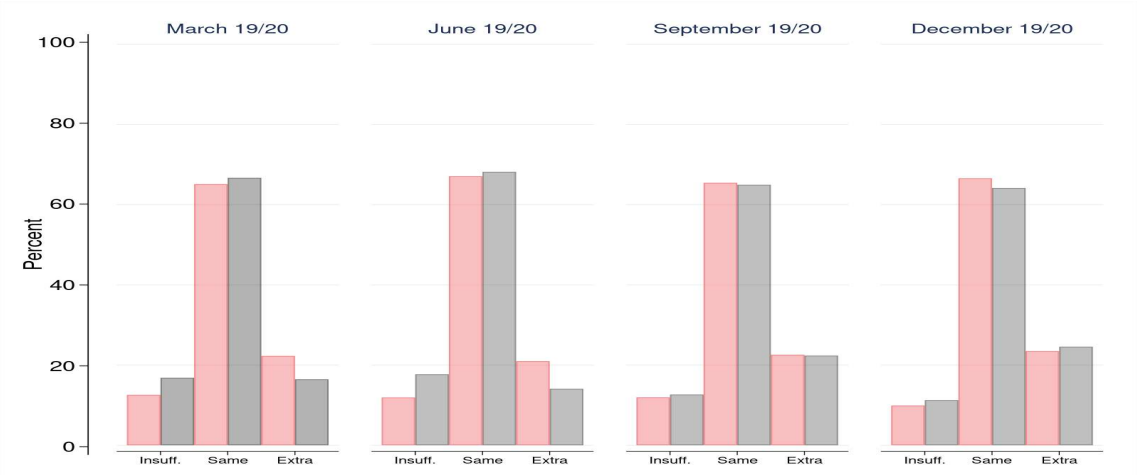
[22]To the best of our knowledge, estimates of habit are mostly obtained under the more standard assumption of superficial habit. See for instance Smets and Wouters, 2005 and Nucci and Riggi, 2018, who argue that a high degree of habit in the euro area is responsible for the countercyclical profile of labour force participation observed there.

markups when they face low demand, raising prices to survive to adverse demand shocks.[23] In the context of the Covid-19 pandemics, Balduzzi et al., 2020 use the MeT survey to show that credit conditions were important determinants of prices for Italian businesses, with credit-constrained firms charging higher prices compared to unconstrained ones.

In this section we test the relevance of liquidity constraints during the Covid-19 shock. To do so, we first show that firms' liquidity and financial conditions were not the major concern during 2020, also due to the massive stimuli implemented by governments. Then, we empirically analyse the relation between these factors and firms' price expectations and strategies during the Covid-19 period.

We use answers to a standard question on liquidity conditions included in SIGE. Firms are asked to assess their expected liquidity conditions over the next three months compared to the current situation. Figure 8 compares the qualitative answers given in each quarter of 2019 and 2020: about 60% of firms claim that liquidity conditions are expected to remain unchanged and quantitatively sufficient in the three considered waves. More importantly, the share of firms declaring insufficient liquidity remains below 20% and only marginally increases during the first two quarters of 2020 compared with the same period of the previous year. Notably, this fraction is mostly comparable to the share

**Figure 8:** Firms' expected liquidity conditions




*Source*: SIGE data. *Note*: Share of firms' assessment on their expected liquidity conditions over the next three months compared to the current situation. Red and grey bars correspond to the answers for 2019 and 2020, respectively.

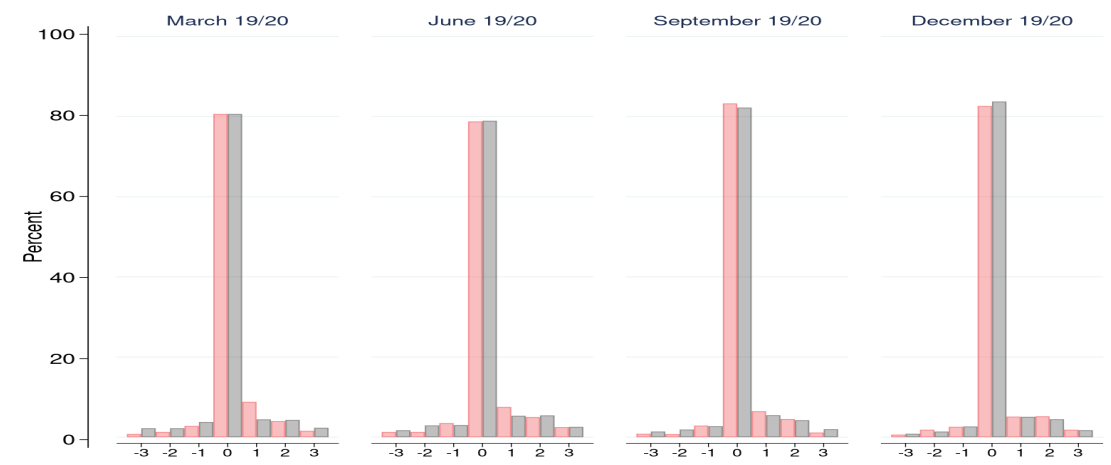
of firms declaring extra liquidity. This appears consistent with the evidence presented by De Socio et al., 2020, that measures enacted by the Italian Government between March and August guaranteed the credit lines and provided the necessary liquidity to Italian

[23]Conversely, Acharya et al., 2020 argue that cheap credit to the so-called "zombie" firms, i.e. the ones generally characterized by low profitability and high leverage ratio, contributed to keep inflation low in the euro area after 2012 since it hampers the adjustment in the aggregate production capacity that usually follows a negative demand shock.

businesses.

In addition, we exploit another question included in the survey where firms are directly asked to quantify the impact of financial conditions on their own expected prices.[24] The question offers a spectrum of answers ranging between -3 to +3, where a negative (positive) sign implies a downward (upward) pressure on prices and the size indicates the intensity. Figure 9 shows the distribution of the answers in each wave of 2019 and 2020. As for the expectations on the evolution of liquidity constraints, it appears evident that the Covid-19 shock has not modified firms' perception about the impact of financial conditions on prices, which remains largely considered as irrelevant by about 80% of firms. Moreover the remaining 20% are broadly balanced between negative and positive assessments.

**Figure 9:** The impact of financial conditions on firms' own expected prices




*Source*: SIGE data. *Note*: Share of firms according to the impact of financial conditions on own product prices. Red and grey bars correspond to the answers for 2019 and 2020, respectively.

We evaluate more formally the relevance of liquidity and financial conditions by including these two factors in the model estimated in Section 3. Specifically, we add two dummies for the liquidity conditions which assume values 1 if they are considered either as insufficient or excessive. We also examine two dummies for negative and positive impact of financial factors. Furthermore, all the dummies are interacted with time fixed effects to capture the different impact that these factors could have played in several moments of the pandemic.

Table 5 presents the main results: there is no systematic correlation between the expected liquidity conditions and the expectations on general and own prices. The coefficients are almost always not significant apart from that linked to the condition of insufficient liquidity in the first quarter which is positively correlated with one and two

[24] As described in the questionnaire in the Appendix, we do not provide a specific definition for "financial conditions". We use this expression in a general way to ask firms if and how these conditions are affecting their product prices in the next 12 months.

**Table 5:** Liquidity and financial conditions on price expectations and strategies

| | Effect on Inflation expectations | | | | Effect on firm decision | | |
|---|---|---|---|---|---|---|---|
| | (1) $\pi^6$ | (2) $\pi^{12}$ | (3) $\pi^{24}$ | (4) $\pi^{48}$ | (5) $p^{12}$ | (6) $D\_inv$ | (7) $D\_occ$ |
| 3m ins.liq. X2020Q1 | -0.000 | 0.258* | 0.327* | 0.100 | -1.291 | -0.121** | -0.167*** |
| | (1.00) | (0.01) | (0.05) | (0.26) | (0.09) | (0.00) | (0.00) |
| 3m ins.liq. X2020Q2 | 0.228 | 0.200 | 0.172 | 0.213 | -0.005 | -0.097** | -0.155*** |
| | (0.19) | (0.20) | (0.19) | (0.07) | (0.99) | (0.00) | (0.00) |
| 3m ins.liq. X2020Q3 | 0.345 | 0.337 | 0.313 | 0.147 | 0.210 | -0.111** | -0.128*** |
| | (0.13) | (0.14) | (0.16) | (0.42) | (0.65) | (0.00) | (0.00) |
| 3m ins.liq. X2020Q4 | -0.068 | -0.150 | -0.155 | -0.120 | -3.379* | -0.171*** | -0.168*** |
| | (0.65) | (0.40) | (0.38) | (0.51) | (0.01) | (0.00) | (0.00) |
| 3m ext.liq. X2020Q1 | 0.008 | 0.021 | 0.062 | 0.072 | 0.097 | 0.046 | 0.038 |
| | (0.92) | (0.78) | (0.46) | (0.43) | (0.82) | (0.28) | (0.32) |
| 3m ext.liq. X2020Q2 | -0.141 | -0.114 | -0.096 | 0.046 | 0.535 | 0.052 | 0.066 |
| | (0.07) | (0.10) | (0.13) | (0.68) | (0.11) | (0.16) | (0.05) |
| 3m ext.liq. X2020Q3 | -0.038 | -0.042 | 0.003 | 0.046 | 0.074 | 0.035 | 0.036 |
| | (0.54) | (0.51) | (0.96) | (0.66) | (0.81) | (0.29) | (0.20) |
| 3m ext.liq. X2020Q4 | -0.031 | -0.029 | -0.090 | -0.072 | 0.485 | 0.034 | 0.074** |
| | (0.60) | (0.65) | (0.15) | (0.33) | (0.11) | (0.26) | (0.01) |
| Neg.fin.imp. X2020Q1 | 0.069 | -0.046 | -0.044 | 0.007 | -1.621 | -0.116* | -0.048 |
| | (0.65) | (0.63) | (0.70) | (0.95) | (0.18) | (0.05) | (0.29) |
| Neg.fin.imp. X2020Q2 | 0.244 | 0.344 | 0.329 | 0.216 | -0.236 | -0.038 | -0.006 |
| | (0.26) | (0.09) | (0.09) | (0.38) | (0.68) | (0.41) | (0.87) |
| Neg.fin.imp. X2020Q3 | 0.178 | 0.134 | 0.077 | 0.028 | 0.504 | -0.136** | -0.035 |
| | (0.31) | (0.50) | (0.71) | (0.87) | (0.40) | (0.01) | (0.42) |
| Neg.fin.imp. X2020Q4 | 0.310 | 0.296 | 0.088 | -0.058 | 0.447 | -0.043 | -0.106** |
| | (0.26) | (0.29) | (0.74) | (0.83) | (0.82) | (0.43) | (0.01) |
| Pos.fin.imp X2020Q1 | 0.271* | 0.212* | 0.317* | 0.262* | 0.745 | 0.094 | -0.001 |
| | (0.04) | (0.04) | (0.02) | (0.03) | (0.08) | (0.06) | (0.98) |
| Pos.fin.imp X2020Q2 | 0.116 | 0.138 | 0.104 | 0.048 | 1.120* | 0.026 | 0.035 |
| | (0.53) | (0.47) | (0.51) | (0.70) | (0.02) | (0.49) | (0.28) |
| Pos.fin.imp X2020Q3 | 0.037 | 0.172 | 0.162 | 0.172 | 0.632 | -0.011 | -0.023 |
| | (0.81) | (0.32) | (0.37) | (0.34) | (0.26) | (0.78) | (0.47) |
| Pos.fin.imp X2020Q4 | 0.012 | -0.061 | -0.121 | -0.123 | -0.301 | -0.023 | 0.051 |
| | (0.94) | (0.73) | (0.45) | (0.48) | (0.75) | (0.56) | (0.13) |
| R2 | 0.06 | 0.07 | 0.05 | 0.03 | 0.04 | 0.06 | 0.07 |
| N | 3961 | 3961 | 3961 | 3961 | 4532 | 4500 | 4522 |

P-values in parentheses. $*p < 0.05, **p < 0.01, ***p < 0.001$. *Note*: The regressions include all the control variables introduced in equation 1, not showed for brevity.

years inflation expectations. Similarly, we do not observe a systematic and significant correlation between the impact of financial factors and expectations on inflation and own prices. On the contrary, the expected liquidity condition is negatively correlated with investment and employment expectations throughout all the pandemic crisis. Interestingly, the same regression run for 2019 shows lower but equally significant coefficients for the dynamics of employment while coefficients are never significant in the correlation with ex-

pected investments. This suggests that the spread of Covid has made the role of expected liquidity conditions on firms' strategies regarding production factors more relevant.

Furthermore, it is important to underline that, even including financial factors, the coefficients linked to all the other variables presented in Tables 2 and 3 (not shown here for the sake of brevity) have kept their sign and magnitude. This represents a further robustness check confirming how the variables already identified are important drivers for firms' expected prices and strategy, providing further strength to our previous results. Moreover, these results represent a strong evidence for not including financial constraints as key mechanisms in our theoretical model.

## 5.2 The Covid-19 compared to previous crises

In this section we exploit the long history of SIGE to analyse how the response of firms' inflation expectations to the Covid-19 shock compares to the previous severe recession episodes, namely the 2008-09 global financial crisis and the 2011 sovereign debt crisis. This comparison can integrate our analysis on the perception of the Covid-19 shock by showing how the effects on firms' inflation expectations are different from those observed in the previous cases. The length of SIGE represents a relevant advantage compared to other surveys which in general are much shorter.

We focus on the 12-month ahead inflation expectations. This is the most appropriate horizon to look at, as it is the only one available in all periods we compare. Moreover, long-term inflation expectations are more telling about the credibility of monetary policy and less appropriate to quantify the direct effects of the Covid-19 shock.[25]

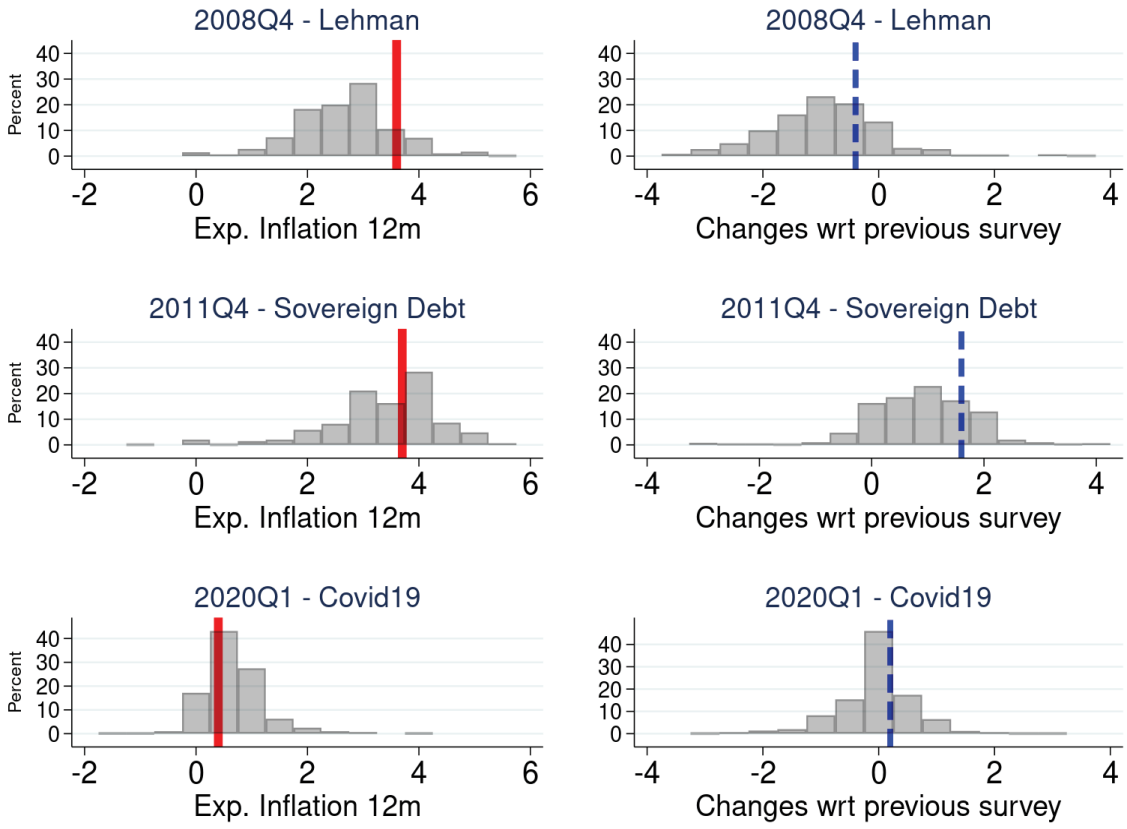
A graphical evidence about the three main crises is presented in Figure 10, which is organised as follows.The left column reports the entire distribution of the 12-month ahead inflation expectations in the quarter following the outburst of the shock. The red vertical line indicates the inflation treatment communicated to the treated firms in that particular survey. The right column displays the change in inflation expectations with respect to the previous survey, allowing us to quantify the size of the revisions. Since the revisions could also be driven by the different inflation treatment, the blue dashed line represents its variation between the surveys.

Several results emerge from this comparison.[26] First, the distribution of inflation ex-

[25]For instance, Galati et al., 2011 study the behaviour of survey-based long-run inflation expectations after the Great Recession finding that they did not change considerably, remaining stable around 2% in the euro area.

[26]With our dataset we cannot examine the effects on the *individual* inflation uncertainty as done in Armantier et al., 2020 because firms are only asked about their point forecasts at different horizons and no information on the associated distribution is requested.

**Figure 10:** Inflation expectations and their revisions during recessions




*Source*: Authors' calculations on SIGE data. *Note*: The left column plots the distribution of the 12-month ahead inflation expectations while the right column their variation with respect to the previous round. The red vertical line represents the value of the inflation treatment (i.e. the last available realized figure for Italian inflation) in the corresponding quarter whereas the blue dashed line represents the variation in the information treatment between two consecutive rounds. For comparability reasons, we only show the inflation treated firms for March 2020 survey.

pectations (left column) is more concentrated around the inflation treatment in 2020Q1, and not as dispersed as in the previous two cases. In other words, we observe a significant smaller level of disagreement. Related to this evidence, also the distribution of the revisions is not as large as in previous crises. Second, the size of the revisions of the inflation expectations with respect to the pre-Covid period (right column) is on average close to zero, and quantitatively much smaller than previous crises. Contrarily, the revisions were largely negative in 2008, also as a consequence of a large drop in oil prices which halved in one quarter. In 2011, the revisions were mostly positive and not driven by the dynamics of oil. Third, even in the face of large shocks, inflation expectations were largely affected by the latest information provided on inflation. This feature appears common across recessions.

All in all, our evidence shows that Covid-19 produced a generally muted response of short-term inflation expectations, since the revisions with respect to the round preceding

the shock are concentrated around zero. This points toward the idea that the complexity of this shock led firms to perceive with uncertainty its inflationary implications and to revise inflation expectations only marginally.

# 6 Conclusions

How does the Covid-19 shock influence firms' pricing choices and inflation expectations? Our paper provides an answer using a very detailed survey of Italian firms conducted by the Bank of Italy.

We do not reach trivial conclusions. While most of the firms in our sample perceive the epidemic as a demand shock, the demand-supply narrative is not that relevant in shaping their inflation expectations and pricing strategies. The direction of planned price changes, instead, appears driven by two other factors: how long the downturn will last and competitive pressures. The longer the time deemed necessary to return to their normal levels of activity and the more attention they pay to their competitors' prices, the more likely firms are to decrease their prices, irrespective of their being affected more by demand- or supply-side factors. Firms' inflation expectations depend negatively on the expected persistence of the aggregate effects of the epidemic on the general economic situation, in addition to the information provided about recent inflation figures.

Intuitively, a firm's benefit from a unit increase in its price is given by the increase in revenue stemming from the units it succeeds in selling at the higher price, while the cost is the decline in current and future demand that the price rise induces. The benefit of raising prices is greater if firms can count on a large share of price-inelastic demand (meaning that firms do not need to care too much about relative prices), while the more persistent the downturn is, the smaller the benefit. Indeed, further into the future the recovery is, the sharper the contraction in demand will be in the initial periods as well. In this case, the crisis exogenously destroys even firms' relations with its more loyal customers: the value of preserving demand exceeds the benefit of raising prices.

Finally, we find no effects of liquidity concerns on firms' pricing strategies, which instead were identified by the literature as a major driver of corporate pricing policies during the Great Recession and the sovereign debt crisis. This suggests that the massive fiscal and monetary stimuli were likely effective in providing liquidity support as the pandemic unfolded.

# References


Acharya, V. V., M. Crosignani, T. Eisert, and C. Eufinger (2020): "Zombie Credit and (Dis-)Inflation: Evidence from Europe," NBER Working Papers 27158, National Bureau of Economic Research, Inc.

Ambler, S. and A. Paquet (1994): "Stochastic Depreciation and the Business Cycle," *International Economic Review*, 35, 101–116.

Armantier, O., G. Kosar, R. Pomerantz, D. Skandalis, K. Smith, G. Topa, and W. van der Klaauw (2020): "How Economic Crises Affect Inflation Beliefs: Evidence from the COVID-19 Pandemic," Staff Reports 949, Federal Reserve Bank of New York.

Balduzzi, P., E. Brancati, M. Brianti, and F. Schiantarelli (2020): "The Economic Effects of COVID-19 and Credit Constraints: Evidence from Italian Firms' Expectations and Plans," Boston College Working Papers in Economics 1013, Boston College Department of Economics.

Balleer, A., S. Link, M. Menkhoff, and P. Zorn (2020): "Demand or Supply? Price Adjustment during the COVID-19 Pandemic," IZA Discussion Papers 13568, Institute of Labor Economics (IZA).

Bank of Italy (2017): *Methods and Sources: Methodological Notes. Survey of Inflation and Growth Expectations.*

Baqaee, D. and E. Farhi (2020): "Supply and Demand in Disaggregated Keynesian Economies with an Application to the Covid-19 Crisis," NBER Working Papers 27152, National Bureau of Economic Research, Inc.

Barro, R. J. (2006): "Rare Disasters and Asset Markets in the Twentieth Century," *The Quarterly Journal of Economics*, 121, 823–866.

——— (2009): "Rare Disasters, Asset Prices, and Welfare Costs," *American Economic Review*, 99, 243–264.

Bartiloro, L., M. Bottone, and A. Rosolia (2019): "The Heterogeneity of the Inflation Expectations of Italian Firms along the Business Cycle," *International Journal of Central Banking*, 15, 175–205.

Bekaert, G., E. Engstrom, and A. Ermolov (2020): "Aggregate Demand and Aggregate Supply Effects of COVID-19: A Real-time Analysis," Finance and Economics Discussion Series 2020-049, Board of Governors of the Federal Reserve System (U.S.).

Blanchard, O. J. and M. Riggi (2013): "Why are the 2000s so different from the 1970s? A structural interpretation of changes in the macroeconomic effect of oil prices," *Journal of the European Economic Association*, 11, 1032–1052.

Bottone, M. and A. Rosolia (2019): "Monetary policy, firms' inflation expectations and prices: causal evidence from firm-level data," Temi di discussione (Economic working papers) 1218, Bank of Italy, Economic Research and International Relations Area.

Brinca, P., J. B. Duarte, and M. F. e Castro (2020): "Measuring Sectoral Supply and Demand Shocks during COVID-19," Working Papers 2020-011, Federal Reserve Bank of St. Louis.

Candia, B., O. Coibion, and Y. Gorodnichenko (2020): "Communication and the Beliefs of Economic Agents," NBER Working Papers 27800, National Bureau of Economic Research, Inc.

Cantelmo, A. (2020): "Rare disasters, the natural interest rate and monetary policy," Temi di discussione (Economic working papers) 1309, Bank of Italy, Economic Research and International Relations Area.

Cecchetti, S., D. Fantino, A. Notarpietro, M. Riggi, A. Tagliabracci, A. Tiseno, and R. Zizza (2021): "Inflation expectations in the euro area: indicators, analyses and models used at Banca d'Italia," Questioni di Economia e Finanza (Occasional Papers) 612, Bank of Italy, Economic Research and International Relations Area.

Coibion, O., Y. Gorodnichenko, and T. Ropele (2020): "Inflation Expectations and Firm Decisions: New Causal Evidence," *The Quarterly Journal of Economics*, 135, 165–219.

Conflitti, C. and R. Zizza (2020): "What's behind firms' inflation forecasts?" *Empirical Economics*, forthcoming.

De Socio, A., S. Narizzano, T. Orlando, F. Parlapiano, G. Rodano, E. Sette, and G. viggiano (2020): "The effects of the COVID-19 shock on corporates' liquidity needs, balance sheets and riskiness," Covid note, Bank of Italy.

Del Negro, M., M. Lenza, G. E. Primiceri, and A. Tambalotti (2020): "What's up with the Phillips Curve?" NBER Working Papers 27003, National Bureau of Economic Research, Inc.

del Rio-Chanona, R. M., P. Mealy, A. Pichler, F. Lafond, and D. Farmer (2020): "Supply and demand shocks in the COVID-19 pandemic: An industry and occupation perspective," Papers 2004.06759, arXiv.org.

Duca, I. A., J. M. Montero, M. Riggi, and R. Zizza (2018): "I will survive. Pricing strategies of financially distressed firms," Working Paper Series 2164, European Central Bank.

ECB (2020): "The scarring effects of past crises on the global economy," Box prepared by Natalia Martín Fuentes and Isabella Model, as part of the ECB Economic Bulletin, Issue 8/2020.

Furlanetto, F. and M. Seneca (2014): "New Perspectives On Depreciation Shocks As A Source Of Business Cycle Fluctuations," *Macroeconomic Dynamics*, 18, 1209–1233.

Galí, J., J. D. López-Salido, and J. Vallés (2007): "Understanding the Effects of Government Spending on Consumption," *Journal of the European Economic Association*, 5, 227–270.

Galati, G., S. Poelhekke, and C. Zhou (2011): "Did the Crisis Affect Inflation Expectations?" *International Journal of Central Banking*, 7, 167–207.

Gilchrist, S., R. Schoenle, J. Sim, and E. Zakrajšek (2017): "Inflation Dynamics during the Financial Crisis," *American Economic Review*, 107, 785–823.

Guerrieri, V., G. Lorenzoni, L. Straub, and I. Werning (2020): "Macroeconomic Implications of COVID-19: Can Negative Supply Shocks Cause Demand Shortages?" NBER Working Papers 26918, National Bureau of Economic Research, Inc.

Hayashi, F. (1982): "Tobin's Marginal q and Average q: A Neoclassical Interpretation," *Econometrica*, 50, 213–224.

King, R. G. and M. W. Watson (1996): "Money, Prices, Interest Rates and the Business Cycle," *The Review of Economics and Statistics*, 78, 35–53.

Neri, S. and T. Ropele (2019): "Disinflationary shocks and inflation target uncertainty," *Economics Letters*, 181, 77–80.

Nucci, F. and M. Riggi (2018): "Labor force participation, wage rigidities, and inflation," *Journal of Macroeconomics*, 55, 274–292.

Ravn, M., S. Schmitt-Grohé, and M. Uribe (2006): "Deep Habits," *Review of Economic Studies*, 73, 195–218.

Riggi, M. and S. Santoro (2015): "On the Slope and the Persistence of the Italian Phillips Curve," *International Journal of Central Banking*, 11, 157–197.

Rosolia, A. (2020): "Does information about current inflation affect expectations and decisions? Another look at Italian firms," Mimeo.

Rotemberg, J. J. (1982): "Monopolistic Price Adjustment and Aggregate Output," *Review of Economic Studies*, 49, 517–531.

Smets, F. and R. Wouters (2005): "Comparing shocks and frictions in US and euro area business cycles: a Bayesian DSGE Approach," *Journal of Applied Econometrics*, 20, 161–183.

——— (2007): "Shocks and Frictions in US Business Cycles: A Bayesian DSGE Approach," *American Economic Review*, 97, 586–606.

# Appendix A. Survey Questionnaire

**INDUSTRY EXCLUDING CONSTRUCTION AND SERVICES**

**Firm**
**Instructions**: For percentage changes, indicate the sign in the first box on the left (+ :for increases; —: for decreases).

**SECTION A – General Information**

**A1.** Number of employees : |__|__|__|__| ADD

**A2.** Share of sales revenues coming from exports: |__|
(1= more than 2/3; 2= Between 1/3 and 2/3; 3= Up to 1/3 and more than zero; 4=Zero) EXPORT4

**SECTION B – General economic situation of the country**

| | …in December 2020? IT6 | …in June 2021? IT12 | …in June 2022? IT24 | … on average between June 2023 and June 2025? IT48 |
|---|---|---|---|---|
| **B1a. (about 3/5 of the sample)** In April consumer price inflation, measured by the 12-month change in the harmonized index of consumer prices was +0.1 per cent in Italy and +0.3 per cent in the euro area. What do you think it will be in Italy... | |__|__|__|,|__|% | |__|__|__|,|__|% | |__|__|__|,|__|% | |__|__|__|,|__|% |
| **B1b. (about 1/5 of the sample)** What do you think consumer price inflation in Italy, measured by the 12-month change in the harmonized index of consumer prices, will be… | |__|__|__|,|__|% | |__|__|__|,|__|% | |__|__|__|,|__|% | |__|__|__|,|__|% |
| **B1c. (about 1/5 of the sample)** The European Central Bank has as an objective the maintenance of the 12-month change in the harmonized index of consumer prices in the euro area close but below 2 per cent in the medium term. What do you think consumer price inflation in Italy, measured by the 12-month change in the harmonized index of consumer prices, will be… | |__|__|__|,|__|% | |__|__|__|,|__|% | |__|__|__|,|__|% | |__|__|__|,|__|% |

**B2.** Compared with 3 months ago, do you consider Italy's general economic situation is …? SITGEN ☐ Better ☐ The same ☐ Worse

**B3.** What do you think is the probability of an improvement in Italy's general economic situation **in the next 3 months**? PROMIG
☐ Zero ☐ 1-25 per cent ☐ 26-50 per cent ☐ 51-75 per cent ☐ 76-99 per cent ☐ 100 per cent

**SECTION C – Your firm's business conditions**

How do you think business conditions for your company will be:

**C1.** in the **next 3 months**? ☐ Much better ☐ Better ☐ The same ☐ Worse ☐ Much worse SITIMP5

**C2**. in the **next 3 years**? ☐ Much better ☐ Better ☐ The same ☐ Worse ☐ Much worse SIMP36C5

For each of the above forecasts imagine there are 100 points available; distribute them among the possible forecasts according to the probability assigned to each one. How do you think business conditions for your company will be:

| | Better SITM3M SITM3A | | | The same SITU3M SITU3A | | | Worse SITP3M SITP3A | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **C3.** In the next **3 months** | | | | | | | | | | **1** | **0** | **0** |
| **C4.** In the next **3 years** | | | | | | | | | | **1** | **0** | **0** |

Please indicate whether and with what intensity the following FACTORS will affect your firm's business **in the next 3 months**.

| Factors affecting your firm's business In the **next 3 months** | ***Effect on business*** | | | ***Intensity*** *(if not nil)* | | |
|---|---|---|---|---|---|---|
| | *Negative* | *Nil* | *Negative* | *Nil* | *Negative* | *Nil* |
| **C5.1** Changes in demand DISIT | 1\|__\| | 2\|__\| | 3\|__\| | 1\|__\| | 2\|__\| | 3\|__\| |
| **C5.2** Changes in your prices PRSIT | 1\|__\| | 2\|__\| | 3\|__\| | 1\|__\| | 2\|__\| | 3\|__\| |
| **C5.3** Availability and the cost of credit CRSIT | 1\|__\| | 2\|__\| | 3\|__\| | 1\|__\| | 2\|__\| | 3\|__\| |
| **C5.4** Uncertainty due to econ. and political factors POLIT | 1\|__\| | 2\|__\| | 3\|__\| | 1\|__\| | 2\|__\| | 3\|__\| |
| **C5.5** Exchange rate dynamics TACAM | 1\|__\| | 2\|__\| | 3\|__\| | 1\|__\| | 2\|__\| | 3\|__\| |
| **C5.6** Oil price dynamics PRPET | 1\|__\| | 2\|__\| | 3\|__\| | 1\|__\| | 2\|__\| | 3\|__\| |
| **C5.7** Tensions on liberalization policies of international trade POLIB | 1\|__\| | 2\|__\| | 3\|__\| | 1\|__\| | 2\|__\| | 3\|__\| |

**C6.1** Since the beginning of April, owing to the spread of the coronavirus, your main business has been ...
☐ Open pursuant to the government decrees ☐ Open in derogation to the government decrees ☐ Open for other reasons (e.g. possibility of working remotely) ☐ Closed pursuant to the government decrees ☐ Closed for other reasons CORAP |__|

**C6.2** In how many months do you think your firm will be able to return to pre-epidemic business levels? (indicate the number of months; 0 if business is already equal to pre-coronavirus levels; -1 if it is higher; 999 if your assessment is 'never') **CORNORM** |__|__|

**C6.3.** Through what channels is the spread of the coronavirus affecting your firm's outlook? *(please indicate no more than 2, in order of importance)*
□ Foreign demand □ Domestic demand □ Supply of raw materials and semi-finished and finished products □ Changes in the prices of inputs purchased in Italy □ Changes in the prices of inputs purchased abroad □ Changes in the prices of your products □ Changes in the quantities supplied □ Availability of work force □ None of the above factors
|__| **COR1a** |__|**COR2a**

**C6.4** Which of the following measures relating to staff management have you taken owing to the spread of COVID-19?
*(please indicate no more than 3, in order of importance)*
□ Use of remote working □ Reduction of working hours □ Increase of working hours □ Use of wage supplementation (*cassa integrazione guadagni* or equivalent schemes) □ Introduction of other temporary policies to reduce costs (e.g. mandatory leave or freeze on bonuses) □ Reducing staff numbers (e.g. by not renewing expired contracts) or not hiring new staff (e.g. seasonal workers) □ Hiring new staff □ None of the above |__| **CORPERS1** |__|**CORPERS2** __|**CORPERS3**

**C6.5** Did your firm apply for liquidity support under one of the measures provided for by the recent government decrees (e.g. Law Decree 18/2020, known as the 'Cure Italy' decree, and Law Decree 23/2020, known as the 'Liquidity' or 'Firms' decree)? □ Yes □ No **CORDL1**
***(Please answer question C6.6 only if your answer to question C6.5 was 'Yes')***

**C6.6** Did your firm obtain the requested amount? □ Yes □ Yes, but only in part □ No **CORDL2**

**C7.** Compared with 3 month ago, do you think conditions for investment are ... ? **SITINV** □ Better □ The same □ Worse

**C8.** What do you think your liquidity situation will be in the next 3 months. given the expected change in the conditions of access to credit?
□ Insufficient □ Sufficient □ More than sufficient **LIQUID**

**C9.** Compared with three months ago, is the total demand for your products ... ? **DOMTOT** □ Higher □ Unchanged □ Lower

**C10.** How will the total demand for your products vary in the next 3 months? **PRETOT** □ Increase □ No change □ Decrease

***(Answer to questions C11-C12 only if the share of sales revenues coming from exports is positive. otherwise go to C13)***

| **Compared with three months ago**, is the foreign demand for your products…? | *Higher* | *Unchanged* | *Lower* | *I do not sell in this market* |
|---|---|---|---|---|
| **C.11** Total **DOMEST** | \|__\| | \|__\| | \|__\| | |
| **C.11.1** In China **RTNEU_CI** | \|__\| | \|__\| | \|__\| | \|__\| |

**C12.** How will the foreign demand for your products vary **in the next 3 months**? **SITCRE** □ Increase □ No change □ Decrease

**C13.** Compared with three months ago, are credit conditions for your company ...? **SITCRE** □ Better □ Unchanged □ Worse

## SECTION D – Changes in your firm's selling prices

**D1**. In the last 12 months, what has been the average change in your firm's prices? **DPRE** |__| |__|__|.|__|%

**D2.** For the next 12 months, what do you expect will be the average change in your firm's prices? **DPREZ** |__| |__|__|.|__|%

Please indicate direction and intensity of the following factors as they will affect your firm's selling prices **in the next 12 months**:

| | ***Effect on firm's selling prices*** | | | ***Intensity*** *(if not nil)* | | |
|---|---|---|---|---|---|---|
| Factors affecting your firm's prices in the next 12 months | *Downward* | *Neutral* | *Upward* | *Low* | *Average* | *High* |
| **D2.1.** Total demand **DPR** | 1\|__\| | 2\|__\| | 3\|__\| | 1\|__\| | 2\|__\| | 3\|__\| |
| **D2.2.** Raw materials prices **MPPR** | 1\|__\| | 2\|__\| | 3\|__\| | 1\|__\| | 2\|__\| | 3\|__\| |
| **D2.3.** Intermediate Input **IICT** | 1\|__\| | 2\|__\| | 3\|__\| | 1\|__\| | 2\|__\| | 3\|__\| |
| **D2.4.** Labour costs **CLPR** | 1\|__\| | 2\|__\| | 3\|__\| | 1\|__\| | 2\|__\| | 3\|__\| |
| **D2.5.** Pricing policies of your firm's main competitors **PRPR** | 1\|__\| | 2\|__\| | 3\|__\| | 1\|__\| | 2\|__\| | 3\|__\| |
| **D2.6** Exchange rate dynamics **TCPR** | 1\|__\| | 2\|__\| | 3\|__\| | 1\|__\| | 2\|__\| | 3\|__\| |
| **D2.7** Inflation expectations dynamics **AINF** | 1\|__\| | 2\|__\| | 3\|__\| | 1\|__\| | 2\|__\| | 3\|__\| |
| **D2.8** Financial conditions **CFIN** | 1\|__\| | 2\|__\| | 3\|__\| | 1\|__\| | 2\|__\| | 3\|__\| |

**D3.** In the last 12 months, what has been the average change in your firm's prices of goods and services bought in Italy and abroad ?
|__| |__|__|.|__|% **DPRE_INT**

**D4.** In the next 12 months, what has been the average change in your firm's prices of goods and services bought in Italy and abroad?
|__| |__| |__|.|__|% **DPREZ_INT**

## SECTION E – Workforce

| **E1.** Your firm's total number of employees in the next 3 months will be: **OCCTOT** | *Lower* | *Unchanged* | *Higher* |
|---|---|---|---|
| | 1\|__\| | 2\|__\| | 3\|__\| |

## SEZIONE F – Investment

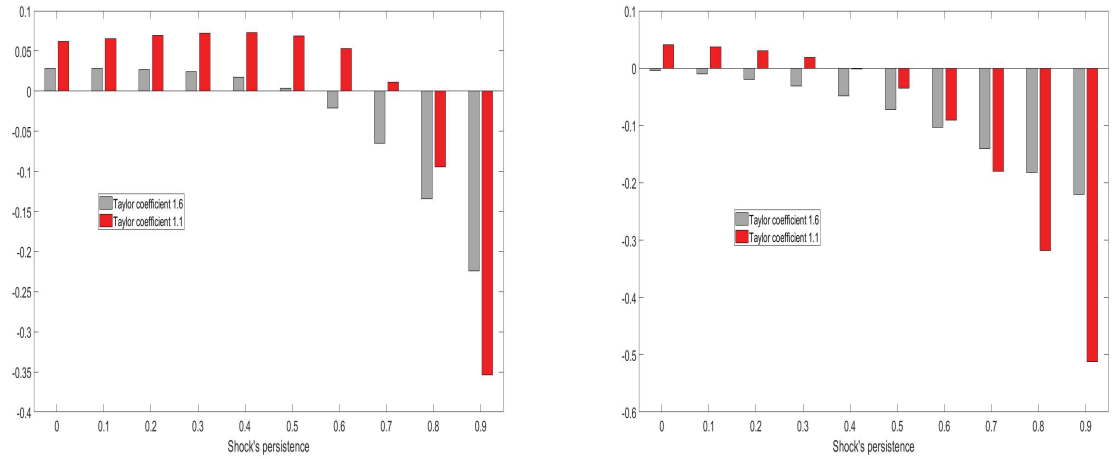
**F1.** What do you expect will be the nominal expenditure on (tangible and intangible) fixed investment in 2020 compared with that in 2019?
□ Much higher □ A little higher □ About the same □ A little lower □ Much lower **INVPRE**

**F2.** And what do you expect will be the nominal expenditure in the second half of 2020 compared with that in the first half of 2020?
□ Much higher □ A little higher □ About the same □ A little lower □ Much lower **INVSEM**

NOTE: The responses "much higher" and "much lower" also apply when, in the two periods compared, investments are zero.

# Appendix B. Sensitivity to the monetary policy responsiveness

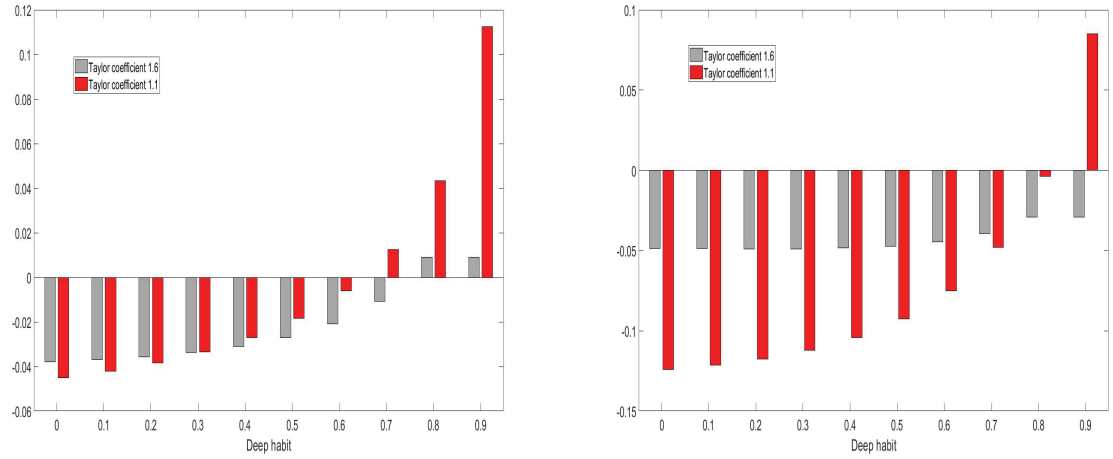
**Figure 11:** Shock's persistence and inflation response. Sensitivity to Taylor coefficient




(a) Forward-looking in. exp. - Cumulated IRFs (b) Backward-looking in. exp. - Cumulated IRFs

*Notes*: The figures report the cumulated IRFs of inflation 3 periods after the shock. IRFs shown in (a) are obtained under the assumption of forward looking inflation expectations ($\gamma = 1$), while those reported in (b) are obtained assuming $\gamma = 0.5$. Deep habit $\theta$ is set to 0.85. The other parameters are calibrated as previously indicated in the text.

**Figure 12:** Deep habit and the inflation response. Sensitivity to Taylor coefficient




(a) Forward-looking in. exp. - Cumulated IRFs (b) Backward-looking in. exp. - Cumulated IRFs

*Notes*: The figures report the cumulated IRFs for inflation 3 periods after the shock. IRFs shown in (a) are obtained under the assumption of forward looking inflation expectations ($\gamma = 1$), while those reported in (b) are obtained assuming $\gamma = 0.5$. The shock persistence $\rho_\delta$ is set equal to 0.2. The other parameters are calibrated as indicated in the main text.