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# Markups and inflation during the COVID-19 pandemic

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## Introduction

In this note, we assess how firms' pricing decisions have been impacting inflation. To do so, we analyze markups—the ratio of a firm's output price to its marginal cost of production (i.e., the price the firm pays for inputs on its last unit of production). Our analysis covers the period from 2015 to 2022. We focus on markups instead of profits or profit margins since these are less well-suited to understanding pricing behaviour.[1]

A key challenge we face is that markups are not directly observable, and how to measure them remains a source of academic debate. Our approach follows the latest advances in the literature, namely the production approach described in De Loecker, Eeckhout and Unger (2020). We measure markups at the firm level using the financial statements of publicly traded Canadian firms. We then assess the extent to which these markups may have impacted the recent evolution of inflation.

Overall, we find that markups of consumer-oriented firms remained roughly stable in the face of rising costs during the pandemic. This suggests firms were able to fully pass higher costs through to the prices they charged their customers. However, we find little evidence of *rising* markups amplifying the inflationary impact of rising costs. These results should be seen as suggestive rather than definitive, given data limitations and the uncertainty associated with estimating markups.

## Defining markups

Markups are defined as the output price divided by marginal cost. Markups can be useful in trying to understand competitive dynamics in a given industry. In a perfectly competitive market, price equals marginal cost, but as industries become less competitive, the price rises above marginal cost.

Since both output prices and marginal costs are unobservable, we need to estimate markups using data from firm-level financial statements. We follow De Loecker, Eeckhout and Unger (2020), who use a first-order condition from a firm's cost minimization problem to derive the following expression for the markup:

$$Markup_{it} = \frac{Price_{it}}{Marginal\ cost_{it}} = \beta_V \frac{Revenue_{it}}{Cost\ of\ goods\ sold_{it}}$$

where:

- A firm's revenue (or sales) is the sum of the output price multiplied by quantity of each type of good the firm sells. This information is available on each firm's income statement.
- Cost of goods sold (COGS) represents all expenses directly associated with producing the output goods and typically includes items such as the cost of purchased inputs and the wages of employees that produce the goods. Essentially, these are the variable costs associated with a firms' production. Most firms report this variable on their income statement.[2]

[1] For example, consider a firm suddenly able to produce more output from a given amount of inputs, with both input and output prices staying fixed. In this case, profits and profit margins would increase with no effect on prices and, hence, inflation.

[2] Presentation of COGS and other costs on financial statements varies across firms, in particular regarding the disclosure of sales, general and administrative expenses, and depreciation and amortization. We find similar results when we estimate markups on alternative datasets.

- $\boldsymbol{\beta_V}$ is the output elasticity of the variable inputs to production (i.e., $\%\Delta Output_{it}/\%\Delta\ Variable\ inputs_{it}$). This parameter is part of each firm's Cobb-Douglas production function and is estimated at the industry level using financial data for each firm in a given industry. Since this parameter can change over time due to improvements in technology, we estimate it using five-year rolling regressions.

The appendix contains full details of deriving the expression for the markup as well as our estimation procedure for $\beta_V$.

## The dataset

Our firm-level financial statement data come from Compustat and cover publicly traded, non-financial firms incorporated in Canada. These firms, while not representative of the full range of firms in Canada, tend to be among the largest in the economy. Importantly, our sample covers the largest consumer-oriented firms, such as big-box retailers.

The prices set by these firms are likely to play a prominent role in the Canadian consumer price index and are thus relevant for assessing the link between markups and inflation.

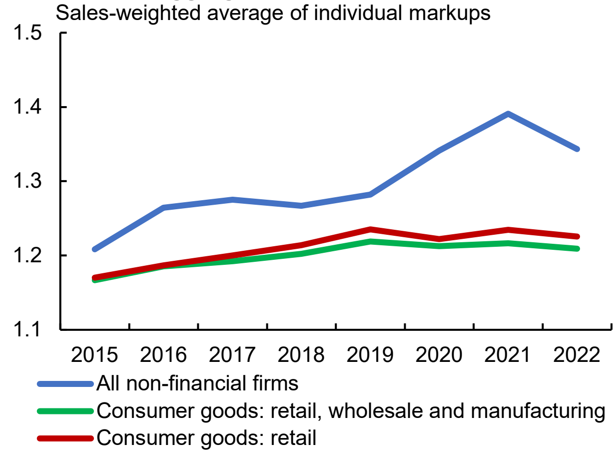
We pay particular attention to two sub-samples of firms: a wider one covering firms producing and/or selling products to consumers and a narrower one covering firms in the retail sector only.

## Recent evolution of markups

We calculate firm-level markups as a product of the estimated output elasticity of variable costs and the ratio of revenue to COGS. The aggregate markup is then calculated as a sales-weighted average of individual markups. **Chart 1** shows the evolution of this measure for all firms as well as for the two sub-samples of consumer-oriented firms.

**Chart 1: Aggregate markups**

Sales-weighted average of individual markups




Sources: Compustat via Wharton Research Data Sevices and Bank of Canada calculations

Last observation: 2022

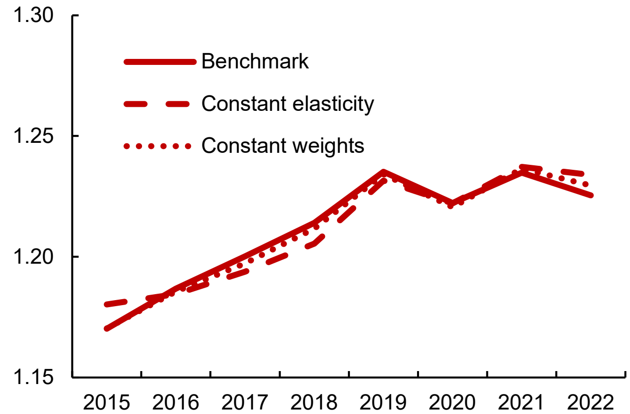
The aggregate markup of all non-financial firms (blue line) had been on an upward trend since 2015 and rose significantly at the beginning of the pandemic. However, this increase was mostly driven by firms in commodities-related sectors, which play an outsized role in our dataset. Markups of these firms tend to move with energy prices, which are set in global markets. Therefore, we focus instead on businesses that mainly produce and/or sell consumer products (the green and red lines). The markups of these firms were on a gradual upward trend before the pandemic but have not changed much since 2020.

Next, we seek to further understand the evolution of markups over time. Note that three factors account for the dynamics in aggregate markups: the ratio of sales to COGS, the output elasticity and weights given to individual firms. Using retail firms as an example, we show the following in **Chart 2**:

- benchmark markups as calculated (solid line)
- markups with constant elasticity (dashed line)
- markups with constant weighting (dotted line)

**Chart 2: Aggregate markups of retail firms under varying assumptions**

Sales-weighted average of aggregate markups




Sources: Compustat via Wharton Research Data Sevices and Bank of Canada calculations

Last observation: 2022

We see that the markup dynamics are largely driven by the ratio of sales to COGS. This is important because it means markup growth is mainly a function of these two variables, which are observed in the data. Consequently, our results do not hinge on the estimates of output elasticities. Consistent with the current literature, our estimated elasticities evolve slowly over time. In addition, reallocation of activity among retail firms does not appear to drive markup dynamics either.[3]

Among consumer-oriented firms, big-box retailers largely drive the dynamics in markups due to their size. Unfortunately, many of these companies have multiple business segments but report only consolidated financial statements. Therefore, our results do not rule out the possibility that markups on certain products have risen during the pandemic. For an individual firm, higher markups on some products could simply be masked by lower markups on products comprising a growing share of its sales.

Lastly, given that sales and COGS largely define the markup dynamics, tracking the evolution of markups is similar to tracking changes in gross profit margins. Publicly available data, such as Statistics Canada's Quarterly Survey of Financial Statements, do not provide a comparable measure of COGS (and thus gross profit), which means it is necessary to use microdata such as from Compustat.[4]

## Linking markups to inflation

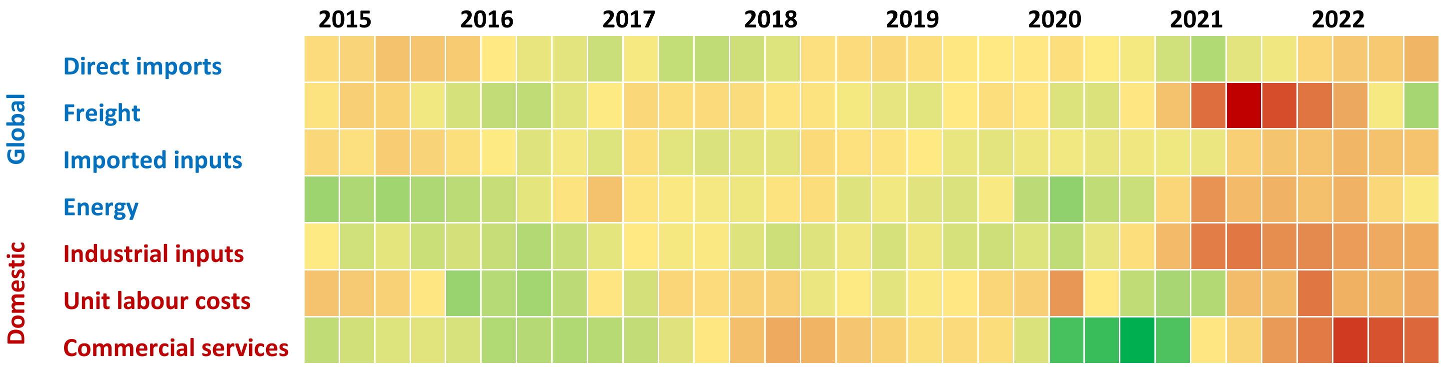
At the firm level, inflation is the product of the growth in markups and growth in marginal costs. When the growth in markups is zero, inflation moves one-for-one with changes in marginal costs. Positive markup growth indicates firms raising their prices by more than the increase in their marginal costs, with both higher markups and higher marginal costs contributing to inflation.

The cumulative growth of markups of consumer-oriented firms was close to zero between 2020 and 2022, consistent with complete pass-through of the various shocks to costs experienced along the supply chain in recent years. Indeed, as **Chart 3** shows, the cost pressures Canadian firms faced intensified significantly in mid-2021. The cost spikes were first evident in global freight and energy as well as in industrial inputs such as chemicals, plastics, lumber and metals. Soon enough, costs associated with labour and commercial services such as trucking also rose significantly. Faced with large and pervasive cost increases, firms appear to have been able to pass them on to consumers. This result is consistent with other recent

[3] Reallocation of activity toward firms with higher markups plays a larger role when we look at all non-financial firms.
[4] The Quarterly Survey of Financial Statements provides an advantage by covering all enterprises operating in Canada, with data measured at the highest level of consolidation in Canada (unlike in Compustat, which consolidates financial statements at the global level).

evidence, such as an examination of price-setting behaviour in the Bank of Canada's Business Outlook Survey (see Asghar, Fudurich and Voll 2023).

**Chart 3: Cost pressures intensified in mid-2021 and proved to be persistent**




Note: The heatmap condenses information from over 50 price series (such as import prices, industrial product prices, shipping rates, etc.) relevant for producing and selling consumer goods (including food) in Canada. The heatmap displays z-scores, with colours reflecting the number of standard deviations away from the pre-pandemic mean of annual growth rates. Red means a high z-score, green means a low z-score.
Sources: Statistics Canada, Haver Analytics, Bank of Canada and Bank of Canada calculations Last observation: 2022Q4

## Appendix: Estimating markups

De Loecker, Eeckhout and Unger (2020) derive the following expression for the markup:

$$Markup_{it} = \frac{Price_{it}}{Marginal\ cost_{it}} = \beta_V \frac{Revenue_{it}}{Cost\ of\ goods\ sold_{it}},$$

where $\beta_V$ is the output elasticity of cost of goods sold (COGS).

This expression is derived from a firm's cost-minimization problem. Specifically, we assume a firm uses capital and variable inputs (measured by COGS) to produce its output. The Lagrangian associated with each firm's cost minimization is:

$$L(V,K,\lambda) = P_v V + rK + F - \lambda(Q - \bar{Q}),$$

where:

- $P_v V$ is the price of inputs ($P_v$) times the quantity of inputs purchased (*V*). The term $P_v V$ is measured using COGS.
- $rK$ is cost of capital times the capital stock.
- $F$ is fixed costs.
- $Q$ is the output produced and $\bar{Q}$ is a fixed production level. Note that the output produced is a function of the amount of input goods (*V*) and capital via a standard Cobb-Douglas production function.

The first-order condition for the amount of inputs purchased (*V*) is:

$$P_v = \lambda \, {\partial Q}/{\partial V}\,.$$

We define the output elasticity as:

$$\beta_V = \frac{\partial Q}{\partial V}\frac{V}{Q}.$$

Plugging the second equation into the first and rearranging them gives:

$$\beta_V = \frac{1}{\lambda}\frac{P_v V}{Q}.$$

The markup formula is obtained by multiplying the above by output price (*P*) and noting that, by definition, $\lambda$ is the marginal cost:

$$Markup = \frac{P}{\lambda} = \beta_V \frac{PQ}{P_v V} = \beta_V \frac{Revenue}{Cost\ of\ goods\ sold}.$$

Revenue and COGS are reported by firms on their income statement. $\beta_V$, which is the output elasticity of variable inputs, must be estimated.

To estimate $\beta_V$, we assume each firm has the following log production function:

$$q_{it} = \omega_{it} + \beta_V v_{it} + \beta_k k_{it} + \epsilon_{it},$$

where:

- $q_{it}$ is log output
- $\omega_{it}$ is log productivity (unobserved and assumed to be correlated with COGS)
- $\beta_v$ is the output elasticity of variable inputs—the main coefficient of interest
- $v_{it}$ is log of the variable input goods
- $\beta_k$ is the output elasticity of capital
- $k_{it}$ is log capital
- $\epsilon_{it}$ is a random error

We use the control function approach of Olley and Pakes (1996) to deal with unobserved productivity ($\omega_t$). Specifically, we assume investment ($i_t$) depends on the capital stock ($k_t$) and is increasing in productivity ($\omega_t$):

$$i_t = f(k_t, \omega_t).$$

Since the function is increasing in productivity, we can invert it and express productivity as an (unknown) function of investment and capital:

$$\omega_t = f^{-1}(k_t, i_t).$$

We approximate the above equation with a polynomial in capital and investment and put it directly into our regression equation:

$$q_{it} = \beta f^{-1}(k_t, i_t) + \beta_v v_{it} + \beta_k k_{it} + \epsilon_{it}.$$

This equation is estimated using five-year rolling regressions to allow $\beta_v$ to vary over time. This accounts for potential improvements in technology that would allow firms to create more output for a given amount of input. Also, we estimate it at the industry level using details from the financial statements of each firm in the industry. This is because we assume firms within an industry have similar production functions but that production functions vary across industries.

## References

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