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DISCUSSION PAPER SERIES

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Tiziano Ropele
Bank of Italy

Yuriy Gorodnichenko
UC Berkeley, NBER and IZA

Olivier Coibion
UT Austin and NBER

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IZA – Institute of Labor Economics

Schaumburg-Lippe-Straße 5–9
53113 Bonn, Germany

Phone: +49-228-3894-0
Email: publications@iza.org

www.iza.org

ABSTRACT

Inflation Expectations and Misallocation of Resources: Evidence from Italy*

Using Italian data that includes both inflation forecasts of firms and external information on their balance sheets, we study the causal effect of changes in the dispersion of beliefs about future inflation on the misallocation of resources. We find that as disagreement increases, so does misallocation. In times of low inflation, the aggregate TFP loss of the dispersed expectations-induced misallocation is moderate, but we argue that it likely becomes quite significant in times of high inflation.

JEL Classification: E31, C83, D84, O47
Keywords: misallocation, inflation expectations

Corresponding author:
Yuriy Gorodnichenko
Economics Department
UC Berkeley
530 Evans Hall Berkeley CA 94720
USA
E-mail: ygorodni@econ.berkeley.edu

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1. Introduction

Disagreement about future inflation is a pervasive characteristic of surveys, be they of firms, households, professional forecasters or even policy-makers. Does this disagreement matter? To the extent that agents act on those expectations (and recent empirical evidence strongly suggests that they do), then disagreement should lead to inefficient economic choices and misallocation of resources.[1] To put it simply, a firm that anticipates higher inflation than an otherwise identical competitor may set higher prices and may therefore sell fewer products: the firm with higher inflation expectations will therefore reduce its labor and capital inputs and become relatively too small. How important is this inflation expectation-induced misallocation?

In this paper, we provide new causal evidence that dispersion in the inflation expectations of firms does indeed lead to a misallocation of resources. We do so by utilizing an Italian survey of firms in which a randomly selected subset of firms is repeatedly provided with information about recent inflation. These treated firms display very little disagreement about inflation relative to untreated firms in the survey. We then use this exogenous variation in inflation disagreement to study how it affects misallocation of resources. To measure the latter, we follow the seminal approach of Hsieh and Klenow (2009) who identify misallocation through differences in marginal revenue products of inputs across firms. Because we can match firms in the survey to external information on their revenues, employment etc., we therefore have measures of both misallocation and expectations disagreement. Exploiting the exogenous information provision in the survey, we construct measures of dispersion separately for treated and for untreated firms. We find that higher dispersion in inflation forecasts leads to greater misallocation, as measured through dispersion in marginal products of both capital and labor, as well as the dispersion in differences between marginal products of capital and labor. To the best of our knowledge, this paper provides the first direct causal evidence of the link between disagreement about aggregate inflation and the misallocation of resources across firms.

How big are the effects resulting from differences in beliefs about inflation? Our empirical evidence combined with some assumptions about parameter values of a standard model of monopolistic competition with sticky prices allow us to quantify the losses associated with dispersed inflation expectations. We find these to be moderate under normal times, but

[1] See e.g. Coibion, Gorodnichenko and Ropele (2020) for evidence that changes in firms' inflation expectations affect their decisions and Coibion, Gorodnichenko and Weber (2022) for corresponding evidence for households.

potentially quite large when inflation rises significantly as it has in the last year and a half. This is because the dispersion in inflation expectations among firms has grown three-fold as expected inflation has risen from 1.5 percent in 2021Q3 to 5.5 in 2022Q4.

Specifically, we consider two thought experiments. The first is a decrease in the dispersion of inflation expectations of the same order of magnitude as what we observe in the Italian survey when firms are told about recent inflation. We think of this as the potential benefit of successful monetary communication. Our estimates imply that the aggregate TFP benefits for a rather modest policy intervention would be on the order of 0.2-0.5 percent. The second experiment considers an increase in dispersion comparable to what was observed from 2021 to 2022 as the inflation rate spiked: a tripling in the cross-sectional standard deviation of inflation expectations across firms. Our estimates imply that this would lead to a loss in aggregate TFP of 2.2 percent or more, a non-trivial cost stemming from higher inflation. Because we focus only on the effects of disagreement about inflation among firms, this is likely to be a lower bound on the aggregate TFP loss of this channel since it ignores policymaker and household dispersion in beliefs.

Our paper ties together two literatures that have largely remained distinct. The first, following Hsieh and Klenow (2009), studies the sources of misallocation. Much of this literature has focused on financial frictions (e.g. Midrigan and Xu 2014, Moll 2014) and capital adjustment costs (Asker, Collard-Wexler and De Loecker 2014). There has also been work focusing on misallocation due to imperfect information about firm-level information (Bachmann and Elstner 2015, David, Hopenhayn and Venkateswaran 2016, and David and Venkateswaran 2019). Relatedly, the New Keynesian literature has emphasized price stickiness as a source of inefficient price dispersion (e.g. Ascari and Ropele, 2007 and 2009, Coibion, Gorodnichenko and Wieland 2012), but empirical evidence on the link between inflation and price dispersion has been mixed (Nakamura et al. 2018, Sheremirov 2020). The second literature focuses on firms' expectations of macroeconomic conditions, particularly inflation. Papers in this literature have focused on how these forecasts speak to models of expectations formation (e.g. Angeletos, Huo and Sastry 2020) or on how macroeconomic expectations affect firms' decisions (Coibion, Gorodnichenko and Ropele 2020). By bridging these two literatures, our paper complements David, Schmid and Zeke (2022) who study the link between macroeconomic risk and misallocation, but we focus on inflation expectations instead.

2. Data

We combine three different sources of information to examine how dispersion in firms' inflation expectations affect the misallocation of resources in Italy. The first source is the Survey on Inflation and Growth Expectations (SIGE, henceforth), from which we elicit firms' inflation expectations and other corporate characteristics. The SIGE also represents the source of the randomized information treatment that serves to generate exogenous variation in inflation expectations (more thoroughly discussed in the next section). Second, we match the SIGE with the Company Accounts Data Service (CADS, henceforth), which includes balance sheet information on Italian limited liabilities firms that we use to construct the marginal revenue products of capital (MRPK, henceforth) and labor (MRPL, henceforth) at the firm level. The third data source is provided by the Italian National Social Security Institute (INPS), which provides information on firm-level employment. We discuss each of them in turn.

2.1 SIGE

The SIGE is a quarterly business survey conducted by the Bank of Italy since December 1999.[2] The reference universe consists of firms headquartered in Italy that operate in industry (excluding construction) and in non-financial private services and that employ at least 50 employees. Since the first quarter of 2013, construction firms have been added. The sample is stratified by three *sectors* of economic activity (industry, non-financial private services and construction; $\mathbb{S}^{(3)}$), four geographical *areas* (North-West, North-East, Centre, South and Islands; $\mathbb{A}^{(4)}$) and three classes of size in terms of number of *employees* (50-199, 200-999, 1000 and over; $\mathbb{E}^{(3)}$). In the years preceding the COVID-19 pandemic, each wave saw the participation of about 1,050 firms (400 in industry, 450 in non-financial private services and 200 in construction). The list of firms used to extract the sample is drawn from INPS and Infocamere databases Sampling weights are provided to ensure that the distribution of firms in the sample represents the distribution of firms in the reference population.

The survey is carried out by a specialist firm that distributes the questionnaire to company managers who are best informed about the topics covered in the survey. About 90 percent of the data is collected through computer-assisted web interviews in the form of an online questionnaire featuring a purpose-designed interface, while the remaining 10 percent are collected through computer-assisted telephone interviews. Data are collected largely in the

[2] Until October 2018, the survey was run jointly with the economic newspaper *Il Sole 24 Ore*.

first three weeks of March, June, September and December. The average response rate is about 45 percent.

The purpose of the survey is to elicit information on firms' expectations concerning inflation, the general economic situation, own-product prices and demand, investment, and employment. Most of the data—with the exception of own-product price changes (past and expected), inflation expectations, and current number of employees—are qualitative and relate to firms' assessments about their own business activity as well as about macroeconomic matters in the reference quarter and looking ahead. Most of the questions are repeated throughout the various waves. On occasion, the survey contains questions on specific aspects of the economy that warrant further investigation. A typical questionnaire is presented in the Appendix.

2.2 CADS

The CADS is a proprietary database owned by Cerved Group S.p.A., a leading information provider in Italy and a major credit rating agency in Europe. CADS includes detailed information on balance sheet and income statements for almost all Italian limited liability non-financial companies since 1993. Information is drawn from official data recorded at the Italian Registry of Companies and from financial statements filed at the Italian Chambers of Commerce. Companies provide data on a compulsory basis. Each company's financial statement is updated annually. This dataset includes yearly balance sheet information on various assets and liability items as well as yearly income statement information.

2.3 INPS

The INPS regularly compiles data archives on the national social security system by collecting monthly administrative information that employers, operating in the private nonagricultural sectors, have to provide to pay pension contributions for their employees. Among other things, for each worker the employers report the gross take-home pay, the type of contract (open-ended or fixed-term) and the broad occupational category (apprentice, blue collar, white collar, supervisor or manager). In this study, we use firm-level annual information on the total number of employees.

3. Measurement of MRPK and MRPL

As outlined in Hsieh and Klenow (2009), in a canonical model of monopolistic competition with heterogeneous firms producing differentiated goods via Cobb-Douglas production functions, the marginal revenue products of capital and labor are approximately given by

$$MRPK_{it} \approx s_i^K \frac{VA_{it}}{K_{it}}$$

$$MRPL_{it} \approx s_i^L \frac{VA_{it}}{L_{it}}$$

where i, t index firms and time, VA_{it}, K_{it} and L_{it} denote respectively value added, capital and labor, s_i^K and s_i^L represent respectively the (steady-state) cost shares of capital and labor.

Using annual information from CADS and from INPS we construct the firm-level data analogues of the theoretical marginal revenue products reported above. We first construct annual measures of MRPK and MRPL and then linearly interpolate them to obtain quarterly estimates. The stock of capital K_i is constructed by the perpetual inventory method using balance-sheet information starting from 1995. The number of workers L_i is taken from INPS since this information is not reported on balance sheets on a mandatory basis.[3] The cost shares of capital and labor are computed as $s_i^K \equiv 1/19 \sum_{t=2006}^{2019} \frac{C_{it}^K}{C_{it}^K + C_{it}^L}$ and $s_i^L \equiv 1 - s_i^K$, where C_{it}^K and C_{it}^L denote respectively the cost of annual amortization of fixed assets and the cost of labor, both from CADS. Table 1 reports the standard deviation of the (log) marginal revenue products of capital and labor for the sample of surveyed firms and for the entire population.

4. Empirical strategy

With measures of firms' inflation expectations and marginal products of inputs, we are in a position to study the link between the two. But causality can run in both directions. Firms with different beliefs may choose to make different decisions, such that dispersed information leads to misallocation. Firms who better allocate their inputs may have more resources left to allocate to information processing, so more misallocation would lead to more dispersed expectations. Because our data also includes a randomized information treatment, our empirical strategy can address this endogeneity and identify the causal effect of dispersed beliefs about inflation on misallocation.

4.1 Randomization

At the core of our research design is the randomization of information provision in the SIGE. Since 2012Q3 the SIGE fielded two versions of the question eliciting annual inflation expectations at various horizons: next 6 months, next year, next two years, and (since 2014Q1) years 3-4. Because expectations are highly correlated across horizons, we focus on one-year-

[3] The number of employees at the firm level is also reported in SIGE. As discussed in Coibion, Gorodnichenko and Ropele (2020) there is a high degree of consistency of levels of employment reported in INPS and SIGE (the correlation is 0.95), but occasionally there are discrepancies largely due to differences in the definition of a firm, for example at a corporate group level as opposed to a narrower level (e.g. headquarters). For about 10 per cent of the observations, we measured the number of employees using the information from SIGE rather than INPS.

ahead forecasts. Approximately 1/3 of the sample received the following question about inflation expectations:

> *"What do you think consumer price inflation in Italy, measured by the 12-month change in the Harmonized Index of Consumer Prices, will be…"*

while the rest of the sample had

> *"In [previous month], consumer price inflation measured by the 12-month change in the Harmonized Index of Consumer Prices was [X.X]% in Italy and [Y.Y]% in the Euro area. What do you think it will be in Italy …"*

We take the first subsample as the control group (no provision of information) and the second subsample as the treatment group (provision of information). Before 2012Q3, all firms received the second formulation of the question so that all firms were in the treatment group. Which version of the question a firm receives was determined via randomization. Once assigned to a group, a firm generally stays in that group for a number of survey waves. Assignment was randomly redrawn in 2012Q4 and then again in 2017Q2. Coibion, Gorodnichenko and Ropele (2020) verify that assignment is not predicted by observable characteristics of firms. After collecting employment and inflation expectations, the survey collects additional information on firms' perceptions and expectations about micro- and macroeconomic conditions. Our sample ends in 2019Q4 to exclude the COVID19 period but we return to post-COVID19 dynamics in section 6.

Figure 1 summarizes the properties of inflation expectations for the two groups. The average inflation expectations (Panel B) and disagreement (cross-sectional standard deviation of expectations; Panel C) are similar across treatment and control groups before 2012Q3 since both were being provided with the same information,[4] but a clear divergence becomes visible after 2012Q3 when their information sets differ. The average expectation of the treatment group follows actual inflation (i.e., the provided signal) much more closely than the average expectation of the control group. We also observe that the disagreement in inflation expectations is considerably smaller for the treatment group than for the control group. Panel A of Figure 1 plots cross-sectional kernel densities for inflation expectations in select quarters and documents that the post-2012Q3 treatment-control differences are a prominent feature of the data: inflation expectations for the treatment group are much more concentrated around the provided information.

[4] For this figure, we construct the control group before 2012Q3 as follows: a firm is taken to be in the control group if it was assigned into the control in the 2012Q3 wave of the survey.

Note that the provided information is publicly available and hence the differences in the properties of inflation expectations suggest a departure from full-information rational expectations (FIRE). As documented in Coibion, Gorodnichenko and Ropele (2020), differences in inflation expectations translate into differences in actions (employment, capital, prices, borrowing decisions, etc.) and outcomes (firms provided with the extra information ultimately make slightly higher profits on average). These results suggest that information frictions leading to more dispersed beliefs can exacerbate the misallocation of resources in the economy.

4.2 Econometric approach

Our baseline econometric specification is a Jorda (2005) projection. To fully utilize information in the survey which is stratified by region, sector and firm size, we construct in any given period 36 cells defined by the Cartesian product $\mathbb{S}^{(3)} \times \mathbb{A}^{(4)} \times \mathbb{E}^{(3)}$ both for the group of treated firms and for control firms. We then compare moments for treated and control firms within corresponding cells in any given period. This focus on cells not only ensures that we juxtapose moments for comparable firms but also increases the sample size and hence the precision of our estimates.

The outcome variable for misallocation for input $X \equiv (K, L)$ is given by $y_{j,t}^{MRPX} \equiv std_{j,t}^{treatment}(\log(MPRX_{i\in j,t})) - std_{j,t}^{control}(\log(MPRX_{i\in j,t}))$ where i, j, t index firms, cells, and time. Note that the standard deviation (std) operator collapses the data for the cell-time unit. Thus, $y_{j,t}^{MRPX}$ measures the difference in the dispersion of marginal revenue products for input X between control and treatment groups within a cell in a given period. The key regressor in our context is the difference in dispersion of one-year-ahead inflation expectations $F_{i\in j,t}\pi^{1y}$ for treated and control firms within a cell-time unit: $x_{j,t} \equiv std_{j,t}^{treatment}(F_{i\in j,t}\pi^{1y}) - std_{j,t}^{control}(F_{i\in j,t}\pi^{1y})$. Before constructing $y_{j,t}^{MRPX}$ and $x_{j,t}$ we trim data at the bottom and top 1 percent to minimize the potential adverse effects of outliers. We also exclude cells than have less than four observations.

We estimate the following equation on the data for 2012Q3-2019Q4:

$$y_{j,t+h}^{MRPX} = c_j^{(h)} + \tau_t^{(h)} + \sum_{k=0}^{4} \beta_k^{(h)} \times x_{j,t-k} + \sum_{k=1}^{4} \rho_k^{(h)} \times y_{j,t-k}^{MRPX} + error_{j,t} \qquad (1)$$

where c and τ are cell and time fixed effects. By varying h from 0 to H, we estimate the impulse response $\left\{\hat{\beta}_0^{(h)}\right\}_{h=0}^{H}$ of the outcome variable y at horizon $t+h$ to a shock in x in period t.

Because the error term can be correlated across time and cells, we use the Driscoll and Kray (1998) standard errors for inference. Note that variation in $x_{j,t}$ comes from randomization and thus we can estimate specification (1) by OLS and do not need to include other controls.[5] Furthermore, although the marginal revenue products could have measurement errors (e.g., capital is interpolated to obtain quarterly series, quality of labor and production function may vary across firms), $x_{j,t}$ is based on exogenous and consistently measured variation in inflation expectations and hence measurement errors in $y_{j,t}^{MRPX}$ should not materially affect $\hat{\beta}_0^{(h)}$.

5. Results

Panels A and B of Table 2 report the estimated impulse responses of the dispersion for $\log(MRPK)$ and $\log(MRPL)$ to a shock in the dispersion of inflation expectations. The responses tend to be hump-shaped with peaks around the third quarter. Across the horizons, the average responses are 7.0 (s.e. 3.5) for $\log(MRPK)$ and 4.6 (s.e. 2.5) for $\log(MRPL)$.[6] Although survey data are inherently noisy, some of the estimated responses (especially peaks) are statistically significant. To further evaluate the importance of inflation expectations in accounting for variation in marginal revenue products, we compute the marginal R^2 from including $\sum_{k=0}^{4} \beta_k^{(h)} \times x_{j,t-k}$ terms in specification (1). We find that across the horizons the average marginal R^2 is 0.03 for $MRPK$ and 0.02 for $MRPK$. Again, given the noise in survey data, this is a sizable increase in the explanatory power. Hence, these results suggest that variation in the dispersion of inflation expectations results in a meaningful variation in the dispersion of marginal revenue products. In other words, dispersed information contributes to the dispersion of marginal revenue products across firms and thus plays a role in the efficiency of resource allocation across firms.

We are not aware of other empirical estimates that can be used to benchmark our results but we can use recent theoretical studies to this end. Specifically, Werning (2022) derives relationships for firms' prices and inflation expectations for various forms of price setting (e.g., time dependent vs. state dependent, Calvo vs. Taylor) holding other expectations and variables constant. Building on Werning (2022), we assume Calvo pricing (to have analytical

[5] Specification (1) also has an instrumental variable interpretation where the instruments are given by a set of indicator variables for the interaction of treatment status, cell and quarter. The set of instruments is thus large and may include many weak instruments (e.g., when actual inflation is close to the consensus belief of the control group). Given that the variation in inflation expectations is created by randomization, we prefer OLS estimation of specification (1).

[6] We also test the joint hypothesis that the path is equal to zero. The p-values are 0.038 for $\log(MRPK)$ and 0.039 for $\log(MRPL)$.

expressions) to relate the dispersion in inflation expectations to the dispersion in prices and, in turn, dispersion in marginal revenue products for the textbook New Keynesian model (e.g., Galí 2015). Although tentative (our results depend on the details of price setting and the *ceteris paribus* assumption in Werning (2022)), our analysis (see Appendix A for derivations) suggests that for plausible calibrations, the sensitivity of the (cross-sectional) standard deviation of the marginal revenue product to the (cross-sectional) standard deviation of inflation expectations varies from 2 to 10. Furthermore, the sensitivity tends to be lower when the elasticity of substitution across varieties of goods is lower, the production function is closer to being linear, and the frequency of price changes is higher. We view these theoretical ranges as being broadly in agreement with our empirical estimates.

In the next step, we run a series of robustness checks of the sensitivity of our results to alternative procedures and assumptions. First, we examine whether alternative definitions of the cell affect our estimates. Our baseline uses the most disaggregated level available in the survey. While this approach maximizes the amount of variation available for regressions, some cells may contain relatively few observations (thus increasing measurement error in x and attenuating $\hat{\beta}_0^{(h)}$) or fail to capture the right definition of "peers" (e.g., for some firms the market is the North of Italy rather than North-East or North-West). Since we do not have a priori information to determine the right size of the cell, we consider 24 possible configurations for cells by appropriately re-combining the four geographical locations, the three sizes, and the three economic sectors. We find (Figure 3) that although there is some variation in the estimates, our baseline generally provides middle-of-the-road if not conservative estimates. We find similar results when we use shorter (6 month ahead) or longer (2 year ahead) horizons for inflation expectations, trim data more aggressively, do not interpolate the data or compute the capital expenditure proxying the rental price of capital by the sum of the firm-specific cost of credit and the capital depreciation rate (see Appendix A).

6. **Aggregate TFP effects of dispersed expectations-induced misallocation**

Although the basic New Keynesian framework provides a way to quantify the effects from the dispersion of prices, we prefer the direct approach developed in Hsieh and Klenow (2009) because it is less reliant on specific assumptions about price setting and other auxiliary assumptions made in mainstream New Keynesian models. We are interested in conducting two thought experiments. First, information treatments reduce the dispersion in inflation expectations and we would like to know how this reduction can affect the aggregate TFP. Because firms and households appear to react similarly to information about past inflation and inflation target (Coibion, Gorodnichenko and Weber 2022, Coibion, Gorodnichenko and Ropele 2020, Bottone, Tagliabracci and Zevi 2022), this experiment can give a sense of what policymakers can potentially achieve through their policy communication. Second, we are interested in quantifying the aggregate TFP loss due to elevated dispersion of inflation expectations during the post-COVID19 surge in inflation. Because our estimation is based on data for a low-inflation environment, this experiment is an out-of-sample exercise and thus more speculative in its nature.

As in Hsieh and Klenow (2009), we use the identifying assumption of no distortions in labor and rely on the following expression for aggregate TFP effects from the dispersion of marginal revenue products (see Gorodnichenko et al. 2018 for derivations)

$$
\begin{aligned}
TFP = & -\left\{\frac{\alpha(1-\alpha)}{2}+\frac{\alpha(1+\alpha)\sigma}{2}\right\} \times \operatorname{var}(\log(MRPK)-\log(MRPL)) \\
& -\frac{\sigma(1+\alpha)}{2} \times \operatorname{var}(\log(MRPL)) \\
& +\frac{\sigma\alpha}{2} \operatorname{var}(\log(MRPK)). \qquad (2)
\end{aligned}
$$

where $\operatorname{var}(\cdot)$ measures the cross-sectional variance, σ is the elasticity of substitution across varieties and $1-\alpha$ is the share of labor costs in value added.

We calculate the change in the dispersion of marginal revenue product for input X with $\Delta\operatorname{var}(\log MRPX_i) = \beta^2 \Delta var(F_{it}\pi^{1y})$ where β is the estimate of $\beta^{(h)}$ in specification (1). Note that we need to run an additional regression of specification (1) with $std_{jt}^{conrol}(\log(MPRK_{ijt}) - \log(MPRL_{ijt})) - std_{jt}^{treatment}(\log(MPRK_{ijt}) - \log(MPRL_{ijt}))$ as the dependent variable which measures the dispersion in the capital-to-labor ratio; the results are reported in Panel C of Table 2. We vary σ from 3 (the baseline in Hsieh and Klenow (2009)) to 10 (a popular calibration in the New Keynesian literature). We set $1-\alpha = 0.84$ which is the average labor share in our sample. For each marginal revenue product, we use the corresponding estimates of β_h averaged across horizons $h = 0, \dots, 6$ for each marginal revenue product.

For the first experiment ("communication"), we set $\Delta\operatorname{var}(F_{it}\pi^{1y}) = 0.51^2 - 0.75^2 = -0.3$ which is the average decrease in the dispersion of inflation expectations after the information treatment in our sample. We find (columns (1)-(3) of Table 3) that policy communication with a basic information treatment (i.e., informing firms about past inflation) can provide discernible aggregate TFP gains by reducing disagreement in inflation expectations. With a high elasticity of substitution ($\sigma = 10$), communicating past inflation to firms improves aggregate TFP by around a half percentage point. A conservative $\sigma = 3$ entails a 0.16 percent gain. These results suggest that even a modest intervention with policy communication can be a useful tool which can improve the allocation of resources by reducing disagreement across managers. Nonetheless, the cost of dispersed beliefs about inflation expectations in normal times is clearly limited.

For the second experiment ("post-COVID19 inflation surge"), we use the change in the disagreement in inflation expectations for Italian firms participating in SIGE during the inflation run-up. Specifically, the cross-sectional standard deviation for the control group increased from 0.93 in 2021Q3 to 3.3 in 2022Q4. Over the same period, the average inflation forecast for the control group increased from 1.5 percent in 2021Q3 to 5.5 in 2022Q4.[7] This positive comovement of average inflation expectations and disagreement in inflation expectations also applies to the pre-COVID19 period: for 2012-2019, a one percentage point increase in average inflation expectations is associated with 0.17 (s.e. 0.07) percentage point increase in disagreement (standard deviation), consistent with earlier evidence in Mankiw, Reis and Wolfers (2004).

Note that specification (1) was estimated on the data from a low inflation environment. Because the mapping from the dispersion of inflation expectations to the dispersion of marginal revenue products depends on the frequency of price changes (see Appendix), we need to adjust estimated βs for the higher frequency of price adjustment during the post-COVID surge in inflation. Although we do not have access to micro-level producer price data for Italy, the SIGE asks firms to report the average size of price changes over the previous 12 months. Using these data, we observe that the share of firms reporting no price change fell by roughly 50 percent in 2022Q4 relative to recent quarters with low inflation. Our theoretical derivations in Appendix A suggest that this increase in the flexibility of prices should reduce β's by a third.

Using the adjusted values for $\beta's$ as calibration, we find (columns (4)-(6)) that the recent surge in inflation expectations disagreement (which likely stems from the rise in inflation and hence average inflation expectation) is rather costly for aggregate TFP: even the conservative estimate with $\sigma = 3$ suggests a 2.2 percent reduction in aggregate TFP. These results suggest that the recent surge in inflation could have an additional headwind for the post-COVID recovery with potentially long-run effects and hence central banks have an additional rationale to respond to inflation.

[7] The experience of US firms is similar, although the US inflation was leading inflation in other countries. In the survey of firms' inflation expectations (http://firm-expectations.org/data.html; see Candia, Coibion and Gorodnichenko (2021) for details), standard deviation increased from 1.3 in 2021Q2 2021 to 2.8 in 2022Q3 while the average forecast increased from 3.2 percent to 6.9 percent over the same period.

These exercises point to several broad conclusions. First, given the positive association between average inflation expectations and disagreement in inflation expectations, our results point toward an underemphasized cost of a higher inflation target: greater misallocation due to more dispersed beliefs. Second, the lack of attention to inflation in recent pre-COVID times likely contributes to the dispersion of inflation expectations which in turn contributes to misallocation of resources. This suggests that more vigorous communication by policymakers could not only help anchor expectations around a desired target but also to achieve a better allocation of resources. Third, households and (to a lesser extent) firms interpret inflation as a supply-side phenomenon (e.g., Kamdar 2018). Because dispersion in inflation expectations increases with inflation,[8] the resulting deterioration in allocation of resources may provide a rationale for this stagflationary view.

7. **Conclusions**

A long literature has studied the systematic disagreement among households and firms about future inflation. But whether this disagreement matters has been a point of contention (e.g. Reis 2021). We provide new causal evidence that higher disagreement about inflation among firms creates more misallocation: dispersed macroeconomic beliefs lead to suboptimal outcomes, in particular when inflation becomes high.

This result highlights an additional cost of inflation that is typically absent in standard New Keynesian analyses of the optimal inflation rate (Andrade et al. 2019). This could also provide a new margin to help explain some of the large differences in misallocation observed between advanced (typically low inflation) economies and developing (typically higher inflation) economies.

Doing so may require moving beyond the imperfect information and rational inattention paradigms which have been so successful in explaining many other features of expectations. This is because the well-known fact that higher inflation is associated with more disagreement (Mankiw, Reis and Wolfers 2004) is not easily reconciled with rational inattention: since higher inflation is also more volatile, agents should choose to be more attentive under high inflation and disagreement should therefore be lower. Explaining this fact should spur new research toward understanding how expectations are formed and how those beliefs affect real outcomes.

[8] The positive association is a common feature in survey data as shown in Mankiw, Reis and Wolfers (2004). For example, the correlation between average one-year-ahead inflation expectations and the disagreement (standard deviation) in inflation expectations in the Michigan Survey of Consumers is 0.61 for the 1978-2019 period. A one percentage point increase in inflation expectations is associated with 0.44 (s.e. 0.08) increase in disagreement (standard deviation).

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Table 1. Standard deviation of (log) marginal revenue products of capital and labor.

	Panel A. Surveyed firms in SIGE					
	$MRPK$	Obs.	$MRPL$	Obs.	MRPK-MRPL	Obs.
All years	68.23	8,509	58.31	8,812	70.05	8457
2012	67.04	907	58.87	951	66.34	901
2013	70.15	1,093	60.68	1,118	71.12	1,087
2014	68.03	1,161	58.55	1,185	70.90	1,148
2015	67.18	1,090	58.16	1,120	71.39	1,090
2016	66.74	1,102	58.58	1,145	70.61	1,101
2017	68.22	1,061	55.92	1,084	67.67	1,052
2018	67.50	963	58.56	993	68.88	952
2019	69.36	1,132	54.72	1,216	72.13	1,126

	Panel B. Universe of firms					
	$MRPK$	Obs.	$MRPL$	Obs.	MRPK-MRPL	Obs.
All years	65.95	143,133	59.99	157,878	81.19	143,133
2012	65.70	16,828	59.93	18,466	77.15	16,923
2013	63.46	16,762	59.62	18,395	75.98	16,799
2014	66.87	16,846	59.64	18,474	78.12	16,848
2015	65.68	17,250	61.93	18,919	80.85	17,236
2016	65.55	18,065	60.10	19,846	82.05	18,061
2017	68.14	18,715	59.88	20,526	85.86	18,684
2018	65.84	19,210	59.56	21,144	84.85	19,188
2019	65.39	19,457	59.06	22,108	82.61	19,394

Notes: The (log) marginal revenue products of capital (MRPK) and labor (MRPL) are calculated as in Section 2.2. All standard deviations reported in the table are multiplier by 100. Values reported in Panel A are computed on the sample of firms of the Survey on Inflation and Growth Expectations (SIGE) using survey weights. Values reported in Panel B are computed on all firms present in the Company Accounts Data System with at least 50 employees and belonging to the same sectors covered in SIGE. Values of the (log) MRPLK and of the (log) MRPL are unweighted. Data are trimmed at bottom and top 1 percent.

Table 2. Baseline results.

	Response horizon h						
	$h=0$	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Dependent variable $std_i^{treat}\left(\log\left(MRPK_{i,t+h}\right)\right) - std_i^{control}\left(\log\left(MRPK_{i,t+h}\right)\right)$							
$std_i^{treat}(F_{it}\pi^{1y}) - std_i^{control}(F_{it}\pi^{1y})$	5.180**	5.022	12.059***	8.034	8.157	5.527	5.032
	(2.512)	(4.542)	(3.683)	(5.300)	(5.815)	(7.886)	(6.608)
Obs.	554	525	501	481	456	433	410
R^2	0.571	0.408	0.344	0.281	0.291	0.312	0.360
R^2 increment	0.013	0.021	0.028	0.018	0.022	0.043	0.065
p-value (path $h = 0, \dots, 6$ = zero)				0.038			
Panel B: Dependent variable $std_i^{treat}\left(\log\left(MRPL_{i,t+h}\right)\right) - std_i^{control}\left(\log\left(MRPL_{i,t+h}\right)\right)$							
$std_i^{treat}(F_{it}\pi^{1y}) - std_i^{control}(F_{it}\pi^{1y})$	-3.812	-0.702	7.718*	8.387**	4.540	10.071**	5.752
	(2.908)	(2.377)	(3.856)	(3.792)	(4.607)	(4.425)	(4.915)
Obs.	554	525	501	481	456	433	410
R^2	0.437	0.355	0.302	0.270	0.283	0.302	0.312
R^2 increment	0.014	0.023	0.030	0.024	0.022	0.026	0.024
p-value (path $h = 0, \dots, 6$ = zero)				0.039			
Panel C: Dependent variable $std_i^{treat}\left(\log\left(MRPK_{i,t+h}\right) - \log\left(MRPL_{i,t+h}\right)\right) - std_i^{control}\left(\log\left(MRPK_{i,t+h}\right) - \log\left(MRPL_{i,t+h}\right)\right)$							
$std_i^{treat}(F_{it}\pi^{1y}) - std_i^{control}(F_{it}\pi^{1y})$	-1.159	-1.279	13.242***	6.047	1.455	4.322	2.244
	(3.587)	(5.137)	(3.770)	(4.230)	(3.486)	(6.109)	(5.074)
Obs.	554	525	501	481	456	433	410
R^2	0.504	0.420	0.422	0.355	0.370	0.379	0.383
R^2 increment	0.025	0.037	0.034	0.008	0.008	0.019	0.026
p-value (path $h = 0, \dots, 6$ = zero)				0.005			

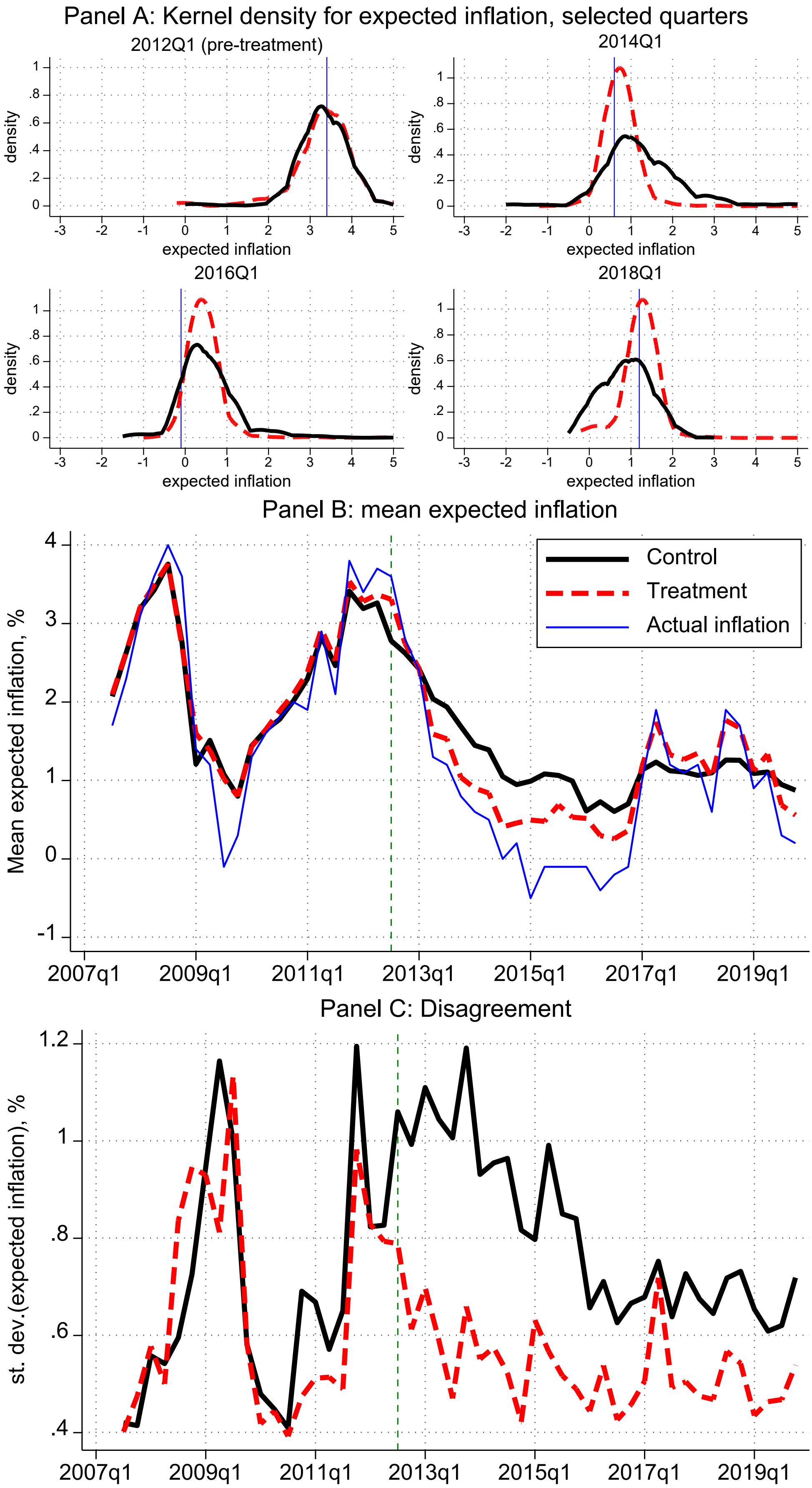
Notes: The table reports estimates of $\beta_0^{(h)}$ in specification (1). The estimation sample is 2012Q3-2019Q4. Cell (sector×region×size) and time fixed effects are included but not reported. The dependent variable is the difference in standard deviation of a marginal revenue product for control and treatment groups. The key regressor is the difference in standard deviation of one-year-ahead inflation expectations for control and treatment groups. In Panels A-C, 4 lags of the dependent variable and 4 lags of the different in dispersion of inflation expectations are included but not reported. Standard errors reported in parentheses are as in Driscoll and Kraay (1998). ***, **, * denote statistical significance at 1, 5 and 10 percent level. The R^2 *increment* is the change in R^2 in the specification with dispersion of inflation expectations relative to the specification where terms with the dispersion of inflation expectations are not included. p-value (path $h = 0, \dots, 6$ = zero) reports the p-value for the joint test of $\beta_0^{(0)} = \cdots = \beta_0^{(6)} = 0$.

Table 3. Aggregate TFP calculations

	Experiment #1 "communication"			Experiment #2 "post-COVID19 inflation surge"		
	(1)	(2)	(3)	(4)	(5)	(6)
Capital share in costs, α	0.162	0.162	0.162	0.162	0.162	0.162
Elasticity of substitution across varieties, σ	10	5	3	10	5	3
Change in the variance of inflation expectations	-0.298	-0.298	-0.298	9.738	9.738	9.738
Sensitivity of marginal revenue product dispersion to dispersion in inflation expectations, β						
coefficient for $std(\log(MRPK) - \log(MRPL))$	3.553	3.553	3.553	2.345	2.345	2.345
coefficient for $std(\log(MRPL))$	4.565	4.565	4.565	3.013	3.013	3.013
coefficient for $std(\log(MRPK))$	7.002	7.002	7.002	4.621	4.621	4.621
Implied change in the variance of marginal revenue products						
change in $\mathrm{var}(\log(MRPK) - \log(MRPL))$	-0.00038	-0.00038	-0.00038	0.005355	0.005355	0.005355
change in $var(\log(MRPL))$	-0.00062	-0.00062	-0.00062	0.008838	0.008838	0.008838
change in $var(\log(MRPK))$	-0.00146	-0.00146	-0.00146	0.020794	0.020794	0.020794
Weights						
weight on $\mathrm{var}(\log(MRPK) - \log(MRPL))$	1.006	0.537	0.349	1.006	0.537	0.349
weight in $var(\log(MRPL))$	5.808	2.904	1.742	5.808	2.904	1.742
weight in $var(\log(MRPK))$	0.808	0.404	0.242	0.808	0.404	0.242
Aggregate TFP loss (-) or gain(+), percent	0.52	0.26	0.16	-7.35	-3.69	-2.23

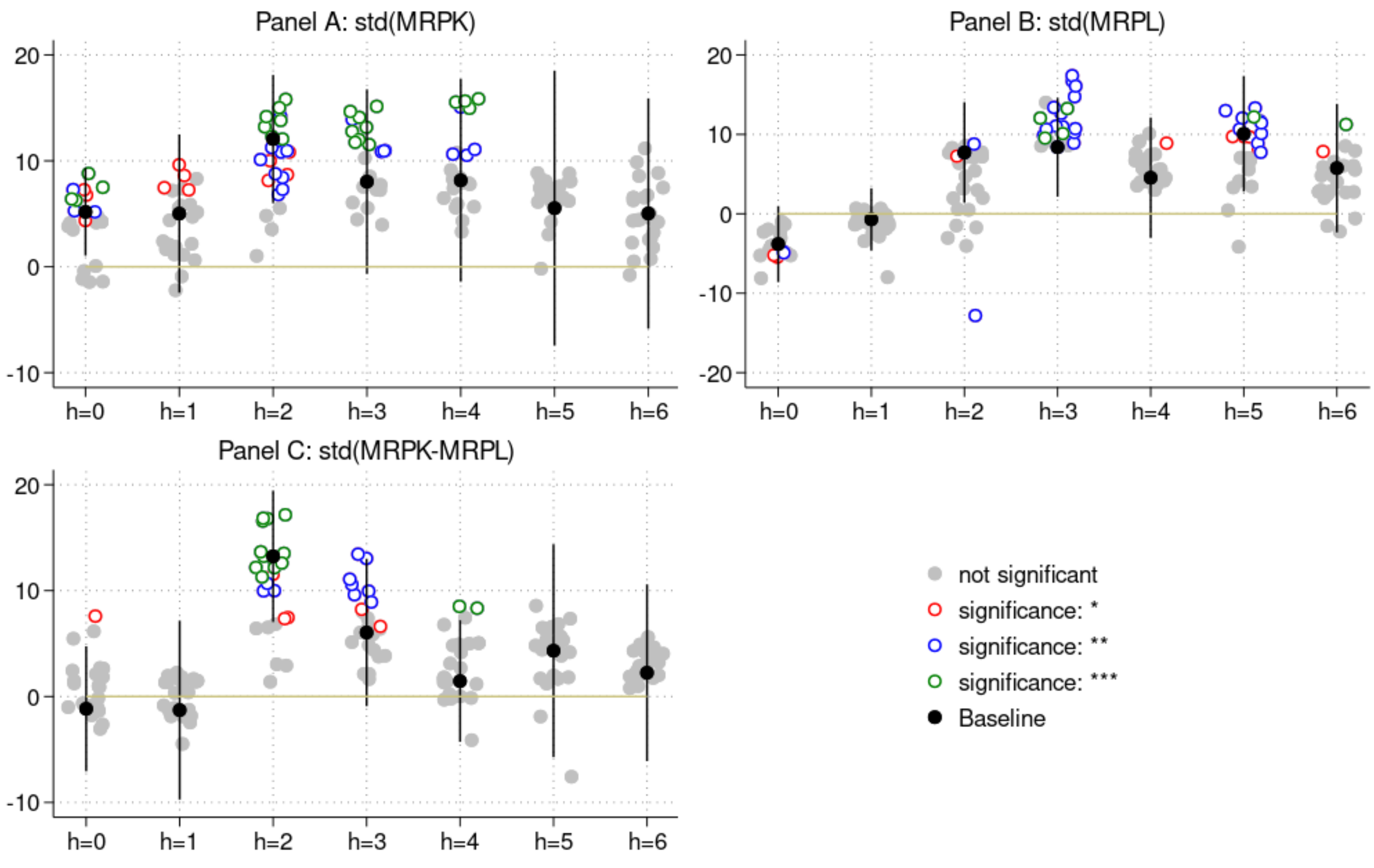
Notes: The table reports the computation of the aggregate TFP losses or gains from misallocation of resources using equation (2) presented in Section 6 and considering two thought experiments. In the "communication" experiment we let the change in the variance of inflation expectations be given by the average decrease in the dispersion of inflation expectations after the information treatment between the treated and control groups. In the "post-COVID19 inflation surge" experiment we let the change in the variance of inflation expectations be given by the increase in the variance of inflation expectations between 2021Q3 and 2022Q4. Data on inflation expectations are trimmed at bottom and top 1 percent. The results reported in the table are calculated for different values of the elasticity of substitution across varieties.

Figure 1. Basic properties of inflation expectations.



Notes: All inflation expectations are for the one-year-ahead horizon. Survey responses in Panel A are restricted to be between -3 and 5 to make the figure more readable. For Panels B and C, we trim survey responses at top and bottom 0.5 percent.

Figure 2. Alternative estimates for the causal effect of inflation expectations dispersion on the dispersion of marginal revenue products

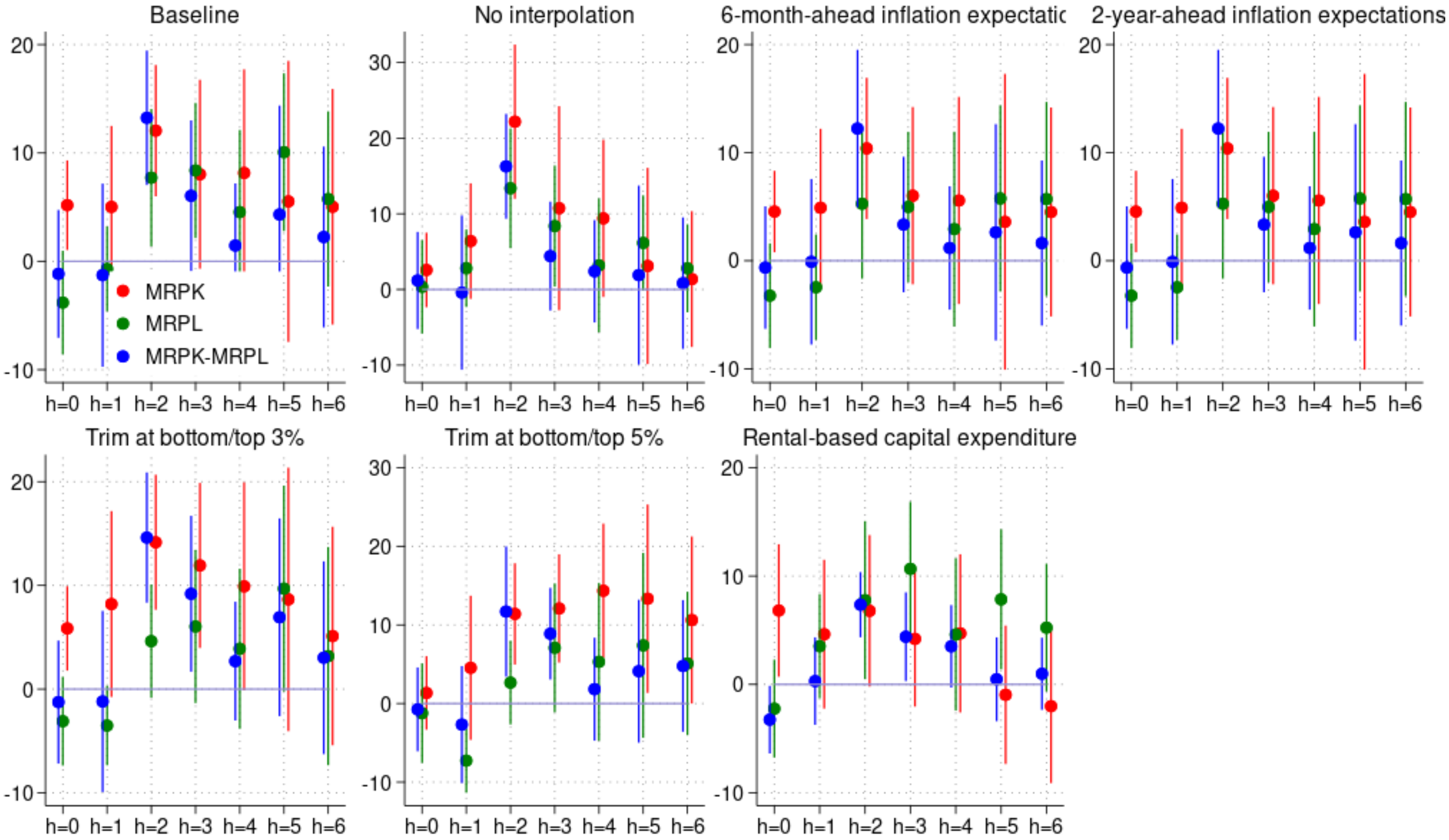


Notes: This figure shows the estimates of the coefficient β_0^h (see notes in Table 1) for alternative definitions of cells. In particular, we consider 24 possible configurations by appropriately re-combining the four geographical locations, the three sizes, and the four economic sectors. The baseline estimates are shown with black circles and whiskers (90 percent confidence interval).

ONLINE APPENDIX

Appendix A. Robustness checks

Appendix Figure 1. Robustness checks to Baseline Estimates.



Notes: This figure shows the estimates of the coefficient β_0^h (see notes in Table 1) for alternative data treatments (no interpolation and trimming at bottom and top 5 or 3 percent) or use of inflation expectations at different horizons (6-month and 24-month ahead). The baseline estimates are shown in the top left panel. Circles represent the point estimates while the whiskers the 90 percent confidence interval.

Appendix B: Derivations

We consider the textbook New Keynesian model (e.g., Gali 2015) to assess how the dispersion of inflation expectations should be related to the misallocation of resources.

We assume that the demand function for a variety produced by firm $i \in [0,1]$ is given by $Y_{it} = Y_t \left(\frac{P_{it}}{\bar{P}_t}\right)^{-\sigma}$ where i, t index firms and time, Y_{it} is output, P_{it} is the price of variety i, $\bar{P}_t$ is the price level. The production function is $Y_{it} = Z_t L_{it}^{1-\alpha}$ where Z_t is the level of technology that is common across firms, L_{it} is the labor input. Workers are freely mobile across firms so that the wage is the same across firms. If follows that the revenue (and value added since there are no intermediate inputs) for firm i is given:

$$R_{it} = P_{it}Y_{it} = P_t Y_t^{1/\sigma} Y_{it}^{1-1/\sigma} = P_t Y_t^{\frac{1}{\sigma}} \left(Z_t L_{it}^{1-\alpha}\right)^{1-1/\sigma} = P_t Y_t^{\frac{1}{\sigma}} Z_t^{1-1/\sigma} L_{it}^{(1-\alpha)(1-1/\sigma)} = X_t L_{it}^{(1-\alpha)(1-1/\sigma)}$$

where $X_t \equiv P_t Y_t^{\frac{1}{\sigma}} Z_t^{1-1/\sigma}$ is common across firms. Marginal revenue product of labor for firm i is given by

$$MRPL_{it} \equiv \frac{\partial P_{it} Y_{it}}{\partial L_{it}} = X_t (1-\alpha)\left(1-\frac{1}{\sigma}\right) L_{it}^{(1-\alpha)\left(1-\frac{1}{\sigma}\right)-1}.$$

In what follows, we will use lower-case letters to denote logs of the corresponding variables, e.g., $l_{it} = \log(L_{it})$. The cross-sectional dispersion of log marginal revenue product is given by

$$var_i(mrpl_{it}) = \left[(1-\alpha)\left(1-\frac{1}{\sigma}\right)-1\right]^2 var_i(l_{it})$$

Note that

$$L_{it} = Z_t^{-\frac{1}{1-\alpha}} Y_{it}^{\frac{1}{1-\alpha}} = Z_t^{-\frac{1}{1-\alpha}} \left(Y_t \left(\frac{P_{it}}{\bar{P}_t}\right)^{-\sigma}\right)^{\frac{1}{1-\alpha}} = Z_t^{-\frac{1}{1-\alpha}} Y_t^{\frac{1}{1-\alpha}} P_t^{\frac{\sigma}{1-\alpha}} P_{it}^{\frac{-\sigma}{1-\alpha}} = Q_t P_{it}^{\frac{-\sigma}{1-\alpha}}$$

where $Q_t \equiv Z_t^{-\frac{1}{1-\alpha}} Y_t^{\frac{1}{1-\alpha}} P_t^{\frac{\sigma}{1-\alpha}}$ is common across firms. It follows that the cross-sectional dispersion of labor input is related to the cross-sectional dispersion of prices $var_i(l_{it}) = \left(\frac{-\sigma}{1-\alpha}\right)^2 var_i(p_{it})$ and hence

$$var_i(mrpl_{it}) = \left[(1-\alpha)\left(1-\frac{1}{\sigma}\right)-1\right]^2 \left(\frac{-\sigma}{1-\alpha}\right)^2 var_i(p_{it})$$

To make further progress, we need to make assumptions about how firms set prices. We posit that firms use Calvo pricing with the probability of price adjustment equal to $1-\lambda$.

From Werning (2022, p. 11), we know that the log approximation for the optimal reset price for the Calvo pricing is given by:

$$p_{it}^* - \bar{p}_{t-1} = \frac{1}{1-\beta\lambda}\pi_{it}^e + a_{it}$$

where β is the discount factor, $1-\lambda$ is the probability of price resets, $\bar{p}_t$ is the average price (i.e., $\bar{p}_t = E_i(p_{it})$ which gives the price level), a_t collects terms that do not depend on inflation expectations (e.g., future real marginal costs). Note that this expression does not require firms resetting their prices to have the same expectations.

In the next step, we relate prices dispersion to the dispersion of inflation expectations and other factors. Using the basic properties o Calvo pricing, we find

$$var_i(p_{it}) \equiv \Delta_t = var_i(p_{it} - \bar{p}_{t-1}) = E_i\{p_{it} - \bar{p}_{t-1}\}^2 - [E_i\{p_{it} - \bar{p}_{t-1}\}]^2$$

$$= \lambda E_i\{p_{i,t-1} - \bar{p}_{t-1}\}^2 + (1-\lambda)E_i\{p_{it}^* - \bar{p}_{t-1}\}^2 - [\bar{p}_t - \bar{p}_{t-1}]^2 =$$

$$= \lambda\Delta_{t-1} + (1-\lambda)E_i\left\{\frac{1}{1-\beta\lambda}\pi_{it}^e + a_{it}\right\}^2 - [\bar{p}_t - \bar{p}_{t-1}]^2 =$$

$$= \lambda\Delta_{t-1} + (1-\lambda)E_i\left\{\frac{1}{1-\beta\lambda}(\pi_{it}^e - \bar{\pi}_t^e) + \frac{1}{1-\beta\lambda}\,\bar{\pi}_t^e + a_{it}\right\}^2 - [\bar{p}_t - \bar{p}_{t-1}]^2$$

$$= \lambda\Delta_{t-1} + (1-\lambda)\left(\frac{1}{1-\beta\lambda}\right)^2 var_i(\pi_{it}^e) + (1-\lambda)E_i\left\{\frac{1}{1-\beta\lambda}\,\bar{\pi}_t^e + a_{it}\right\}^2$$

$$+ 2\frac{1-\lambda}{1-\beta\lambda}E_i\left\{(\pi_{it}^e - \bar{\pi}_t^e)\left(\frac{1}{1-\beta\lambda}\,\bar{\pi}_t^e + a_{it}\right)\right\} - [\bar{p}_t - \bar{p}_{t-1}]^2$$

To simplify this expression, we note that by definition, $\bar{\pi}_t \equiv \bar{p}_t - \bar{p}_{t-1}$and that

$$E_i\left\{(\pi_{it}^e - \bar{\pi}_t^e)\left(\frac{1}{1-\beta\lambda}\,\bar{\pi}_t^e + a_{it}\right)\right\} = E_i\left\{(\pi_{it}^e - \bar{\pi}_t^e)\left(\frac{1}{1-\beta\lambda}\,\bar{\pi}_t^e\right)\right\} + E_i\{(\pi_{it}^e - \bar{\pi}_t^e)a_{it}\}$$

$$= E_i\{(\pi_{it}^e - \bar{\pi}_t^e)(a_{it} - \bar{a}_t + \bar{a}_t)\} = E_i\{(\pi_{it}^e - \bar{\pi}_t^e)(a_{it} - \bar{a}_t)\} + E_i\{(\pi_{it}^e - \bar{\pi}_t^e)\bar{a}_t\}$$

$$= E_i\{(\pi_{it}^e - \bar{\pi}_t^e)(a_{it} - \bar{a}_t)\} = cov_i(\pi_{it}^e, a_{it})$$

This covariance may be time varying because the source of shocks in the economy can differentially affect expectations about real marginal costs and inflation. It follows that

$$var_i(p_{it}) \equiv \Delta_t = \lambda\Delta_{t-1} + (1-\lambda)\left(\frac{1}{1-\beta\lambda}\right)^2 var_i(\pi_{it}^e) + 2\frac{1-\lambda}{1-\beta\lambda}cov_i(\pi_{it}^e, a_{it})$$

$$+ (1-\lambda)E_i\left\{\frac{1}{1-\beta\lambda}\,\bar{\pi}_t^e + a_{it}\right\}^2 - \bar{\pi}_t^2$$

$$= \lambda\Delta_{t-1} + (1-\lambda)\left(\frac{1}{1-\beta\lambda}\right)^2 var_i(\pi_{it}^e) + 2\frac{1-\lambda}{1-\beta\lambda}cov_i(\pi_{it}^e, a_{it})$$

$$+ (1-\lambda)E_i\left\{\frac{1}{1-\beta\lambda}\,\bar{\pi}_t^e + \bar{a}_t + a_{it} - \bar{a}_t\right\}^2 - \bar{\pi}_t^2$$

$$= \lambda\Delta_{t-1} + (1-\lambda)\left(\frac{1}{1-\beta\lambda}\right)^2 var_i(\pi_{it}^e) + 2\frac{1-\lambda}{1-\beta\lambda}cov_i(\pi_{it}^e, a_{it})$$

$$+ (1-\lambda)\left\{\frac{1}{1-\beta\lambda}\,\bar{\pi}_t^e + \bar{a}_t\right\}^2 + (1-\lambda)var_i(a_{it}) - \bar{\pi}_t^2$$

Note that this expression holds for any group of firms. That is,

$$\Delta_t^{control} = \lambda\Delta_{t-1}^{control} + (1-\lambda)\left(\frac{1}{1-\beta\lambda}\right)^2 var_i^{control}(\pi_{it}^e) + 2\frac{1-\lambda}{1-\beta\lambda}cov_i^{control}(\pi_{it}^e, a_{it})$$

$$+ (1-\lambda)\left\{\frac{1}{1-\beta\lambda}\,\bar{\pi}_t^{control,e} + \bar{a}_t^{control}\right\}^2 + (1-\lambda)var_i^{control}(a_{it}) - \bar{\pi}_t^{control,2}$$

$$\Delta_t^{treat} = \lambda\Delta_{t-1}^{treat} + (1-\lambda)\left(\frac{1}{1-\beta\lambda}\right)^2 var_i^{treat}(\pi_{it}^e) + 2\frac{1-\lambda}{1-\beta\lambda}cov_i^{treat}(\pi_{it}^e, a_{it})$$
$$+ (1-\lambda)\left\{\frac{1}{1-\beta\lambda}\,\bar{\pi}_t^{treat,e} + \bar{a}_t^{treat}\right\}^2 + (1-\lambda)var_i^{treat}(a_{it}) - \bar{\pi}_t^{treat,2}$$

Hence,

$$\Delta_t^{control} - \Delta_t^{treat}$$
$$= \lambda\left(\Delta_{t-1}^{control} - \Delta_{t-1}^{treat}\right) + (1-\lambda)\left(\frac{1}{1-\beta\lambda}\right)^2 \left\{var_i^{control}(\pi_{it}^e) - var_i^{treat}(\pi_{it}^e)\right\}$$
$$+ 2\frac{1-\lambda}{1-\beta\lambda}\left(cov_i^{control}(\pi_{it}^e, a_{it}) - cov_i^{treat}(\pi_{it}^e, a_{it})\right)$$
$$+ (1-\lambda)\left\{\frac{1}{1-\beta\lambda}\left(\bar{\pi}_t^{control,e} - \bar{\pi}_t^{treat,e}\right) + (\bar{a}_t^{control}\right.$$
$$\left. - \bar{a}_t^{treat}\right)\left\{\frac{1}{1-\beta\lambda}\left(\bar{\pi}_t^{control,e} + \bar{\pi}_t^{treat,e}\right) + \bar{a}_t^{control} + \bar{a}_t^{treat}\right\}$$
$$+ (1-\lambda)\left\{var_i^{control}(a_{it}) - var_i^{treat}(a_{it})\right\} - \left\{\bar{\pi}_t^{control} - \bar{\pi}_t^{treat}\right\}\left\{\bar{\pi}_t^{control} + \bar{\pi}_t^{treat}\right\}$$

If we assume that the control group has expectations close to those of the treatment group on average, then $\bar{\pi}_t^{control,e} - \bar{\pi}_t^{treat,e} \approx 0$ and $\bar{\pi}_t^{control} - \bar{\pi}_t^{treat} \approx 0$ on average so that the terms in red could be small (i.e., could be higher order terms). The term in blue does not include inflation expectations directly but it may be corelated with expectations and it may be varying over time. The term in green may vary over time if e.g., treatment and control groups have different beliefs about the sources of fluctuations in the economy.

Let $\Xi_t \equiv \Delta_t^{control} - \Delta_t^{treat}$ be the difference in price dispersion between treatment and control groups. Let $\Psi_t \equiv var_i^{control}(\pi_{it}^e) - var_i^{treat}(\pi_{it}^e)$ be the difference in dispersion of inflation expectations between treatment and control groups. Using these definitions, we can re-write the expression above as

$$\Xi_t = \lambda\Xi_{t-1} + (1-\lambda)\left(\frac{1}{1-\beta\lambda}\right)^2 \Psi_t + residual$$

where the residual maybe correlated with other variables on the right-hand side, thus underscoring the importance of using exogenous variation in inflation expectations. Because the dispersion of the marginal revenue product is proportional to the dispersion of prices, we have

$$\Upsilon_t \equiv var_i^{control}(MRPL_{it}) - var_i^{treatment}(MRPL_{it}) = \left[(1-\alpha)\left(1-\frac{1}{\sigma}\right) - 1\right]^2 \left(\frac{-\sigma}{1-\alpha}\right)^2 \Xi_t$$

and therefore

$$\frac{\partial\Upsilon_{t+h}}{\partial\Psi_t} = \left[(1-\alpha)\left(1-\frac{1}{\sigma}\right) - 1\right]^2 \left(\frac{-\sigma}{1-\alpha}\right)^2 \lambda^h(1-\lambda)\left(\frac{1}{1-\beta\lambda}\right)^2$$

If we work with standard deviations and assume zero dispersion in the steady state (which is the standard result for the case with zero trend inflation), the response of the standard deviation for the marginal revenue product to a unit shock in the standard deviation for inflation expectations is given by

$$\sqrt{\left[(1-\alpha)\left(1-\frac{1}{\sigma}\right)-1\right]^2\left(\frac{-\sigma}{1-\alpha}\right)^2(1-\lambda)\left(\frac{1}{1-\beta\lambda}\right)^2}$$

The table below presents the value of this response for various calibrations of the parameters. When elasticity of substitution is low, the production function is closer to linear (γ closer to zero), and the frequency of price changes is high (λ is smaller), the response is weaker. This table suggests that the range of plausible responses likely goes from 2 to 10 which is close to the responses we observe empirically.

Appendix Table B1. Contemporaneous response of the standard deviation for the marginal revenue product to a unit shock in the standard deviation for inflation expectations.

	Parameterizations						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Parameters							
α	0.3	0.1	0.3	0.1	0.3	0.3	0.1
β	0.99	0.99	0.99	0.99	0.99	0.99	0.99
λ	0.75	0.75	0.75	0.75	0.5	0.5	0.5
σ	10	10	5	5	10	5	5
red	27.94	4.46	9.88	2.42	27.94	9.88	2.42
green	0.25	0.25	0.25	0.25	0.50	0.50	0.50
blue	15.08	15.08	15.08	15.08	3.92	3.92	3.92
Response	10	4	6	3	7	4	2

Appendix C: Survey questionnaire

INDUSTRY EXCLUDING CONSTRUCTION AND SERVICES

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

SEZIONE 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 2015?	...in June 2016?	...in June 2017?	... on average between June 2018 and June 2020 ?
B1a. (about 2/3 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 0.0 per cent in the euro area. What do you think it will be in Italy...	IT6 |__| |__|__|,|__|%	IT12 |__| |__|__|,|__|%	IT24 |__| |__|__|,|__|%	IT48 |__| |__|__|,|__|%
B1b. (about 1/3 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...	IT6N |__| |__|__|,|__|%	IT12N |__| |__|__|,|__|%	IT24N |__| |__|__|,|__|%	IT48N |__| |__|__|,|__|%

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

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 SITMP5

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:

	SITM3M Better SITM3A	SITU3M The same SITU3A	SITP3M Worse 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*	*Positive*	*Low*	*Average*	*High*
C5. Changes in demand DISIT	1|__|	2|__|	3|__|	1|__|	2|__|	3|__|
C6. Changes in YOUR PRICES PRSIT	1|__|	2|__|	3|__|	1|__|	2|__|	3|__|
C7. AVAILABILITY and the COST OF CREDIT CRSIT	1|__|	2|__|	3|__|	1|__|	2|__|	3|__|
C7.Bis UNCERTAINTY DUE TO ECONOMIC AND POLITICAL FACTORS POLIT	1|__|	2|__|	3|__|	1|__|	2|__|	3|__|
C7.Ter EXCHANGE RATE DYNAMICS TACAM	1|__|	2|__|	3|__|	1|__|	2|__|	3|__|
C7. Quarter OIL PRICE DYNAMICS PRPET	1|__|	2|__|	3|__|	1|__|	2|__|	3|__|

C8. Compared with 3 month ago. do you think conditions for investment are ... ? ❑ Better ❑ The same ❑ Worse SITINV

C9. 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

C10. Compared with three months ago. is the **total** demand for your products ... ? ❑ Higher ❑ Unchanged ❑ Lower DOMTOT

C11. How will the **total** demand for your products vary in the next 3 months? ❑ Increase ❑ No change ❑ Decrease PRETOT

(Answer to questions C12-C13 only if the share of sales revenues coming from exports is positive. otherwise go to C14)

C12. Compared with three months ago. is the **foreign** demand for your products ... ? ❑ Higher ❑ Unchanged ❑ Lower DOMEST

C13. How will the **foreign** demand for your products vary in the next 3 months? ❑ Increase ❑ No change ❑ Decrease PREEST

C14. Compared with three months ago. are credit conditions for your company ...? ❑ Better ❑ Unchanged ❑ Worse SITCRE

C15 Overall. do you think your firm passed the most difficult stage of the economic situation? ❑ No ❑ Yes CONSUP

C16 Do you expect a solid improvement of your production/work rates in the coming months? ❑ No ❑ Yes RITPRO

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 <u>in the next 12 months</u>:						
Factors affecting your firm's **prices** in the next 12 months	***Effect on firm's selling prices***			***Intensity*** *(if not nil)*		
	Downward	*Neutral*	*Upward*	*Low*	*Average*	*High*
D3. TOTAL DEMAND DPR	1|__|	2|__|	3|__|	1|__|	2|__|	3|__|
D4. RAW MATERIALS PRICES MPPR	1|__|	2|__|	3|__|	1|__|	2|__|	3|__|
D5. LABOUR COSTS CLPR	1|__|	2|__|	3|__|	1|__|	2|__|	3|__|
D6. PRICING POLICIES of your firm's main competitors PRPR	1|__|	2|__|	3|__|	1|__|	2|__|	3|__|

SECTION E – WORKFORCE

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

SECTION F – INVESTMENT

F1. What do you expect will be the nominal expenditure on (tangible and intangible) fixed investment in 2015 compared with that in 2014? ❒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 2015 compared with that in the first half of 2015: ❒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.