The pass-through of cost shocks to firms' prices and the impact on value added[1]

July 2024

Abstract

The post-pandemic surge in intermediate goods and energy prices has intensified scrutiny of firms' pricing policies for their role in feeding the inflationary dynamics and accommodating the sequence of cost shocks. This work combines firm-level balance sheet and price data to estimate the contributions of prices (relative changes in output and intermediate input prices) and quantities (relative changes of output and input quantities) to the nominal growth rate of value added. We document that between 2016 and 2022 the transmission of intermediate input price changes to firms' output prices was less than one-to-one, resulting in a negative contribution of pricing policies to aggregate value added. The primary driver of value added growth, including its strong surge in the aftermath of the pandemic shock, is instead the dynamics of quantities. Moreover, estimates suggest that, at the individual level, a greater transfer of input price increases to output prices is associated to higher value added for the firm; this relationship is stronger for large corporates and for those more dependent on intermediate inputs. Moreover, we document that pricing policies provide a limited hedge against fluctuations in input prices: firms adjust their prices in response to idiosyncratic cost shocks but these adjustments do not result in an increase in value added.

GEL codes: G00, G30, L1.

Keywords: firms' price setting, operating pass-through, economic margins.

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1. Introduction and main findings

The resurgence of inflation in the years 2021-22, in the context of cost-push shocks due to the energy crisis, supply chain disruptions and the post-pandemic pent-up demand, prompted renewed interest in firms' pricing policies. Firms' prices represent mostly what consumer pay, thus their role in the propagation of the inflationary dynamic is important. At the same time, when pricing policy are set as a spread over marginal costs, they define the extent firms' bear (or share) the burden of soaring production costs with their customers; thus they can be viewed as an operational hedging tool against cost-shocks.

This paper analyses the relationship between firms' pricing policies and their value added dynamic, highlighting the contributions made by changes in prices and quantities to the growth rate of value added. The analysis is based on detailed firm-level survey data on output and intermediate input price changes, which are available for a sample of Italian non-financial firms. These data are used to decompose the annual variation of value added into three additive components: i) pricing policy, ii) intermediate input productivity and iii) the interaction between the two. Differently from metrics derived from national accounts, firm-level analysis helps explaining heterogeneities depending on firms' exposure to input price shocks, firms' reliance on intermediate input and their capacity to shift a price shock along the supply chain to consumers' markets.

We complement the evidence derived from our decomposition with regression analysis of the response of firms' pricing policies and value added dynamics to idiosyncratic intermediate input price shocks. This enables us to characterise the economic resilience of firms, in terms of their cost-transfer capacity to output prices.

The analysis is based on Italian firms' survey data for the 2016-22 period drawn from the Bank of Italy's Survey on Inflation and Growth Expectations (SIGE). The sample covers mostly unlisted companies with at least 50 employees in the manufacturing, service and construction sectors. It accounts for approximately 1,500 observations per year. Furthermore, we utilise company balance sheet data from the Cerved database to gather firms' revenues, intermediate costs, and value added. It is important to note that the use of value added, defined as the difference between revenues and the cost of intermediate goods and services, allows for a nuanced understanding of economic margins. In particular, it enables for the identification of the role played by volatile and generally large shares of total costs: in the euro area, the share of intermediate goods and energy costs over total costs ranges from 80 to 60 percent in the case of manufacturing and service sectors, respectively.[2] Although value added is highly correlated with operating profit, such as gross operating profits, unit profits or mark-ups measures, it differs from operating profit; the latter accounts for all firms' cost factors (since it takes into account also personnel expenses).

Previous studies analyzed the relationship between firms' pricing behaviour and their economic margins and, related to our work, two complementary research questions have been investigated: first, how does an inflationary environment affect firms' profits and, second, how do profits feedback into the inflationary dynamics.

The former strand of research suggests that when inflation is high profits tend to expand. However, if inflation is particularly high, profits decelerate and eventually drop. Andler and Kovner (2022) use quarterly firm-level data for US listed companies to show that in the 2021-22 period profit margins growth was more pronounced in industries with higher inflation. However, in the long run, the authors' document that in high inflation regimes, firms' gross profits growth weakens and, eventually, falls. These results are consistent with the intuitive mechanism documented in Moore (1983), that is, differences in the pace of output and input price variations lead profits to expand only when output prices grow faster; this is often the case in not too high inflation regimes.

[2] Panetta, F., 2024, *Economic developments and monetary policy in the euro area*, Speech by the Governor of the Bank of Italy, 30th Assiom Forex Congress. The figures for the U.S. economy are not different and about half of firms' total costs are due to intermediate input; Moro, A., 2010, *Biased technical change, intermediate goods and total factor productivity*, working paper.

The second strand investigates if and to what extent firms' pricing policies, measured via mark-ups, the premium above the total cost that provides the seller with a profit, contribute to inflation. The guiding narrative is that inflation is linked to, or perhaps caused by, enterprises charging higher mark-ups, when raising prices above what would be justified by the increase in expenses. In the face of unprecedented increases in energy and intermediate input prices as a result of 2020-22 shocks, the expected drop in firms' profits did not materialize and, in contrast, non-financial firms operating profits rebounded substantially. This situation raised some concerns about corporations increasing prices more than their costs, a mechanism that would intensify inflation pressures.

Empirical evidence, however, indicates that the surge in inflation during the specified period cannot be attributed to pricing policies, as mark-ups mostly remained stable or returned to pre-pandemic levels. In Italy, Colonna *et al*. (2023) utilized national accounts data to demonstrate that despite the growing proportion of gross operating surplus in relation to value added (*i.e.*, the profit share), mark-ups remained constant overall.[3] Similarly, Leduc *et al.* (2024) provided comparable evidence for the United States. Additionally, Ganapati *et al.* (2020) and Champion *et al.* (2023) revealed that in both the United States and Australia: a) the transmission of cost-shocks to output prices generally is incomplete, resulting in approximately a 0.7 percent increase in output prices for every 1 percent rise in costs, and b) contrary to the expectations of competitive markets, the pass-through effect is lower in industries with higher levels of concentration.

In the cross-section of industries, high mark-up act as a buffer against fluctuations in consumer prices due to economic cycle. Firm level data for the Euro area (Kouvavas *et al.*, 2021) show that inflation in sectors with high mark-up displays a lower sensitivity to shocks (oil supply, global demand and monetary policy). It can be argued that firms with greater market power are less likely to pass on cost-shocks to end prices. Similarly, Kharroubi *et al.* (2023) document a diminished impact of cost-push shocks (global oil supply shocks) to producers' price inflation in sectors where firms apply higher mark-ups. However, not all shocks are alike and high mark-up provide little cushion against prices pressures stemming from inflationary oil shocks. Conversely, dis-inflationary shocks are passed on to consumers more weakly by high mark-up firms; which are instead more likely to increase their revenues, and hence their profits.

Our work makes several contributions to the existing literature. Firstly, unlike previous studies, we specifically consider the dynamics of intermediate input prices and, importantly, its heterogeneity across the spectrum of firms. By using granular firm-level data on intermediate input and output prices we are able to analyse how changes in prices impact firms' value added, while also recognizing that these impacts may vary among firms. Secondly, although our sample is limited to a subset of Italian non-financial corporations, we use survey weights to ensure that our findings are representative of the entire population, thus allowing for generalization to the broader Italian business landscape. Lastly, the use of survey data provides us with a unique advantage in examining how firms' pricing decisions are influenced by cost-shocks, defined as differences between actual and expected changes in intermediate input prices.

The results of our analysis suggest that firms' pass-through of intermediate input to output prices is, on average, incomplete. Contrary to what perfect competition would suggest, a significant portion of cost increases are borne by firms, with no industry or size class exhibiting complete pass-through. The contribution of pricing policies (made by both changes in output and input prices) to the annual growth rate of value added is minimal and, generally, negative. However, the years 2021-22 indicate a notable shift in the relative contribution of prices. Through a higher operating pass-through, the pricing policies of large firms provide them with only a limited shield against cost hikes. Lastly, we document how pricing policies respond to adverse cost shocks, *i.e.* unexpected cost increases, yet firms' value added does not improve significantly. This suggests that firms

[3] In national accounts data, an increase in the profit share (the ratio between gross operating profits and value added), as many advanced economics witnessed in the post-pandemic recovery, is often interpreted as a signal of inflationary pressure generated by firms' pricing strategies. Colonna et *al.*, (2023) provide a decomposition of the profit share which demonstrates how its increase is also compatible with constant mark-ups if a) intermediate input cost increase outpace labour costs and b) there is limited substitutability amongst input. Thus the profit share is not unambiguously informative of the relationship between mark-ups and price dynamics.

strive to uphold their existing profitability levels and opt to share a portion of the economic losses with either end consumers or businesses in order to retain their market share.

The rest of the paper proceeds as follows. Section 2 sets out the modelling framework and section 3 describes the data. Section 4 discusses the decomposition of value added growth rate at various levels of aggregation (for the economy as a whole, by firm size class and sector); the paragraph then illustrates results from regression analysis. Section 6 concludes.

2. Modelling framework

This section outlines a decomposition of the nominal growth rate of firm-level value added yielding three additive components: a pricing policy or 'price' component, an intermediate input productivity or 'quantity' component and the interaction between the two 'price and quantity'. Descriptive evidence on the relative importance of these components is provided in time series for the whole sample of firms as well as by size groups, sectoral affiliation and different degrees of intermediate input intensity.

We use then these components in a regression setting, to estimate the extent to which changes in a firm's pricing policies correlate with its value added dynamic; while controlling for firm and time effects.

Lastly, we investigate how a price shock to intermediate input (being energy or shortages in materials, for instance) translates in a change in a firm's pricing policy and how it affects its prospective value added growth rate. To this end, idiosyncratic price shocks are used as an instrument to retrieve exogenous changes in a firm's pricing policy.

2.1. Price and quantity contributions to value added

To single out the contribution of pricing policies to the dynamics of value added, we decompose firms' nominal growth rates of revenues, intermediate costs and value added into a price and quantity components (holding previous period quantities and prices fixed, respectively). Firms' reported change in input and output prices over the past 12 months and the realized revenues and intermediate costs growth rates are used for this purpose.

Formally, the annual growth rate (Δ) of revenues can be decomposed as follows:

$$\Delta Rev_{t,\ t-1} = \frac{p_t^o q_t^o - p_{t-1}^o q_{t-1}^o}{p_{t-1}^o q_{t-1}^o}$$

$$\Delta Rev_{t,\ t-1} = \Delta p^o_{t,\ t-1} + \Delta q^o_{t,\ t-1} + \Delta p^o q^o_{t,\ t-1} \tag{1}$$

where, $\Delta p^o_{t,\ t-1}$ is the (observable from survey data) firms' reported change in output prices between *t* and *t-1*, $\Delta q^o_{t,\ t-1} = \left[\left(1+\Delta Rev_{t,t-1}\right)/\left(1+\Delta p^o_{t,\ t-1}\right)-1\right]$ is the implied change in output quantities and $\Delta p^o q^o_{t,\ t-1} = \left[\Delta p^o_{t,\ t-1} * \Delta q^o_{t,\ t-1}\right]$ is the interaction between price and quantity components. Similarly, the annual growth rate of intermediate costs ($\Delta Cost_{t,\ t-1}$) can be decomposed in an intermediate input price changes $\left(\Delta p^i_{t,\ t-1}\right)$, a quantity and an interaction components as in Eq. (1). Rearranging the revenues and intermediate costs decompositions yields, in short, the following decomposition for the growth rate of value added:

$$\Delta VA_{t,t-1} = \frac{VA_t - VA_{t-1}}{VA_{t-1}} = \frac{1}{VA_{t-1}}\left[(\Delta Rev * Rev_{t-1}) - (\Delta Cost * Cost_{t-1})\right]$$

$$\Delta VA_{t,\ t-1} = \Delta p^{VA}_{t,\ t-1} + \Delta q^{VA}_{t,\ t-1} + \Delta pq^{VA}_{t,\ t-1} \tag{2}$$

where: the contribution made by firms' pricing policies (both output and intermediate input prices), productivity and the interaction term between prices and quantities are defined in Eq. (3) to (5). For the derivation of (1) and (2) see Appendix 1.

$$\Delta p^{VA}_{t,t-1} = \frac{1}{VA_{t-1}} \left[\left(Rev_{t-1} * \Delta p^{o}_{t,\,t-1} \right) - \left(Cost_{t-1} * \Delta p^{i}_{t,\,t-1} \right) \right] \tag{3}$$

$$\Delta q^{VA}_{t,t-1} = \frac{1}{VA_{t-1}} \left[\left(Rev_{t-1} * \Delta q^{o}_{t,\,t-1} \right) - \left(Cost_{t-1} * \Delta q^{i}_{t,\,t-1} \right) \right] \tag{4}$$

$$\Delta pq^{VA}_{t,t-1} = \frac{1}{VA_{t-1}} \left[\left(Rev_{t-1} * \Delta p^{o}_{t,\,t-1} * \Delta q^{o}_{t,\,t-1} \right) - \left(Cost_{t-1} * \Delta p^{i}_{t,\,t-1} * \Delta q^{i}_{t,\,t-1} \right) \right] \tag{5}$$

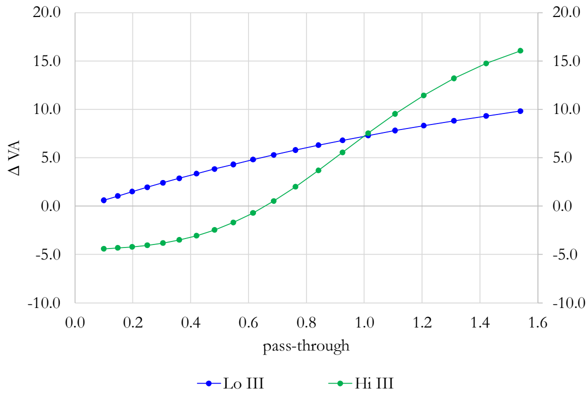
The contribution of prices (3) and quantities (4) to the nominal value added growth rate is thus pinned down by three factors: (*i*) the difference between output and input price changes ($\Delta p^{o}_{t,\,t-1} - \Delta p^{i}_{t,\,t-1}$) a proxy for a firm's pricing policy (PP) or, equivalently, its operating pass-through ratio; (*ii*) the difference between output and intermediate input quantity changes ($\Delta q^{o}_{t,\,t-1} - \Delta q^{i}_{t,\,t-1}$), a proxy for the productivity of intermediate inputs (IIP) and; (*iii*) the difference between revenues and intermediate input costs ($Rev_{t-1} - Cost_{t-1}$) a proxy for the intensity of intermediate inputs (III). Under the assumption of a positive elasticity of intermediate goods and services to output quantities, for firms with low intermediate input intensity, intermediate costs per unit of revenues weigh less and even a substantial increase in their price could have little impact on marginal costs.

Figure 2 illustrates the comparative statics of the relationship between firms' pricing policies, measured for ease of interpretation by the ratio between output and input changes, and the growth rate of value added. It is assumed that the share of intermediate input used to produce 1 unit of output is 0.1 and 0.9, respectively. These two polar cases demonstrate how a firm's economic performance is influenced by the interaction of its production function and pricing policy; output quantities are held constant thus changes in value added are driven exclusively by changes in pricing policies.

As the figure suggests, an increase in value added is compatible with pass-through below one -in contrast to what perfect competition hypothesize- especially when firms' intensity in the use of intermediate input is low. Nonetheless, even for firms with high intermediate input intensity positive changes in value added are achievable when the pass-through reaches a certain threshold (*e.g.* 0.6 in our case). It also noteworthy that firms with high III experience a more substantial impact on their value added as a result of changes in pass-through; this is evident from the steeper slope of the curve (we will point out this particular feature in the empirical section).

In the context of the extraordinary increase in firms' value added over the years 2021-22 and consequential policy debate regarding its sources, Figure 2 adds two elements to this discussion that are helpful to note: (1) evidence of firms' higher profits is not unambiguously informative of greedy pricing policies (firms' passing on their cost increases to customers more than one-to-one). In turn, pass-through lower than one are compatible with value added and profits growth, especially if the intensity of intermediate input is not too high and productivity gains (or, equivalently, changes in the input mix) allow savings in the use of intermediate inputs; (2) high (low) intensity of intermediate input can amplify (dampen) the response of value added growth rate to changes in pricing policies and, equivalently, gains (losses) in productivity.

Figure 1: Change in pass-through and value added



Note: The figure illustrates the relationship between a firm's pricing policy, measure by the ratio between output and intermediate input price changes (a proxy for pass-through) and value added for two hypothetical firms having low and high intermediate input intensity. Low (high) intermediate input intensity are defined by setting intermediate input quantities equal to 0.1 (0.9) for each unit of output.

2.2 Response of firms' pricing policy to cost-shocks

The decomposition of value-added growth rate presented in the previous section provides a basis for investigating how changes in a firm's pricing policy affects its economic performance. This is achieved through the use of reduced-form approach in a panel data regression setting, wherein firm and time effects are controlled for.

Investigating this relationship in causal setting is a challenging task due to endogeneity concerns which include: (i) simultaneity bias, whereby variations in value added are jointly determined by firms' pricing policies (see Eq. 2); and (ii) omitted variables bias, whereby third factors could cause both changes in pricing policies and value added. These factors include, for instance, a firm's market power, the extent of competition or exposure to international markets.

We start from estimates of the endogenous equation (2) and compare results with a more parsimonious semi-identity model in (6):

$$\Delta VA_{i,t,t-1} = \alpha + \beta_1 PP_{i,t,t-1} + \beta_2 IIP_{i,t,t-1} + \gamma_i + \tau + \varepsilon_{i,t,t-1} \quad (6)$$

where: $\Delta VA_{i,t,t-1}$ is the firm-level value added growth rate, $dPP_{i,t,t-1}$ is the firm's pricing policy measured by the difference between output and input price changes ($\Delta p_t^o - \Delta p_t^i$), and $IIP_{i,t}$ is the firm intermediate input productivity measured by the difference between output and input quantity changes (Δq_t^o-Δq_t^i) term, γ_i and τ are firm and time fixed effects. Simultaneity and omitted variables bias, are addressed in (7-8) using instrumental variable (IV) approach where idiosyncratic shocks to intermediate input costs occurred in the *t-1* period ($Z_{i,t-1}$) are used in the first stage to isolate exogenous variations in a firm's pricing policy (see Figure 2):

$$\Delta VA_{i,t,t-1} = \alpha + \delta \widehat{dPP_{i,t,t-1}} + \gamma_i + \tau + \varepsilon_{i,t,t-1} \quad \text{(7, second stage)}$$

$$dPP_{i,t,t-1} = \alpha + \gamma Z_{i,t-1} * X_i + \gamma_i + \tau + \mu_{i,t,t-1} \quad \text{(8, first stage)}$$

where: $Z_{i,t-1}$ is the lagged value of the difference between the realized $\Delta p^i_{i,t,t-1}$ and expected $\widehat{\Delta p}^i_{i,t,t-1}$ intermediate input price changes between *t* and *t-1*, and X_i is a vector of firms' characteristics which is used to test differences non-monotonicity in the response of PP.

The definition of shock that we follow aligns with the concept of surprise or unexpected change. The instrument is relevant under the assumption that firms adjust their current pricing policy following input price forecasting errors made in the previous period; in turn the correlation between firm-level input cost shocks and the change in value added is about 0.3. Exogeneity rests on both the independence between the instrument and the outcome variable and the assumption that effects on the outcome occur only via the endogenous variable (exclusion restriction). A nearly null correlation between the instrument and the outcome is suggestive that the former condition may hold. The latter condition implies that the input prices forecasting error made by a firm impacts its value added changes only via firm-specific changes to its pricing policy. Due to the idiosyncratic nature of the shock this assumption seems reasonable; in contrast, if the instrument involved a generalized cost shock, the impact on a firm value added could occur also via other channels such as market demand or supply changes.

Figure 2: Timeline of variables used in the regression

$\mathbf{\Delta VA_{t,t-1}} = (VA_t - VA_{t-1})/VA_{t-1}$

$\mathbf{dPP_{t,t-1}} = PP_t - PP_{t-1}$

$\mathbf{Z_{t-1}} = \Delta p^i_{t-1} - E(\Delta p^i_{t-1})_{|\ t-2}$

Note: The figure illustrates the main variables used in the regression and their temporal references.

3. Data

Information on firm-level prices is sourced from SIGE. The survey is conducted on a quarterly basis and collects information on consumer inflation expectations over different time horizons, changes in their own purchases and selling prices, as well as firms' sentiment on aggregate cyclical developments. The sample is representative of medium-sized and large Italian firms is obtained using a stratified random sampling approach, which combines economic sector, firm size and geographical area information as strata. In order to derive aggregate statistics, a weighting coefficient is provided for each sample unit. This accounts for the ratio between the number of respondent companies and the number of companies in the reference universe.[4]

The primary data for our analysis is derived from survey responses to the following questions:

- What was the average variation of output price for the products or services sold by your company over the last 12 months?
- What was the average variation of intermediate input price for the product or services purchased by your company over the last 12 months?

The SIGE sample was matched with balance-sheet information from Cerved on revenues and value added. The resulting dataset (Table 1) includes observations for the period 2016-22.[5]

Table 1: Descriptive statistics

year	N. firms	Δ output price	Δ intermediate input price	Δ revenues	Δ intermediate costs	Δ value added
	units	*percent*	*percent*	*percent*	*percent*	*percent*
2016	586	0.16	0.94	3.52	4.09	3.56
2017	580	0.91	1.96	5.78	7.55	4.04
2018	628	0.91	1.69	3.15	4.18	2.07
2019	670	0.63	1.16	0.33	1.01	-1.44
2020	836	0.17	0.69	-8.76	-7.50	-10.12
2021	992	3.12	6.94	19.55	19.24	22.37
2022	867	6.67	11.48	16.52	19.39	12.49

Source: Bank of Italy's SIGE, Cerved.
Note: The table reports the number of firms included in the matched SIGE-Cerved dataset and weighted averages (using survey weights) of relevant variables. Percentage changes (Δ). Value added is the difference between revenues and intermediate costs.

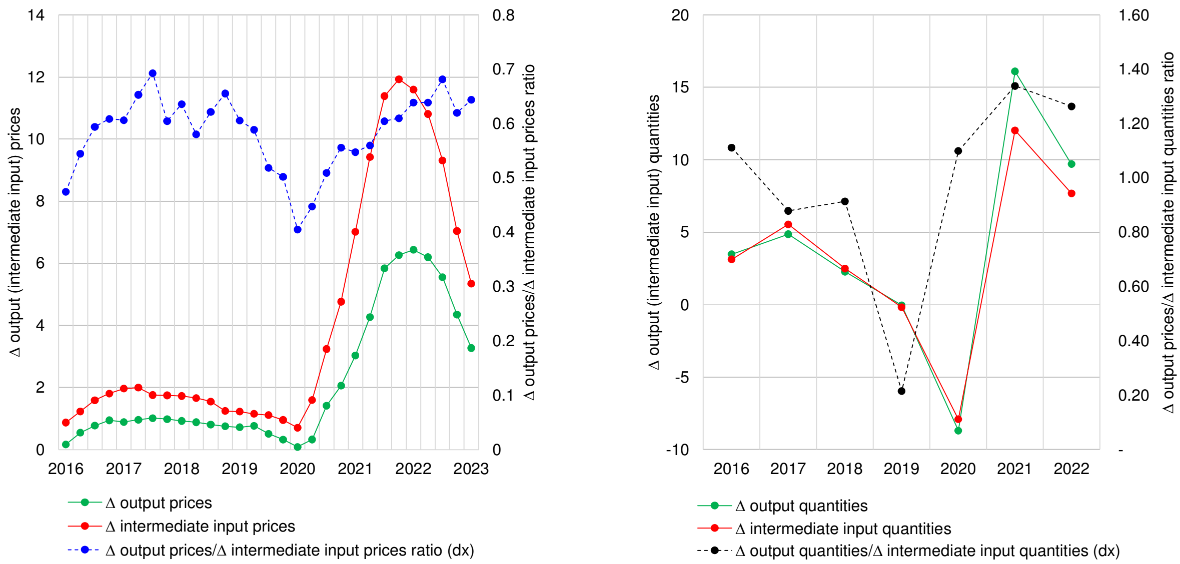
[4] For more information about the survey are available at the following: IAI_methods_and_sources.pdf (bancaditalia.it).
[5] The years prior to 2016 were not considered in the analysis because intermediate input cost data were not collected.

The extent to which changes in intermediate input prices are passed on to customers via output prices, also defined as the operating pass-through, can be illustrated by the ratio between the overall 12-month output and intermediate input price variations. This is a simple upper bound proxy that does not account for a number of factors that would be included in a fully-fledged model of firms' price setting behaviour, such as the state- and time-dependence features documented in Riggi and Tagliabracci (2022).[6]

In the 2016-23 period, the average firms' operating pass-through was incomplete. For a 1 percent change in intermediate input prices, only approximately 0.6 percent was passed on to sale prices in the same year (Figure 2 – panel a). Despite facing high inflation due to energy shock and supply chain disruptions, the average increase in output prices did not exceeded the increase in input intermediate input costs.[7] In late 2022, when energy price pressures abated, the average pass-through rebounded to its pre-pandemic level. This pricing pattern is in line with previous empirical evidence regarding two key aspects: (a) the persistence of output price changes, where future adjustments closely mirror past output price trends (rather than responding immediately to input price changes); and (b) the potential non-linear nature of firms' pricing policies, which depend on the nature of cost-shocks. In cases of inflationary cost-shocks, firms may choose to absorb some of the negative impact by reducing pass-through to customers (Kharroubi *et al.*, 2023). Another noteworthy aspect of the price data is the reduced dispersion in operating pass-through since the onset of monetary tightening in early 2022 (Figure A.1 in the Appendix). The reduced heterogeneity in firms' pricing policies, following a cost-push inflationary shock, lends support to the role of the input cost channel. This is the case when firms face similar changes in their costs and variations in their sale prices also tend to align.

Figure 2: Firms' operating pass-through and intermediate input productivity

panel a: operating pass-through *(per cent)* — panel b: intermediate input productivity *(per cent)*



Source: Bank of Italy's SIGE, Cerved.
Note: panel a) illustrates the reported 12-month percentage change in output and intermediate input prices and the ratio between the two for the whole sample of firms included in the SIGE; panel b) reports estimated output and intermediate input quantities and the ratio between the two for the sample of firms included in SIGE and Cerved. Percentage changes in output/input quantities are derived according to Eq. (1.b).

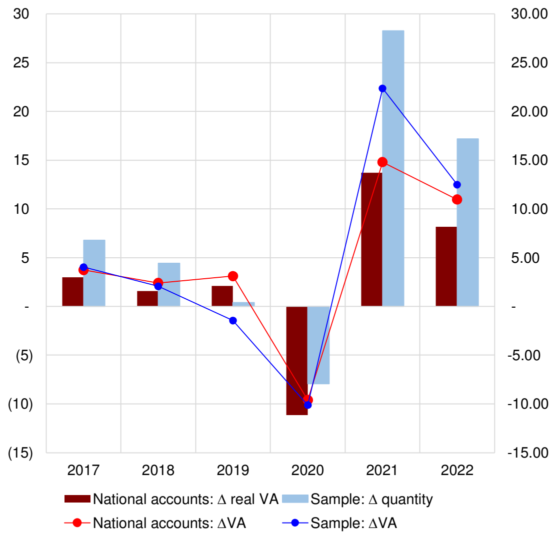
[6] The probability of a firm adjusting its prices can vary with *(i)* time and *(ii)* the macroeconomic or firm-specific conditions. The latter case belongs to the theoretical modelling framework of state-dependent models: changes in firm-level costs for intermediate products, revenues, utilization capacity are found to be important state variables (Lein, 2010). Empirical studies that look at the importance of both state- and time-dependent factors for firm-level price setting see also Dixon and Grimme (2022), and Riggi and Tagliabracci (2022).
[7] Riggi and Tagliabracci (2022) find that the pass-through of input costs to output prices is quantitatively limited over the period 2017-22: a one per cent increase in the prices of intermediate input leads to roughly a 0.2 per cent rise in Italian firm's selling prices.

Developments in output and intermediate input quantities, as implied by equation 1.b using both firms' prices and balance-sheet information, indicate that their variations were greatly aligned until the onset of the pandemic (Figure 2 – panel b). This suggests relative stability in the intensity with which intermediate input enter the production function. Subsequently, there was a shift in this pattern, with output quantities increasing at a faster rate than intermediate inputs; thus resulting in a higher level of productivity for intermediate inputs above pre-pandemic levels.

Our reference measure for firms' economic performance is represented by value added (VA). Unlike the gross operating margin, which provides a measure of firms' operating profits, VA is gross of labour costs. Due to the relative stickiness with which labour costs adjust to the consumers' price dynamics, changes in VA and operating profits are highly correlated. From SIGE, we are able to directly observe intermediate input price dynamics and, as a result, to obtain accurate information to decompose VA without having to resort to other estimates or proxies. Despite these advantages, due to the features of the survey, firms report the average input and output price changes across the range of products or services used or sold. While this may simplify the task of questionnaire respondents, it introduces some layers of inaccuracy as individual product price paths may differ substantially from the average.

To put our matched SIGE-Cerved sample into context, Figure 3 illustrates the nominal and real growth rate of value added from the national accounts and our sample, respectively. The two series are very close in level and their correlation exceeds 0.95 over the period, suggesting that the SIGE-Cerved sample is also representative of developments affecting the whole business sector.

Figure 3: Benchmarking SIGE with National accounts data



Source: SIGE, Cerved, National accounts.
Note: The figure shows the nominal and real value added growth rate for the private non-financial corporate sector (national accounts) and for the firms included in the matched SIGE-Cerved dataset. Survey weights are used to report sample observations to the population of Italian companies. Percentage changes (Δ). Value added is the difference between revenues and intermediate costs.

4. Results

4.1 Pricing policies over time

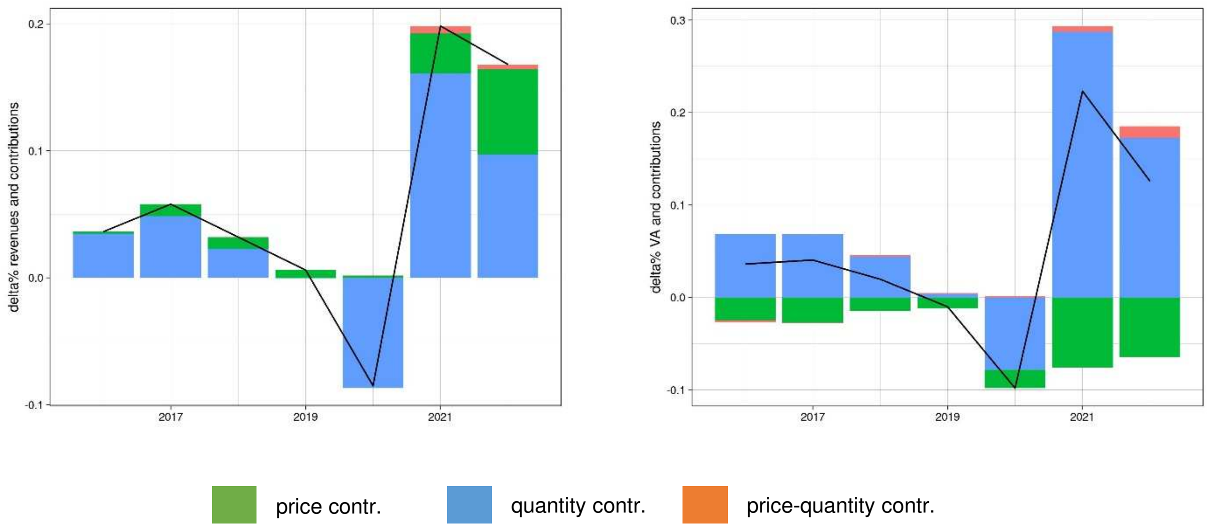
Figure 4 decomposes revenues and value added growth rates (solid lines) by their price and quantity components (histograms) given in equations (1) and (2). Firms' revenues (panel a) fluctuations over the 2016-22 period are correlated with output prices. The latter account on average for approximately one-third of revenues growth. However, during the period of economic recovery following the global pandemic, the notable surge in inflation also manifested itself in a substantial increase in the incidence of output price inflation on revenue growth rates.

The aggregate dynamic of value added is only modestly affected by firms' pricing policies and their contribution is negative (panel b). This result suggests that, on average, the incomplete pass-through of input cost increases to output prices, given also the high extent of intermediate input intensity, typically does not provide firms with an operation hedging against changes in intermediate input prices. Moreover, the growth in value added over time is predominantly driven by improvements in productivity of intermediate inputs; a technological shift in the production process or the substitutability of inputs –which could have become less available and relatively more expensive during the 2021-22 period- could lead to these results.

The aggregate results presented here contribute to the ongoing debate regarding the potential impact of firms' pricing policies in the recent inflationary episode. Our findings, which indicate a negative effect of pricing policies on the value added dynamic, are consistent with prior evidence from Italy, which suggests that firms' charging constant mark-ups did not contribute to soaring inflation (Colonna et *al.*, 2023).

Figure 4: Price and quantity contributions to revenues and value added

Panel a – delta% revenues Panel b – delta% value added



Source: Bank of Italy's Survey on Inflation and Growth Expectations and Cerved.
Note: The histograms decompose the weighted average revenue and value added growth rates (solid lines) into a price, quantity and an interaction component derived according to equations (1) and (2).

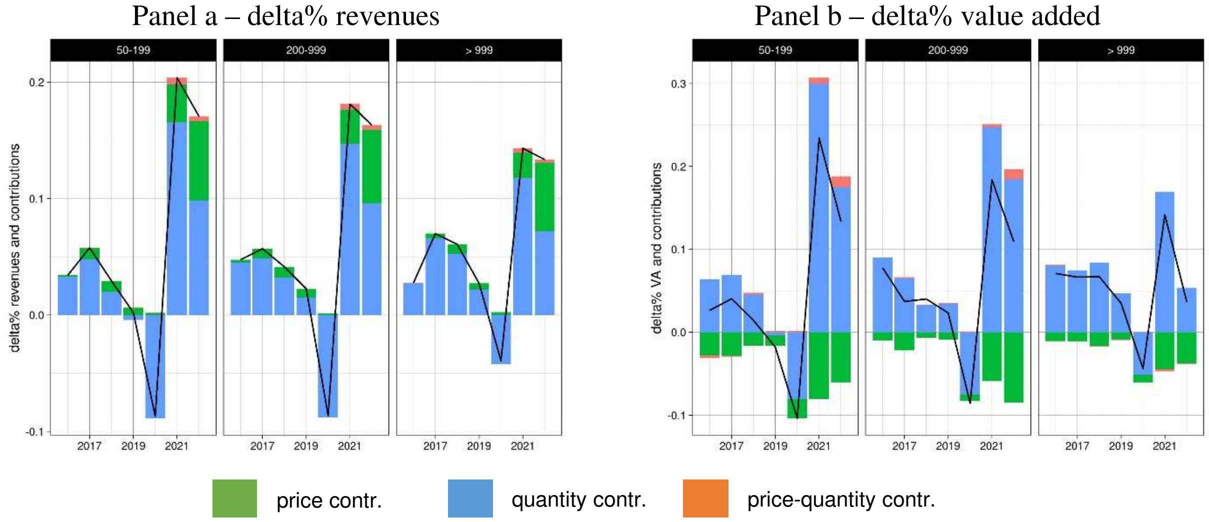
4.2 Size and sectoral differences

By examining firm-level data, it is possible to investigate potential heterogeneity between firms' pricing policies depending on their characteristics. Notably, firm size (given by the number of employees), can help differentiate between companies with different market power, exposure to cost fluctuations or international competition.

Figure 5 decomposes the nominal revenues and value added growth rate between medium (50-199), large (200-999) and very large (more than 999 employees) companies in their price, quantity and interaction components. For the sample period as a whole the average contribution of prices to revenues growth rates is modest for both medium-large and very large firms (accounting for about 2 and 1.7 per cent, respectively). As expected, this values align closely to inflation dynamic, given that firms' sale prices are covered to various degrees in consumer price indices.

Some differences are apparent with regard to the contribution of prices to the dynamics of value added across the firm-size spectrum. On average, for larger firms, the contribution of pricing policies to value added is negative but nevertheless more muted with respect to the smaller ones. The incidence of the price component on the value added growth rate is approximately 40 percent for the former and about 70 percent for the latter. These discrepancies could be due to the fact that larger firms are less susceptible to fluctuations in intermediate input prices, since the impact of such price increases is approximately half that of smaller firms. Furthermore, the divergence in these outcomes became more pronounced following the impact of the pandemic.

Figure 5: Revenues and value added decompositions by firm size

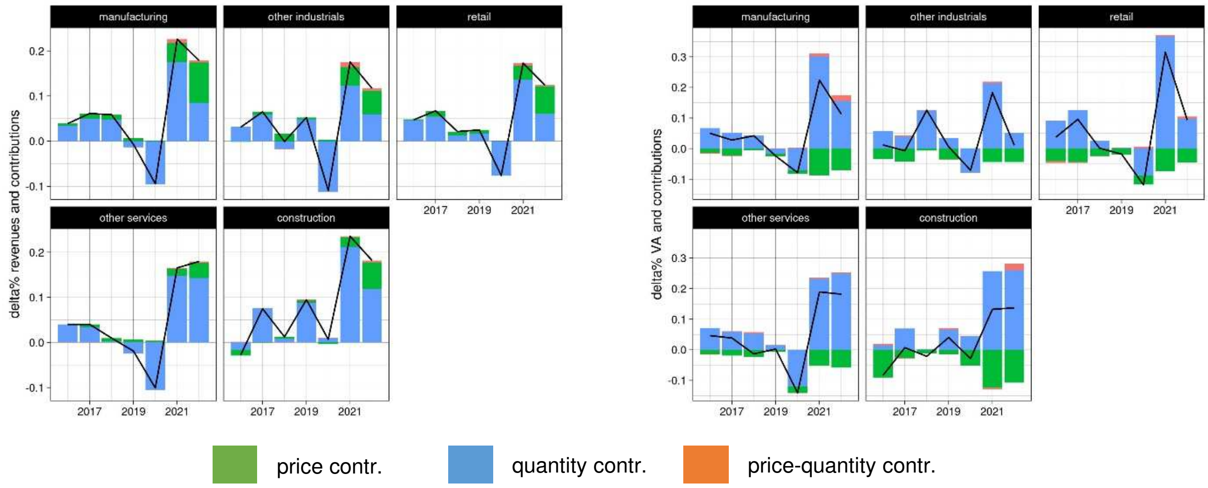


Source: Bank of Italy's Survey on Inflation and Growth Expectations and Cerved.
Note: The histograms decompose the weighted average revenue and value added growth rates (solid lines) into a price, quantity and an interaction component derived according to the equations (1) and (2). Firm size classes are defined by the number of employees with medium firms 50-199, large 200-999 and very large >999.

In contrast, differences across industries are less clear-cut. Sale price increases display a common pattern across sectors, and similarly to the aggregate trend, their contribution to the change in revenues increased notably only after the pandemic shock (Figure 6). The contribution of pricing policies to sectoral value added growth is on average negative, even across sectors. It became more severe only after the pandemic. This negative incidence of prices on value added growth rates was particularly pronounced in the construction sector.

Figure 6: Revenues and value added decompositions by sector

Panel a – delta% revenues Panel b – delta% value added

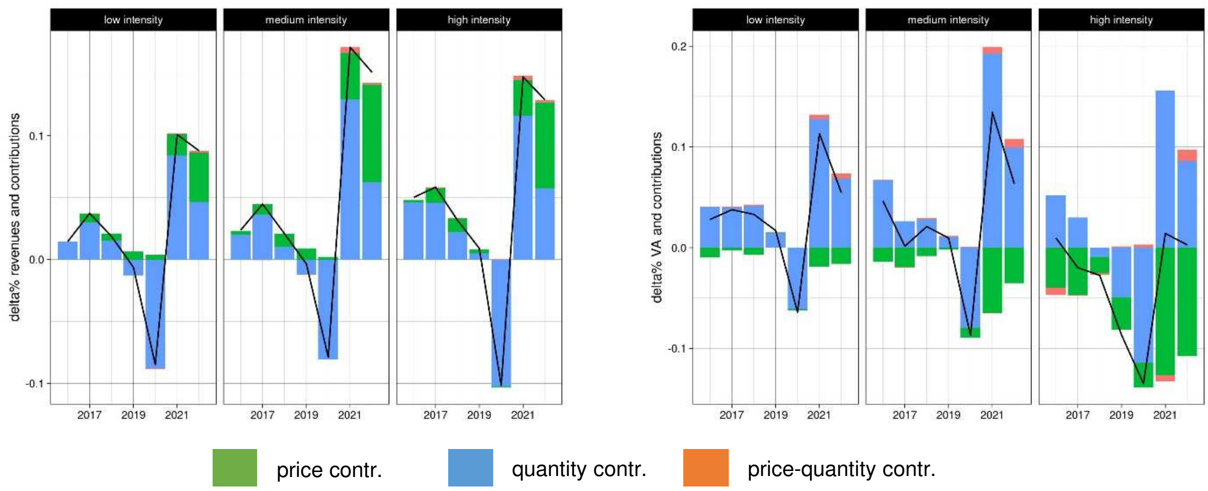


Source: Bank of Italy's Survey on Inflation and Growth Expectations and Cerved.
Note: The histograms decompose the weighted average revenue and value added growth rates (solid lines) into a price, quantity and an interaction component derived according to equations (1) and (2).

Finally, using intermediate input intensity as a grouping variable helps identifying those firms for which pricing policies are more important in steering their value added dynamics. For high intermediate input intensity firms (in the 3rd bucket of their sectoral distribution) input price changes result in larger contributions to the nominal value added growth rate; a result in line with comparative statics on the role of pricing policies depending on firms' production function provided in Figure 1.

Figure 7: Revenues and value added decomposition by intermediate input intensity

Panel a – delta% revenues Panel b – delta% value added



Source: Bank of Italy's Survey on Inflation and Growth Expectations and Cerved.
Note: The histograms decompose the weighted average revenue and value added growth rates (solid lines) into a price, quantity and an interaction component derived according to equations (1) and (2).

4.3 Cost-shock driven pricing changes and the impact on value added

The evidence in the previous section, based on the accounting decomposition approach, seems to suggest a negative contribution of pricing policies alone on firms' economic margins. This could be due to both incomplete pass-through to output prices and to the high extent of intermediate input intensity. Existing research on the cyclical behaviour of mark-ups indicates that firms may encounter demand or technological constraints that inhibit their ability to fully adjust prices in response to cost shocks. Furthermore, the competitive landscape and market structure can also significantly impact pricing decisions and the transmission of cost shocks.

In this section we utilize firm-level panel data covering the period from 2016 to 2022 to estimate the regression model specified in (2.2) and contrast pooled estimates with those derived from a panel with individual and time fixed effects. Firstly, results from the endogenous regression (columns 1-2 in Table 2), validate that firm level contributions of prices and quantities decompose the nominal value added growth rate in an additive manner, as indicated by the nearly unit coefficients and zero intercept.

Table 2: Testing the accounting decomposition

	Pooled	**FE**
	(1)	**(2)**
(Intercept)	-0.0009 (0.0037)	
ΔP^{VA}_t	0.9549 *** (0.0505)	0.9485 *** (0.0530)
ΔQ^{VA}_t	0.9938 *** (0.0233)	0.9922 *** (0.0304)
ΔPQ^{VA}_t	0.4672 (0.3054)	0.5256 (0.3093)
Fixed-Effects:	-------------------	-------------------
year	No	Yes
firm	No	Yes
S.E.: Clustered	by: firm & year	by: firm & year
Observations	5129	5129
R2	0.861	0.917

Source: our estimates based on SIGE and Cerved data.
Note: The table reports OLS estimates of equation (2) using panel data from the SIGE-Cerved sample for the 2016-22 period. Observations are weighted using survey weights.

Secondly, the parsimonious model in (6), is used to delve more into the role played by pricing policies and intermediate input productivity terms (Table 3). The elasticity of the value added growth rate to contemporaneous IIP term is positive and significant; consistent with descriptive evidence provided in the previous section on the substantial positive contribution of quantity in driving value added dynamics. A one-standard deviation increase in IIP (13 percentage points) correlates with an increase by 11 percentage points in value added. Controlling for time invariant firm characteristics, within firms' estimates suggests that changes in PP correlate with increasing value added (column 3), but the magnitude of this effect is lower – with respect to the effect of productivity - and varies over time. A one-standard deviation increase in PP (5 percentage points) correlates with a 6 percentage points increase in value added. For the years 2021-22, however, increasing pass-through from rising intermediate input to output prices did not shield economic margins resulting in a drop of value added (column 4). This finding aligns with prior evidence indicating that firms have limited operational hedging capacity of their gross operating cash flows through sale price increases. Specifically, firms have limited capacity to transfer input cost increases to output prices, and changes in pricing policies result in a non-significant increase of firms' value added. Champion *et al.* (2023) document findings that are consistent with those presented here. They estimate a pass-through of 0.85, which implies that cost increases are only partly incorporated in sale prices which, in turn, leads to a fall in profit margins.

Table 3: Pricing policies over time

	Pooled (1)	Pooled (2)	FE (3)	FE (4)
(Intercept)	0.0534 (0.0363)	0.0481 (0.0367)		
PPt	0.3824 (0.2123)		0.8918 *** (0.1602)	
IIPt	1.271 *** (0.1252)		1.204 *** (0.1192)	
PPt * 2016		0.5771 (0.5087)		-1.510 (0.8273)
PPt * 2017		1.093 (0.5671)		1.022 ** (0.3936)
PPt * 2018		1.270 * (0.5522)		0.6579 (0.7109)
PPt * 2019		2.555 *** (0.5795)		1.927 ** (0.6056)
PPt * 2020		1.502 *** (0.3492)		0.9890 (0.6775)
PPt * 2021		-1.486 *** (0.2867)		-1.895 *** (0.2968)
PPt * 2022		-0.7800 ** (0.2406)		-0.7694 ** (0.2801)
Fixed-Effects:	------------------	------------------	------------------	------------------
year	No	No	Yes	No
firm	No	No	Yes	Yes
S.E.: Clustered	by: firm & year	by: firm & year	by: firm & year	by: firm & year
Observations	5129	5129	5129	5129
R2	0.143	0.021	0.515	0.413

Source: our estimates based on SIGE and Cerved data.
Note: The table reports OLS estimates of equation (6) using panel data from the SIGE-Cerved sample for the 2016-22 period. Observations are weighted using survey weights.

Within estimates suggest that the effect of PP on value added dynamics varies along with firms' heterogeneity. For very larger firms', value added tend to increase by more when operating pass-through rise: the magnitude of value added rise is three-fold compared to the smaller ones (Table 4). Similarly, PP are significantly more important for firms' economic margins when the intensity of intermediate input is high.

Table 4: Pricing policies by intermediate input intensity

	Pooled (1)	FE (2)	Pooled (3)	FE (4)
(Intercept)	0.0532 (0.0363)		0.0580 (0.0354)	
PPt * Size = 1	0.3286 (0.2269)	0.7825 *** (0.1983)		
PPt * Size = 2	0.4987 ** (0.1772)	1.128 *** (0.1775)		
PPt * Size = 3	1.208 ** (0.3997)	2.312 ** (0.6527)		
IIPt * Size = 1	1.281 *** (0.1431)	1.191 *** (0.1422)		
IIPt * Size = 2	1.184 *** (0.1198)	1.169 *** (0.1752)		
IIPt * Size = 3	1.514 *** (0.2572)	1.917 *** (0.2792)		
PPt * Int. Input intensity = 1			-0.2296 (0.3424)	0.3981 (0.2204)
PPt * Int. Input intensity = 2			0.0505 (0.2274)	0.8137 *** (0.2115)
PPt * Int. Input intensity = 3			0.5547 (0.4275)	0.9911 ** (0.3463)
PPt * Int. Input intensity = 4			1.446 *** (0.2737)	1.719 *** (0.4069)
IIPt * Int. Input intensity = 1			0.8232 *** (0.1510)	0.8219 *** (0.1355)
IIPt * Int. Input intensity = 2			1.241 *** (0.1831)	1.240 *** (0.1961)
IIPt * Int. Input intensity = 3			1.608 *** (0.3899)	1.570 *** (0.2721)
IIPt * Int. Input intensity = 4			1.741 *** (0.2695)	1.472 ** (0.4452)
Fixed-Effects:	------------------	------------------	------------------	------------------
year	No	Yes	No	Yes
firm	No	Yes	No	Yes
S.E.: Clustered	by: firm & year	by: firm & year	by: firm & year	by: firm & year
Observations	5129	5129	5129	5129
R2	0.144	0.5154	0.158	0.520

Source: our estimates based on SIGE and Cerved data.
Note: The table reports OLS estimates of equation (6) using panel data from the SIGE-Cerved sample for the 2016-22 period. Observations are weighted using survey weights. Size classes 1, 2, 3 correspond to medium (between 50 and 199 employee), large (between 200 and 999 employee) and very large (more than 999 employee) firms. Firms are assigned to intermediate input intensity classes using quartiles of the sectoral distribution of the intermediate costs to revenues ratio.

Previous estimates obtained from the endogenous equation are suggestive of the extent of correlations between pricing policies and changes in value added and indicate potential heterogeneity of this relationship across the spectrum of firms. To overcome simultaneity and omitted variables bias inherent in previous results, 2SLS-IV approach is used. Input cost shocks (or surprises) occurred in the period *t-1* are used to shift the operating pass-through in period *t* and recover local estimates of value added changes.

Results are reported in Table 5. First stage confirms that firms adjust their pricing policies following an idiosyncratic input cost shock (columns 2). A one-standard deviation cost shock (5 percentage points) results in a (partial) 3 percentage point increase in operating pass-through. This however does not result in a statistically significant impact on value added.

The instrument does not affect firms' pricing policies in a monotonous manner. By introducing an interaction term for the size class of the firm in the first stage, we can effectively consider the varying abilities of firms to convert cost shocks into output prices. Our findings indicate that larger firms possess a higher capability to endure cost fluctuations and enhance their operational pass-through (columns 4). Nevertheless, this alone does not lead to positive changes in value added.

Table 5: The pass-through of cost shocks to value added

	ΔVA_t	dPP_t	ΔVA_t	dPP_t	ΔVA_t
	(second stage)	*(first stage)*	*(second stage)*	*(first stage)*	*reduced form*
	(1)	(2)	(3)	(4)	(5)
dPP_t	0.0825 (1.054)		0.0527 (1.016)		
Input cost shock $_{t-1}$		0.6267 *** (0.1315)			0.0517 (0.6511)
$dIIP_t$			0.0019 (0.0020)	-3.31e-5 (0.0006)	
Input cost shock t-1 * Size =1				0.6611 *** (0.1385)	
Input cost shock t-1 * Size =2				0.4100 ** (0.1183)	
Input cost shock t-1 * Size =3				1.066 *** (0.1297)	
Fixed-Effects:	--------------	-------------------	---------------	-------------------	----------------
year	Yes	Yes	Yes	Yes	Yes
firm	Yes	Yes	Yes	Yes	Yes
S.E.: Clustered	by: firm & year	by: firm & year	by: firm & year	by: firm & year	by: firm & year
Observations	2019	2019	2019	2019	2019
R2	0.45	0.53	0.45	0.54	0.45
F-test (1st stage)		595.29		209.85	
Wald (1st stage)		22.718		108.96	

Source: our estimates based on SIGE and Cerved data.
Note: The table reports estimation of equations (6) and (7) using panel data with firm-time fixed effects. Robust standard errors in parenthesis.

5 Conclusion

The strong increase in inflation over the past few years fed a vigorous debate around its sources and, consequently, the most appropriate policy response. One of the hypothesis under scrutiny, the “greed-flation”, suggests that firms may have charged higher prices with respect to the increased costs. This narrative, which echoed in a number of discussions in Europe as well as the United States, does not find empirical support in our study.

We use firm-level data on output and intermediate input price changes to illustrate the contribution of firms’ pricing policies and that of productivity to the growth rate of their value added. This decomposition accounts for a number of heterogeneities, generally hidden within aggregate statistics, such as: differences in firms’ intermediate input intensity, exposure to input price changes and the capacity to transfer price changes from suppliers to consumer markets.

Overall, the robust growth in output quantities has driven the positive developments in value added observed during the post pandemic recovery. When examining heterogeneity across firms, we find that the pass-through of input price variations to end prices correlates with positive developments in value added especially for the larger firms and those with higher intermediate input intensity.

Finally, we isolate exogenous shifts in firms’ pass-through due to idiosyncratic cost shocks. Following an unexpected increase in input prices, we find that firms’ increase their pass-through, with larger firms doing so by a greater extent. However, this increase in pass-through is not necessarily a sign of resilience given that their value added does not improve significantly. This evidence is compatible with firms’ aiming to maintain their current profitability and share part of the economic consequences with their counterparts (final consumers or other businesses) in order to retain market shares. The paper offers new evidence on firms’ price setting behaviour and the extent to which firms and consumers share the burden of a cost shock.

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7 Appendix

A1. Firms' revenues, intermediate costs and value added growth rates decomposition

In what follows we illustrate the accounting decomposition of the revenues and value added percentage changes into price, quantity components and the interaction between the two.

Superscripts (o, i) indicate output and input while (Δ) the percentage change between *t* and *t-1*.

$$\Delta Rev_{t,\,t-1} = \frac{p^o_t q^o_t - p^o_{t-1} q^o_{t-1}}{p^o_{t-1} q^o_{t-1}} \qquad (1)$$

by defining $p^o_t = p^o_{t-1} * (1+\Delta p^o_{t,\,t-1})$ and $q^o_t = q^o_{t-1} * (1+\Delta q^o_{t,\,t-1})$ we obtain:

$$\Delta Rev_{t,\,t-1} = \frac{p^o_{t-1} * \left(1+\Delta p^o_{t,\,t-1}\right) * q^o_{t-1} * \left(1+\Delta q^o_{t,\,t-1}\right) - p^o_{t-1} q^o_{t-1}}{p^o_{t-1} q^o_{t-1}} =$$

$$\Delta Rev_{t,\,t-1} = \frac{p^o_{t-1} * pq^o_{t-1} * \left[\left(1+\Delta p^o_{t,\,t-1}\right) * \left(1+\Delta q^o_{t,\,t-1}\right) - 1\right]}{p^o_{t-1} q^o_{t-1}} =$$

$$\Delta Rev_{t,\,t-1} = \left[\left(1+\Delta p^o_{t,\,t-1}\right) * \left(1+\Delta q^o_{t,\,t-1}\right) - 1\right]$$

Given $\Delta p^o_{t,\,t-1}$ (1.a) from firms' responses in SIGE, we are able to retrieve the followings (1.b) as the quantity component

$$\Delta q^o{}_{t,\,t-1} = \left[\left(1+\Delta Rev_{t,\,t-1}\right) / \left(1+\Delta p^o_{t,\,t-1}\right) - 1\right] \qquad (1.b)$$

and (1.c) as the interaction between price and quantity:

$$\Delta p^o_{t,\,t-1} q_{t,\,t-1}{}^o = \left[\Delta p^o_{t,\,t-1} * \Delta q^o_{t,\,t-1}\right] \qquad (1.c)$$

So that the summation of the three components (1.a,b,c) totals the overall $\Delta Rev_{t,\,t-1}$.

Expressions from 1 to 1.c can be adapted to intermediate costs (*i.e.* the difference between Revenues and Value added) to obtain a similar decomposition.

$$\Delta Cost_{t,\,t-1} = \frac{p^i_t q^i_t - p^i_{t-1} q^i_{t-1}}{p^i_{t-1} q^i_{t-1}} = \left[\left(1+\Delta p^i_{t,\,t-1}\right) * \left(1+\Delta q^i_{t,\,t-1}\right) - 1\right] \qquad (2)$$

The percentage change in value added is thus defined as follows:

$$\Delta VA = \frac{(Rev_t - Cost_t) - (Rev_{t-1} - Cost_{t-1})}{(Rev_{t-1} - Cost_{-1})} = \frac{(Rev_t - Rev_{t-1}) - (Cost_t - Cost_{t-1})}{(Rev_{t-1} - Cost_{-1})} \qquad (3)$$

$$= \frac{(Rev_t - Rev_{t-1})}{(Rev_{t-1} - Cost_{-1})} * \frac{(Rev_{t-1})}{(Rev_{t-1})} - \frac{(Cost_t - Cost_{t-1})}{(Rev_{t-1} - Cost_{-1})} * \frac{(Cost_{t-1})}{(Cost_{t-1})}$$

by defining VA = Rev-Cost we obtain:

$$\Delta VA = \frac{1}{VA_{t-1}} \left[\left(\Delta Rev_{t,\,t-1} * Rev_{t-1}\right) - \left(\Delta Cost_{t,\,t-1} * Cost_{t-1}\right)\right]$$

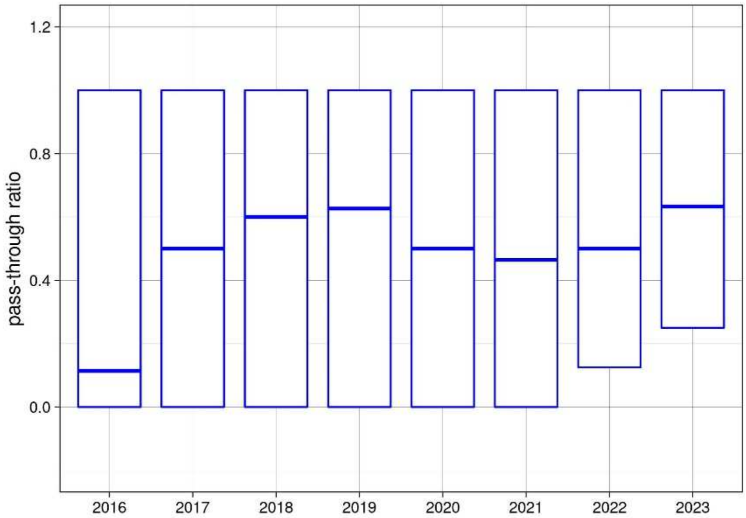
From (1-3) we are able to retrieve the following VA additive decomposition into price, quantity, and the interaction between the two components:

$$\Delta p_{t,\,t\text{-}1}^{VA} = \frac{1}{VA_{t\text{-}1}}\left[\left(Rev_{t\text{-}1} * \Delta p_{t,\,t\text{-}1}^{o}\right) - \left(Cost_{t\text{-}1} * \Delta p_{t,\,t\text{-}1}^{i}\right)\right] \qquad 3.1$$

$$\Delta q_{t,\,t\text{-}1}^{VA} = \frac{1}{VA_{t\text{-}1}}\left[\left(Rev_{t\text{-}1} * \Delta q_{t,\,t\text{-}1}^{o}\right) - \left(Cost_{t\text{-}1} * \Delta q_{t,\,t\text{-}1}^{i}\right)\right] \qquad 3.2$$

$$\Delta pq_{t,\,t\text{-}1}^{VA} = \frac{1}{VA_{t\text{-}1}}\left[\left(Rev_{t\text{-}1} * \Delta q_{t,\,t\text{-}1}^{o} * \Delta p_{t,\,t\text{-}1}^{o}\right) - \left(Cost_{t\text{-}1} * \Delta q_{t,\,t\text{-}1}^{i} * \Delta p_{t,\,t\text{-}1}^{i}\right)\right] \qquad 3.3$$

Figure A1: Box-plot firms' pricing policies



Source: SIGE data.

Note: The figure reports box-plots of operating pass-through, the ratio between output and input price changes over the last 12 months reported by firms included in the SIGE sample.