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- In U.S. Compustat data, large firms are more responsive with SG&A (net of R&D) to monetary policy shocks
- Imperfect competition over frictional customer capital magnifies the response of advertising expenditures for large firms
- An unintended consequence of expansionary monetary policy may be to increase large firms' market power through its effect on non-traditional forms of investment
- Intangible capital dynamics may explain the secular collective behavior of declining interest rates, rising market power, and increasing market concentration

Monetary Policy, Customer Capital, and Market Power*

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Abstract

In U.S. firm-level data, large firms increase their spending on customer capital significantly more than small firms following an interest rate decline. We interpret this evidence in a model with product market frictions where heterogeneous firms strategically advertise to build a customer base. When a firm advertises, it shifts customers' demand away from competitors. This externality is especially severe when firms have a sizable existing customer base, discouraging smaller competitors and making them less responsive to interest rate shocks. The model provides a rationale for the rise in market concentration and market power in recent decades, while interest rates fell.

JEL Classifications: E22, L11, E52, E40, D43

Keywords: customer capital, monetary policy, industry concentration, product market competition

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1 Introduction

Interest rates have seen a marked decrease over the last few decades, and in recent years reached historic lows in an effort by government and monetary institutions to stimulate investment and economic growth (Rachel and Smith, 2017). Meanwhile, concentration and profitability have increased across most U.S. industries, while business investment and overall growth have slowed down.[1] A growing body of research has focused on jointly rationalizing the coincident trends of declining long-term interest rates and low industry dynamism (Eggertsson et al., 2018; Farhi and Gourio, 2019; Liu et al., 2019). This article investigates the role of imperfect competition and customer capital in the relationship between interest rates, industry concentration, and market power.

The value of a customer base is viewed as one of the most critical assets of a firm. In the U.S., total advertising expenditures amount to as much as 2-3% of GDP, with substantial heterogeneity across industries (Arkolakis, 2010; Gourio and Rudanko, 2014a). Managers advertise not only to promote their product but also to restrain the entry (and sales) of their rivals, leading to strategic interactions among firms (Doraszelski and Markovich, 2007). Despite extensive literature pointing at firm investment in demand as a key driver of industry dynamics, few studies have investigated the macro-level implications of imperfect competition over customer capital.[2]

When a firm advertises, it inevitably draws customers away from its competitors, reducing their sales. This externality is particularly pronounced for firms whose existing customer base is sizable, discouraging smaller competitors and making them less responsive to interest rate shocks. Large firms can thus increase market share following interest-rate reductions. If customer relationships are persistent, these micro-level dynamics further imply that reductions in interest rates may lead to higher market concentration and higher market power in the long run.

[1] See, e.g., Grullon et al. (2019); De Loecker et al. (2020); Covarrubias et al. (2020)

[2] See, e.g., Dinlersoz and Yorukoglu (2012), Gourio and Rudanko (2014a), Perla (2019), Roldan-Blanco and Gilbukh (2020) and Cavenaile and Roldan-Blanco (2020).

This article investigates the interaction between interest rates, customer capital, and market power using novel evidence for the U.S. economy and a theoretical model. Section 2 provides evidence that the firm-level response to monetary policy varies with firm size. The primary dataset combines quarterly firm-level data from Compustat with a time series of identified exogenous shocks to policy interest rates, obtained from high-frequency surprises in interest rate futures contracts within narrow time windows around policy announcements (Kuttner, 2001; Gürkaynak, Sack, and Swanson, 2005). The elasticities of interest are estimated using local projection regressions as in Jordà (2005), where the primary variable of interest is firm-level selling and marketing expenses to build customer capital. This variable is typically reported on the income statement as a selling expense within "Selling, General and Administrative Expenses" (SG&A).[3]

Following a plausibly exogenous and unexpected reduction in interest rates, large firms increase their spending on sales and marketing significantly more than smaller firms. This evidence is consistent with large firms disproportionately taking advantage of interest-rate reductions to secure or increase their market share. Heterogeneity by size is particularly pronounced in industries where advertising intensity is higher, showing that the SG&A variable credibly captures customer capital dynamics.

A testable implication of the finding that large firms gain relatively more from interest-rate declines is that asset prices should reflect the heterogeneous pass-through of interest rate on firms' market shares and value. In line with this prior, large firms' stock returns vary more negatively with interest rate shocks, and even more so in industries with high advertising intensities.[4]

Motivated by these findings, Section 3 develops a theoretical model of an industry where heterogeneous firms compete over customers' attention (Dinlersoz and Yorukoglu, 2012; Gourio and Rudanko, 2014b). The theoretical analysis focuses on the problem of

[3]We remove R&D expenditures which Compustat often includes in SG&A.

[4]Our results are consistent with Kroen, Liu, Mian, and Sufi (2020), who show that the stock returns of firms in the top 5% are more negatively correlated with interest rates than smaller firms' stock returns.

two heterogeneous firms selling differentiated products. Product market frictions require that for a new customer relationship to form, each buyer must first become aware of its existence and then decide whether to enter the firm's customer *base* by buying its product. Firms can influence consumer awareness in future periods through advertising. Buyers are exposed to ads at random: the probability that a given buyer is reached by one firm is independent of the other firm reaching her. Customer relationships are long-term: Each period, a fraction of customers is lost at an exogenous rate, making the firms' problem dynamic. Due to the strategic nature of advertising, both a firm's awareness level and its rival's awareness are state variables for firm decision-making.

On the one hand, advertising increases a firm's sales by expanding its customer base. On the other hand, it reduces its rival's future sales by diverting customers' attention away from it. The latter effect is more substantial for firms whose customer base is sizable, giving larger competitors competitive advantage. Notably, strategic interactions over customer capital are such that the firm-level advertising elasticity to interest-rate changes increases in firm size, in line with the empirical findings.

Section 4 calibrates the model to investigate the implications of imperfect competition and declining interest rates on the long-run industry structure. Analysis of the steady-state equilibrium reveals a negative monotonic relationship between the real interest rate and industry concentration. These effects can be significant: A change in the real interest rate equal to the one observed in the U.S. since 1980 can generate increases in industry concentration similar to those in the U.S. over the same period. A key parameter for the model's long-run implications is the depreciation (churn) rate of customer capital: only when customer relationships are persistent do interest-rate reductions lead to higher concentration in the long run. Sensitivity analyses on this parameter show that the main results are robust to choosing parameter values within reasonable ranges.

The central insights of the baseline model generalize to richer frameworks. First and foremost, results are robust to allow firms to influence customer acquisition through advertising and pricing. The differences in elasticities could be even more significant when prices are endogenous. The latter result captures the notion that with price competition, small firms have a considerable incentive to keep their market shares low to reduce the intensity of price competition (Fudenberg and Tirole, 1984; Fishman and Rob, 2003). In the model with endogenous prices industry concentration is positively (negatively) related to aggregate profits (interest rates) in the steady-state equilibrium. Therefore, in the extended model, declining long-run interest rates are correlated to increasing private returns to capital (Eggertsson, Robbins, and Wold, 2018; Gomme, Ravikumar, and Rupert, 2011, 2015). Last but not least, it is shown that the baseline model with exogenous differences across firms can be micro-founded in a dynamic model of advertising competition where firm differences stem from idiosyncratic shocks to demand or technology (Doraszelski and Markovich, 2007).

Two alternative explanations for the heterogeneous advertising response to interest rate shocks are explored in Section 5: heterogeneous financial frictions, and economies of scale. Both these channels may lead to heterogeneous elasticities through their differential effect on the shadow cost of customer capital. Adding direct controls for variables that should affect the cost of firms' external financing to the baseline specifications does not eliminate the size effect, nor do they significantly affect the coefficient magnitudes.[5] Similarly, adding a control for the share of lagged selling expenses over sale – a sufficient statistic of the heterogeneous scale effect on marketing expenses – is inconsequential for the primary elasticity estimates. It is thus unlikely that the central findings are due to heterogeneous financial frictions or scale effects.

Related Literature This article makes contact with three main strands of the literature. First and foremost, it contributes to the literature on the role of customer capital for firm and industry dynamics. Doraszelski and Markovich (2007) study the long-run

[5]The set of control variables for financial frictions may include distance-to-default or firm age (Ottonello and Winberry, 2020; Cloyne, Ferreira, Froemel, and Surico, 2018).

industry structure in a dynamic model of advertising competition, showing that advertising may lead to a sustainable competitive advantage and more concentrated industry structure. Dinlersoz and Yorukoglu (2012) focus instead on the effects of cost of information dissemination on an industry with many firms. The current study contributes to this literature by investigating the long-run implications of interest rate reductions when firms engage in strategic advertising competition. The focus on strategic interactions and interest rates further differentiate this work from studies of the customer capital implications for firm investment dynamics (Gourio and Rudanko, 2014b), firms' life cycle (Perla, 2019; Roldan-Blanco and Gilbukh, 2020), firm size distribution (Luttmer et al., 2006), R&D and economic growth (Cavenaile and Roldan-Blanco, 2020), export market penetration (Arkolakis, 2010), trade (Drozd and Nosal, 2012), financing and stock returns (Dou, Ji, Reibstein, and Wu, 2021) and international prices (Fitzgerald and Haller, 2014).

This paper also contributes to an important line of research in macroeconomics and finance, documenting cross-sectional differences in the cyclicality of firms of different sizes. This literature offers a mixed picture. A series of papers, dating back at least to Gertler and Gilchrist (1994), has used plausibly exogenous monetary policy shocks to demonstrate that small or financially constrained firms' sales and capital investment are relatively more correlated to the state of the economy (Cloyne, Ferreira, Froemel, and Surico, 2018; Jeenas, 2018). On the other hand, several studies have challenged both the "financial accelerator" view of aggregate fluctuations and that small firms are more cyclical than large firms. Ottonello and Winberry (2020) finds that firms with lower default risk – those that are arguably less financially constrained – are the most responsive to monetary shocks in their capital investment, even after controlling for firm size. Crouzet and Mehrotra (2020) also challenges the importance of financial constraints in explaining the heterogeneity in capital investment by size. Kurtzman and Zeke (2020) argue that unconventional expansionary monetary policies can lead to capital reallocation towards large firms. Moscarini and Postel-Vinay (2012) shows that the employment growth of large firms comoves much more strongly than that of smaller firms with aggregate unemployment and the aggregate economy thereof.

This study sheds light on a new dimension of heterogeneous cyclicality: firm expenditures on investment in intangibles. It is shown that large firms are more cyclical in SG&A spending than small firms, even after controlling for proxies of financial constraints. That the financing of intangibles may be less related to traditional forms of credit constraints is well-documented in the macro-finance literature (Hall et al., 2015; Haskel and Westlake, 2018). Insofar as credit constraints may still be significant for the financing of physical or working capital, the confluence of different factors may explain why the evidence on sales and investment is instead more mixed.

Whether the secular increase in industry concentration results from high barriers to competition or technological factors is the object of active debate among macroeconomists.[6] Recently, several studies have argued that the increasing importance of investment in intangible assets played an important role in driving up concentration (Corrado, Hulten, and Sichel, 2009; Corrado and Hulten, 2010; Bajgar, Criscuolo, and Timmis, 2019). This paper's results show that intangible-driven concentration may involve both technological and anti-competitive roots, as the properties of intangibles may lead firms to invest in increasing their market share strategically. In this sense, the findings in this article resonate with studies arguing that good and bad concentration sources may coexist (Crouzet and Eberly, 2018; Covarrubias, Gutiérrez, and Philippon, 2020).

Finally, this paper's findings are closely related to recent work by Liu, Mian, and Sufi (2019) showing that a decline in interest rate can lead to more concentrated markets by triggering heterogeneous innovation responses by market leaders and followers in a patent race model. This study complements Liu, Mian, and Sufi (2019) in two ways: by providing direct causal evidence of high versus low market share firms' response to

[6]See Gutiérrez and Philippon (2017); De Loecker, Eeckhout, and Unger (2020); Eggertsson, Robbins, and Wold (2018); Barkai (2019); Farhi and Gourio (2019) for papers in the first group and Haskel and Westlake (2018); Autor, Dorn, Katz, Patterson, and Van Reenen (2020); Dorn, Katz, Patterson, Van Reenen et al. (2017); Liu, Mian, and Sufi (2019); Akcigit and Ates (2020, 2019) for papers in the second group.

interest rates and focusing on a different model of strategic interactions among firms. In Liu, Mian, and Sufi (2019), market leaders invest more aggressively to avoid fierce neck-and-neck competition with their competitors in the future. As market followers understand that the leaders will fight harder, their investment response is dampened. In this paper's model, larger firms invest more aggressively than small ones in equilibrium because of a competitive externality in product markets. As the interest rate declines, the competitive externality increases in magnitude and leads to a disproportionately large customer capital investment response by larger firms.

2 Empirical Results

This section introduces the data and discusses the construction of the central variables for the empirical exercise. The main empirical results follow: first, following a plausibly exogenous and unexpected reduction in interest rates, larger firms increase their spending on selling expenses more than other firms in the same industry. Second, the heterogeneity in interest rate responses is particularly pronounced in industries with higher advertising intensity.

2.1 Data

The empirical analysis combines quarterly balance-sheet information for publicly listed U.S. companies retrieved from Compustat with a time series of identified exogenous shocks to policy interest rates.

Using Compustat data has both advantages and disadvantages. On the one hand, it is one of the few datasets with rich high-frequency information on firms over a long period. As such, it is ideal for studying the firm-level transmission of monetary policy shocks. On the other hand, it only includes public firms, and the conclusions may only apply to this particular type of firm.

Firm-Level Variables Firm size is constructed as the log difference between firm sales and average industry sales in a given period.[7] Firm-level expenditures on customer acquisition include spending on salespeople, marketing, and advertising to build customer capital. This type of expense is typically reported on the income statement as a selling expense within "Selling, General and Administrative Expenses" (SG&A).[8] Compustat often adds R&D expenditures in the *xsga* variable. To isolate the contribution of reported SG&A, we follow the methodology in Peters and Taylor (2017) and define net SG&A as the difference between *xsga* and R&D expenditures, whenever possible.

Advertising expenses are also reported in Compustat, but only for a minority of observations and annually. This variable is used to construct a measure of industry-level advertising intensity, for which limited availability and lower frequency are less constraining. Industry advertising intensity is defined as the average of firm annual advertising spend divided by annual sales for those firms which report both in a given year. Two additional industry measures are constructed from annual Compustat data and used as controls: industry intangible spend and R&D intensity. Industry intangible spend intensity is defined as the average of firm total intangible spend (SG&A, net of R&D, plus R&D spend) divided by annual sales for those firms which report both in a given year. Industry R&D intensity is defined as the average of firm R&D spend divided by annual sales for those firms which report both in a given year.

To address concerns that cyclicality or aggregate trends in advertising intensity potentially drive the results, we first residualize each industry measure on time fixed effects.[9] The unconditional means of these industry measures are then added back to regressions to retain the economic interpretations of coefficients. The results are qualitatively unchanged if the raw industry measures are used instead.

[7] We trim yearly log sales at the 1% level. We compute this statistic only if there are at least ten firms within an industry at a given point in time.

[8] SG&A also includes general and administrative expenses that are unrelated to advertising, which means that only a fraction of the observed SG&A can be attributed to investment in customer capital.

[9] In this procedure, we weight regressions by the numbers of firms in each industry-year, so that the average industry measure within each year is constant over time.

An industry is a 3 digit SIC code. SIC codes corresponding to finance, real estate, insurance, and public administration are excluded from the analysis, together with industry-quarter observations with less than 10 observations. Table 1 presents simple summary statistics on the sample used in the analysis.

Monetary Policy Shocks A well-known threat to identifying the dynamic causal effects of monetary policy on aggregate variables is the possibility of reverse causality: interest rates both affect and respond to the economy (Kuttner, 2001; Gürkaynak, Sack, and Swanson, 2005). To address the endogeneity concern, we use intraday changes in fed funds futures around the 30-minute window surrounding scheduled Federal Reserve announcements as the primary measure of monetary policy shocks.[10] Monetary policy shocks are aggregated to the quarterly frequency by summing up the intraday surprises within each quarter. The quarterly shock series has a median of exactly zero and a mean of negative 1 basis points. The standard deviation is slightly above 6 basis points, and the distribution has fat tails, with kurtosis of 7.3.

Although this type of monetary policy shocks is widely used in empirical work, there may be some concerns about the amount of variation (and the number of shocks) included in short series. For this reason, Online Appendix A considers alternative measures of monetary policy shocks, including measures computed from close-to-close changes in fed funds futures prices, which are available for a more extended period. Results are broadly robust to these alternative series.

2.2 Heterogeneous Responses to Monetary Policy by Size

The dynamics of differential responses across firms is estimated using local projections regressions, à la Jordà (2005). We consider the following specification:

[10] To account for the critical role of forward guidance, we use a maturity several months out (Gürkaynak, Sack, and Swanson, 2005). We use maturity that corresponds to the following FOMC meeting and take the data from the replication files of Nakamura and Steinsson (2018).

$$\Delta^k \log\left(Y_{j,t}\right) = \beta_k i^{FF}_{\epsilon,t} s_{j,t-1} + \alpha_k i^{FF}_{\epsilon,t} I_j + \xi_k s_{j,t-1} + \gamma_k X_{j,t} + \epsilon_{j,t,k}, \quad (1)$$

where j indexes firms. The main dependent variable is $\Delta^k \log Y_{j,t} = \Delta^k \log sga_{j,t}$, where $sga_{j,t}$ is SG&A (net of R&D expenses) of firm j at time t. The delta operator is defined as the k-th period difference between log investment in period $t+k$ and log investment in the current period, e. g., $\Delta^k \log sga_{j,t} \equiv \log sga_{j,t+k} - \log sga_{j,t}$.

The term $s_{j,t-1}$ measures (relative) firm size, constructed as the log difference between firm sales and average industry sales in a given time period; $i^{FF}_{\epsilon,t}$ is the monetary policy shock, I_j is an industry dummy, and $X_{j,t}$ is a vector of fixed effects.[11] Firm-by-quarter fixed effects account for differential firm seasonality and average growth rates, and industry-by-time fixed effects eliminate heterogeneous responses by industry.[12] Standard errors are clustered two-ways, by firm and time.

The vector of coefficients $\hat{\beta}_k$, $k = 1,..,20$ measures how the cumulative response of the dependent variable in quarter $t+k$ to a shock in quarter t depends on the firm's demeaned size in $t-1$; it thus captures the heterogeneous effects of the monetary policy shock.

Panel (a) of Figure 1 plots the estimates of $\hat{\beta}_k$ from regression (1). The coefficient can be interpreted as the difference in the log change in SG&A spending (net of R&D) between a firm and one a log point smaller that results from a 100 basis point contractionary monetary policy shock. The estimated effects are large: In response to a 100 basis point increase (decrease) in the interest rate, a firm at its peak reduces (increases) SG&A by 11 percentage points more than firms that are one standard deviation smaller.[13]

Panel (b) of Figure 1 reports the differential effect of a 100 basis point contractionary shock on firms in the top and bottom size quintile using a semi-parametric version of equation (1), in which $s_{j,t-1}$ is a dummy denoting the quintile of demeaned firm sales (relative to its industry). At their peak, a 100 basis point fall in interest rates would

[11] In robustness exercises in Section 5, we consider specifications with additional controls.

[12] Note that industry-by-time fixed effects absorb the term $i^{FF}_{\epsilon,t} I_j$ in equation (1).

[13] We obtain this estimate by multiplying the within-industry log standard deviation in sales times the peak of the estimated coefficient.

lead firms in the largest size quintile to increase their SG&A expenditures by up to 35 percentage points more relative to firms in the bottom quintile.

2.2.1 Industry Heterogeneity

This section establishes a link between the heterogeneity by size and *customer capital* by showing that the differences among firms are especially sizable in industries with high advertising intensity. We modify regression (1) to also include an interaction between industry advertising-intensity, firm size, and the monetary policy shock:

$$\Delta^k \log\left(Y_{j,t}\right) = \beta_k i^{FF}_{\epsilon,t} s_{j,t-1} + \phi_k i^{FF}_{\epsilon,t} s_{j,t-1} a_{j,t-4} + \alpha_k i^{FF}_{\epsilon,t} I_j + \xi_k s_{j,t-1} + \gamma_k X_{j,t} + \epsilon_{j,t,k}, \tag{2}$$

where $a_{j,t-4}$ measures the mean advertising intensity in the firm's industry the year before the shock.[14] To ensure that these results are driven by cross-sectional variation in industry advertising intensity, and not time-series variation, the measure is first residualized on year fixed effects, and then the unconditional mean (across industries and years) is added back for economic interpretation. The results are qualitatively unchanged if we use the raw industry advertising intensities instead.

Panel (b) of Table 2 displays the estimated coefficients for β_k and ϕ_k for various horizons k. The coefficient on ϕ_k is negative and significant, showing that the heterogeneity is increasing in the industry advertising intensity. Conversely, the coefficient on β_k is statistically insignificant, meaning that this heterogeneous response is absent in industries with very low advertising intensity.[15] Intuitively, industries with high advertising intensity should be those in which customer acquisition and customer capital are relatively important. The previous results thus suggest that the size heterogeneity in firm SG&A response to monetary policy is likely driven by dynamics linked to customer acquisition.

To address concerns that the result in (2) may be driven by industries with high intan-

[14] As we mention in the data section, the advertising item in Compustat is only populated for a minority of observations and is observed annually.

[15] We present the results of (1) in a comparable format in Panel (a) of Table 2, for comparison.

gible (rather than just advertising) intensity, in a third specification we add a control for the interaction with industry intangible intensity, $T_{j,t} = \frac{\text{intangible investment}}{\text{sales}}$:[16]

$$\Delta^k \log\left(Y_{j,t}\right) = \beta_k i^{FF}_{\epsilon,t} s_{j,t-1} + \phi_k i^{FF}_{\epsilon,t} s_{j,t-1} a_{j,t-4} + \phi^T_k i^{FF}_{\epsilon,t} s_{j,t-1} T_{j,t-4} + \xi_k s_{j,t-1} + \gamma_k X_{j,t} + \epsilon_{j,t,k}. \quad (3)$$

Panel (c) of Table 2 presents the estimated coefficients in this specification. Industry advertising intensity is statistically significant, while the coefficient on the interaction with industry intangible investment intensity is not significantly different from zero. This suggests that advertising intensity, rather than overall intangible intensity, is related to the heterogeneity by size.

2.2.2 Evidence on Stock Market Returns

Suppose large firms gain relatively more from interest-rate declines due to product market dynamics. In that case, their market value should also respond more favorably to a fall in interest rates, more so in advertising-intensive industries. This section documents the heterogeneous response of firm stock returns to monetary policy shocks.

For weeks in which there are scheduled FOMC announcements, we regress the average daily stock return in that week on the monetary policy shock, interacted with firm size and industry characteristics as in (1) and (3).[17] Table 3 presents the results, for different sets of controls and fixed effects. Large firms' stock returns do indeed vary more negatively with interest rate shocks. Specifically, a 100 bps expansionary shock in interest rates implies a 0.5-1% higher stock return for the firm than firms within the same industry that are one standard deviation smaller. These findings are consistent with Kroen, Liu, Mian, and Sufi (2020), who show that stock returns of firms in the top 5% are more negatively correlated with interest rates than smaller firms' stock returns. Furthermore, this effect is particularly pronounced in industries with high advertising intensities, con-

[16]For brevity we omit the industry dummy term in (3) as it is absorbed by the industry-time fixed effects.
[17]This is analogous to those specifications, except the frequency of the data is different.

sistent with the results on firm SG&A spending.[18]

2.3 Additional Results

Robustness analysis considers specifications analogous to (1), but the dependent variables are now sales, firm capital expenditures, and firm R&D investment. Figure 2 displays the resulting estimates for β_k. When $\beta_k < 0$, following an expansionary (contractionary) monetary policy shock large firms increase (decrease) the dependent variable more than small firms in the same industry. Panel (a) shows that large firms' sales are more responsive to monetary policy shocks than small firms' sales within the same industry. However, the response timing seems to be lagged relative to those in Figure 1. Panel (b) shows the estimate for capital expenditures, which also results in $\beta_k < 0$, though the relationship is less clear - and less statistically significant at most horizons - than for other variables. Panel (c) shows that R&D expenditures exhibit qualitatively similar heterogeneity in size as SG&A expenditures (net of R&D).

Controlling for Research and Development One concern may be that firm R&D and customer capital spend are correlated, and therefore dynamics related to R&D may be driving the results. To test whether the heterogeneous SG&A spend is amplified in high R&D intensive industries, we modify specification (2) to control for interactions of size and monetary policy shocks with industry R&D intensity. R&D intensity is likely to capture the importance of research and development within an industry. Table 4 presents the regression results. The heterogeneous responsiveness by size is neither economically nor statistically significantly increasing in R&D intensive industries. Consistent with the prior specifications, the heterogeneous effect of monetary policy shocks is increasing in

[18]We include interactions of firm size with industry advertising and intangible intensity in specifications (3) and (4) to isolate the effect of advertising on stock returns. Advertising and intangible intensity are correlated, and there may be channels through which interest rate shocks interact with tangibility to affect stock returns. For instance, tangibility may affect the terms with which firms can finance via debt, as in Falato et al. (2020). Therefore, controlling for both interactions in Table 3 is important.

advertising-intensive industries. The coefficient estimates imply that industries with negligible advertising spend are likely to exhibit, on average, no significant heterogeneity by size in their intangible investment response to monetary policy shocks.

2.4 Discussion

Two key empirical findings emerge from this section: (i) large firms' selling and marketing expenses are more responsive to monetary policy shocks than small firms' expenses; (ii) this effect is driven by firms operating in adverting-intensive industries. Moreover, the cross-sectional differences in the response of marketing expenditures to a monetary policy shock evolve in a hump-shaped fashion, peaking several quarters after the shock. In the next section, we rationalize this evidence using a model where customer capital dynamics interact with imperfect competition among firms.

The advertising literature provides some context for these results and for the model that follows. Studies in this literature emphasize the importance of advertising as a strategic variable.[19] Managers use advertising not only to promote their product (and sales) but also to restrain the entry (and sales) of their rivals. The theoretical model in the next section accounts for these competitive dynamics while showing that they are also the critical factor generating firm advertising's heterogeneous response to interest rate shocks.

In many industries, most brands do not advertise continuously, nor is advertising constant over time. Instead, managers systematically switch advertising on and off, a phenomenon known as *pulsing*. While practitioners may have different reasons to adopt this practice, pulsing is broadly considered an effective way to maximize exposure while managing limited budgets (Dubé, Hitsch, and Manchanda, 2005). The fact that managers choose to advertise only infrequently is evidence of carry-over effects, whereby current advertising levels affect future demand. The model captures similar dynamics by assuming that advertising is an inter-temporal decision.

[19] See, e.g., Bagwell (2007) for a review of the literature.

The prevalence of pulsing strategies may also, in part, explain the delayed onset of the interest-rate responses observed in Figure 1. However, pulsing alone is unlikely to explain the horizon at which the peak effect occurs (three years). For instance, in packaged goods industries, the typical firm has several pulsing episodes in a given year, about one per quarter (Gijsenberg and Nijs, 2019). While pulsing alone may be insufficient to explain the observed patterns, the model in the next section provides a second rationale for the hump-shaped response spanning multiple quarters. Large firms acquire relatively more customers in response to an interest-rate decline, as they impose a more severe externality on competitors. If the interest-rate shock is persistent, this externality's size grows over time, leading to an endogenous amplification mechanism. If and when the peak happens depends on how transitory the effect of monetary policy shocks have on interest rates. We will come back to this point in more detail at the end of Section 4.

3 The Model

This section proposes a theoretical model that can rationalize the findings in the previous section while being consistent with key features of firm advertising strategies. The model relies on two key ingredients: product market frictions and imperfect competition among firms. To focus attention on the role of advertising competition on the industry equilibrium, we start by describing the most parsimonious model. A discussion of several model extensions is provided at the end of this section.

3.1 A Description of the Model

The economy consists of a duopolistic industry where firms are ex-ante heterogeneous in their marginal cost and ability to attract customers. Product market frictions require that for a new customer relationship to form, each active buyer must first become aware of the firm's existence and then decide whether to buy its product. Firms can influence future levels of consumer awareness through advertising, but buyers are exposed to ads at random.[20] In each period, any given buyer will become aware of either one firm, both firms, or none. If a buyer is aware of only one firm, we assume that he/she will buy the firm's product (and enter the firm's customer base) with probability one. If the buyer is instead aware of both firms, he/she will decide from whom to buy at random.[21]

A firm's *customer base* refers to the share of active buyers that are both aware of the firm and buy its product. Firms sell their products to all buyers in their customer base at a fixed, predetermined price. Customer relationships are long-term, yet a fraction of customer awareness is lost at some fixed rate in each period. Due to the strategic nature of advertising, both a firm's awareness level and its rival's awareness are state variables for the firm's decision-making.

Lastly, the measure of active buyers is endogenous in the model: buyers choose to search only if the present value of a new customer relationship makes up for the cost of search (Gourio and Rudanko, 2014a). While this margin is not necessary for the primary results, letting buyers respond to interest-rate shocks shows an additional channel through which interest rates may differentially affect firm choices.

3.2 Environment

Time is discrete, and indexed by $t = 1, .., \infty$. The economy is populated by a unit continuum of *potential* buyers. To enter the market, potential buyers must put some search effort. Buyers' search translates into a probability $m_b \in [0, 1]$ of successfully entering the marketplace in each period. This probability is i.i.d. so that m_b also denotes the mass (fraction) of *active* buyers at a given point in time. Each firm $i = 1, 2$ can target a fraction

[20] Therefore, advertising in the model has a merely informative role (Grossman and Shapiro, 1984; Stegeman, 1991; Fershtman and Muller, 1993; Boyer and Moreaux, 1999).

[21] In the baseline model where prices are exogenous, the results do not depend on the specific value of this probability, which we thus set equal to one half.

of active buyers through customer acquisition technology, which we call advertising.[22] $s_i \in [0,1]$ denotes the level of firm i's *awareness*, namely, the share of active buyers reached by i thanks to its advertising efforts.

Potential customers are exposed to advertising at random. Consumers can thus be categorized into four mutually exclusive and exhaustive groups: (1) a fraction $m_b s_1(1-s_2)$ only reached by firm 1; (2) a fraction $m_b s_2(1-s_1)$ only reached by firm 2; (3) a fraction $m_b s_1 s_2$ reached by both firms; and (4) a fraction $1 - m_b(s_1 + s_2 - s_1 s_2)$ reached by neither. Each customer buys one unit of the good from at most one firm. When both firms reach a customer, s/he chooses from whom to buy at random. Thus, given (s_1, s_2), the share of active customers that buy from firm i is given by:

$$D_i(s_i, s_j) = s_i\left(1 - \frac{s_j}{2}\right), \text{ for } i = 1,2; j = 3-i. \tag{4}$$

$D_i(\mathbf{s})$ denotes firm i's *customer base*. Due to the random nature of advertising, the size of the firm's customer base depends not only on firm i's awareness level s_i, but also on its rival's awareness s_j. In particular, given s_i, the larger its rival awareness level s_j, the more firm j diverts customers' attention away from firm i, the lower firm i's customer base.

Buyer Problem The buyer's value of search is assumed exogenous and equal to some fixed value C, which we can set equal to one.[23] Buyer search has decreasing marginal returns, the search cost being given by $\kappa_b(m_b) > 0$, with $\kappa_b' > 0$ and $\kappa_b'' > 0$. The problem of a representative buyer can thus be written as:

$$\max_{m_b} -\kappa_b(m_b)\, r_t^{\eta} + m_b, \tag{5}$$

[22]This can be interpreted more broadly as encompassing hiring salespeople, marketing, branding, and all other investments in gaining customers.

[23]The results below are robust to allowing the present value of search to a buyer depending on the endogenous probability of buying from any of the sellers. Proofs are available upon request.

where $r_t > 1$ is the policy interest rate at time t, governing the present discounted value of the buyer's search, and η is the sensitivity of buyer search to changes in policy rates. For tractability, we set $\kappa_b(m_b) = \frac{1}{2}m_b^2$, such that m_b is equal to:

$$m_{b,t} = r_t^{-\eta}. \tag{6}$$

The buyers' trade-off depends on the current interest rate r and the elasticity η. The higher the interest rate r, the lower the present value of search, the lower the buyer's search efforts.

Note that the buyer's problem is not essential for any of the results that follow, neither is the specific value of η. All the results would go through with $\eta = 0$ and $m_b = 1$. Allowing for $\eta > 0$ allows the real interest rate to affect the equilibrium through the consumption/savings decisions of buyers: the larger η, the more the buyers' search (and consumption) change with the policy interest rate.[24]

Firm Problem In each period, firm i chooses advertising efforts a_i to expand its customer awareness level. The firm's advertising decisions are governed by a quadratic cost function $\kappa_i(a) = k_i\frac{a_i^2}{2}$. The term $k_i \in (0,1)$ denotes the firm's advertising efficiency, which we allow varying across firms. A lower value of k_i indicates that a higher share of customers is reached per dollar spent. Customer relationships are long-lasting, but firms lose some consumer awareness in each period for exogenous reasons at rate $\delta \in (0,1]$.

To focus on the role of advertising competition, we abstract from pricing dynamics in the baseline model and assume that firm i earns exogenous (constant) flow profits $\pi_i > 0, i = 1,2$ from any customer that buys its product. The term π_i captures the firms' sales efficiency or marginal costs and is heterogeneous across firms.

[24]Note that η captures the degree of pass-through of monetary policy shocks on consumption decisions of buyers. For empirical evidence on the pass-through of monetary policy shocks on household consumption, see Di Maggio, Kermani, Keys, Piskorski, Ramcharan, Seru, and Yao (2017) and Auclert (2019), among others.

Each firm maximizes the present discounted value of profits, which reads:

$$V_{it}(s_{it}, s_{jt}) = \pi_i m_b D_i(s_{it}, s_{jt}) + \max_{a \geq 0} \left\{ -k_i \frac{a^2}{2} + r^{-\nu} V_{it+1}(s_{it+1}, s_{jt+1}) \right\} \tag{7}$$

$$s_{it+1} = (1-\delta)s_{it} + a_{it}, \tag{8}$$

$$m_b = r^{-\eta}. \tag{9}$$

The vector $\mathbf{s}_t = (s_{it}, s_{jt})$ denotes the state of the industry. The measure of active buyers m_b is written as a constant for simplicity, but can change due to policy actions as in (6). The period profits of firm i depend on the firm's sales efficiency parameter, π_i, and the firm's *effective* customer base, which is given by the product of $D_i(\mathbf{s_t})$ and the measure of active buyers m_b. Equation (8) denotes the law of motion of firm i's customer awareness. Finally, the constant $\nu \geq 0$ denotes the sensitivity of the firm's internal discount rate to the policy rate r.[25]

The equilibrium properties of the model are introduced sequentially. We first consider the extreme case of full customer depreciation ($\delta = 1$) to illustrate the effect of advertising competition on firm-level investment decisions. We then consider the more general case when $\delta < 1$ to describe the long-run implications of the model.

3.3 Full Depreciation Case

When $\delta = 1$, a firm's advertising efforts equal the firm's awareness level in each period, i.e., $s_{i,t} = a_{i,t}$. The first order condition of each firm i reduces to

$$s_{it} = \frac{\tilde{\pi}_i}{\tilde{r}} \left(1 - \frac{s_{jt}}{2}\right), \quad \text{for } i = 1, 2; j = 3 - i. \tag{10}$$

[25] By letting ν be different than one, we allow for the possibility that firm investment may be more or less responsive to changes in the market interest rate (Sharpe and Suarez, 2020). In this sense, one could also interpret ν as indexing the pass-through elasticity of firms' decisions to scale up.

where $\tilde{r} = r^{\nu+\eta}$ is the firm's *effective* interest rate, which depends on the sensitivity of both firm's and buyers' advertising (search) effort to changes in r. The term $\tilde{\pi}_i \equiv \pi_i/k_i$ captures the marginal customer valuation for firm i. Because the problem with $\delta = 1$ is static, the subscript t is omitted in the rest of this section.

Solving for the Nash equilibrium of firm i yields:

$$s_i = \frac{2\tilde{\pi}_i\left(2\tilde{r} - \tilde{\pi}_j\right)}{4\tilde{r}^2 - \tilde{\pi}_i\tilde{\pi}_j} \quad \text{for } i = 1, 2; j = 3 - i. \tag{11}$$

A firm's awareness level (and advertising) increases in the firm's marginal customer valuation and decreases in the competitor's valuation. Notably, the equilibrium awareness s_i decreases in the policy interest rate r, the more so the stronger the effect of interest rate shocks on the buyers' and sellers' decisions to consume and scale up, respectively.

However, the overall effect of an interest rate shock on firm-level awareness is not fully determined by η and ν. The elasticity of s_i to r is given by:

$$\epsilon_i \equiv -\frac{d\ln s_i}{d\ln r} = \underbrace{\left(\quad \nu + \eta \quad\right)}_{\text{direct effect}}\underbrace{\left(\frac{8\tilde{r}^2}{4\tilde{r}^2 - \tilde{\pi}_i\tilde{\pi}_j} - \frac{2\tilde{r}}{2\tilde{r} - \tilde{\pi}_j}\right)}_{\text{strategic interaction effect}}. \tag{12}$$

This equation highlights the two distinct channels through which a change in the market interest rate r affects advertising. The first channel, which is proportional to $\nu + \eta$, captures a standard inter-temporal trade-off of firms: as the interest rate falls, the present discounted value of a future customer base increases, leading both firms to advertise more. Absent strategic interactions among firms, the direct channel would fully summarize the elasticity of advertising to interest rates.

The second term in equation (12) captures the role of strategic advertising competition. Insofar as firms' customer valuations differ, this term is heterogeneous across firms, and so is the firm-level response to an interest rate shock. The following proposition summarizes the main theoretical result.

Proposition 1. *If an interior solution of the firms advertising game exists, then the elasticity* $\epsilon_i \equiv -\frac{ds_i}{dr}\frac{dr}{ds_i}$ *of* s_i *with respect to the policy rate* r*:*

1. *is increasing in the firm's customer valuation* $\tilde{\pi}_i$*:* $d\epsilon_i/d\tilde{\pi}_i > 0$*;*

2. *is decreasing in the competitor's customer valuation* $\tilde{\pi}_j$*:* $d\epsilon_i/d\tilde{\pi}_j < 0$*;*

3. *depends on both the firm's and buyer's elasticity to* r : $\epsilon_i \in (0, \nu + \eta)$.

for $i = 1, 2; j = 3 - i$.

Proof. See Online Appendix B.

Corollary 1. *If an interior solution of the firms advertising game exists, then the elasticity* $\epsilon_i^\kappa \equiv -\frac{d\kappa_i(s_i)}{dr}\frac{r}{\kappa_i(s_i)}$ *of firm-level expenditure on customer capital* $\kappa_i(s_i)$ *with respect to the policy rate* r *increases in firm's size* D_i*:* $d\epsilon_i^\kappa/dD_i > 0$*, for* $i = 1, 2; j = 3 - i$.

Proof. The result follows from Proposition 1 and the assumptions that $\kappa_i' > 0$ and $dD_i/ds_i > 0$.

Proposition 1 and its corollary show that in the model, the advertising elasticity to a change in the interest rate is heterogeneous across firms, and increases in a firm's marginal valuation. As the interest rate falls, both firms advertise more, and competition intensifies. In turn, the incentive of lowering the competitor's sales also strengthens. The latter effect is more substantial for the firm that values the marginal customer more, hence the results. Because firms with higher customer valuation will have a more sizable customer base in equilibrium, this result further implies a positive correlation between firm size and advertising elasticity to interest rates.

3.4 Less-than-Full Depreciation

This section goes back to the more general case where $\delta < 1$. A standard envelope condition implies that the value of a marginal customer depends on the extra flow of profits generated in the current period, plus its continuation value, i.e.,

$$V_{ii}(\mathbf{s}) = m_b \pi_i \left(1 - \frac{s_j}{2}\right) + r^{-\nu} W_i'(\mathbf{s}'), \tag{13}$$

where we now expressed the problem in its recursive formulation. The term $W_i'(\mathbf{s}')$ denotes the value of a marginal customer in the next period for firm i. Its value depends on the assumptions on competition between firm i and j, which we describe below.[26]

The firm's advertising effort is pinned down by a standard first order condition that sets the marginal costs of advertising equal to its marginal benefits. The marginal costs are linear, due to the assumption on quadratic costs. The marginal benefits equal the value of the marginal customer:

$$k_i a_i = r^{-\nu} W_i'(\mathbf{s}') \text{ for } i = 1, 2. \tag{14}$$

Equilibrium The equilibrium system is solved under two alternative scenarios. In the baseline scenario, firms internalize the effect of their actions on the competitors' future advertising efforts. This case corresponds to a standard dynamic duopoly problem of advertising competition, as in Doraszelski and Markovich (2007). We will refer to this equilibrium as the "full internalization" one.

In the second scenario, firms do not internalize the role of the advertising externality on their competitor's future actions. This will be the "no internalization" equilibrium. Considering this scenario is instructive for two reasons. First, it yields closed forms solutions for the steady-state equilibrium allowing for a tractable characterization of the effect of interest rates on long-run industry concentration. Secondly, it makes it possible to gauge the impact of strategic interactions on the industry equilibrium.

In both cases, the solution concept is the Markov Perfect Equilibrium (MPE). Agents solve dynamic programming problems that are interdependent only through the payoff-

[26]The notation is such that $V_{ii} \equiv \frac{\partial V_i}{\partial s_i}$, $V_{ij} \equiv \frac{\partial V_i}{\partial s_j}$, $V_{ii}' \equiv \frac{\partial V_i'}{\partial s_i}$ and $V_{ij}' \equiv \frac{\partial V_i'}{\partial s_j}$.

relevant state $\mathbf{s} = (s_i, s_j)$. The equilibrium consists of investment strategies, $\mathbf{a}(s_i, s_j)$ which are optimal at every state, regardless of how that state was reached, against the optimal decisions of all other agents (Ericson and Pakes, 1995).

3.4.1 Internalization

When firm i internalizes the fact that its action impose a negative externality on its competitor, the term $W_i'(\mathbf{s}')$ reads:

$$W_i'(\mathbf{s}') = (1-\delta)\, V_{ii}(\mathbf{s}') + \frac{\partial a_j}{\partial s_i} V_{ij}(\mathbf{s}') \tag{15}$$

where $V_{ij} = -\frac{1}{2} s_i m_b \pi_i + r^{-\nu} \left[(1-\delta)\, V_{ij} + \frac{\partial a_j}{\partial s_j} V_{ij} \right]$. The second term captures the role of strategic interactions among firms, by allowing for a non-zero derivative of the the competitor's advertising efforts a_j to the firm's awareness level s_i.

The system of equilibrium conditions (13)-(15) does not admit an analytical solution. However, despite its complexity, the problem admits a linear solution of the following form:

$$\mathbf{a} = \Phi \mathbf{s} + \mathbf{b}, \tag{16}$$

where $\mathbf{a} = (a_i, a_j)$ is the vector of advertising choices, $\mathbf{s}$ is the state vector, Φ is a matrix of coefficients and $\mathbf{b}$ is a vector of constants. The next section analyzes the properties of the equilibrium solution numerically.

3.4.2 No Internalization

When firm i does not internalize the role of the externality on their competitor's actions, the term $W_i'(\mathbf{s}')$ simplifies to

$$W_i'(\mathbf{s}') = (1-\delta)\, V_{ii}(\mathbf{s}'). \tag{17}$$

Equation (17) makes clear that firm i only takes into account the effect of its actions on its own customer base's value in the future period. In this case, solving the equilibrium system is straightforward, given a linear guess on the equilibrium policy function. In other words, a linear solution as the one in (16) constitutes an equilibrium of this more straightforward problem as well.

3.4.3 Steady State

Considering the "no internalization" case turns out useful to analyze the properties of the long-run equilibrium. The steady state of the "no internalization" case can be written as:

$$s_i = \frac{4\rho\tilde{\pi}_i - 2\tilde{\pi}_i\tilde{\pi}_{-i}}{4\rho^2 - \tilde{\pi}_i\tilde{\pi}_{-i}}, \text{ for } i = 1, 2, \tag{18}$$

where $\rho \equiv \delta(r^{\nu} - (1-\delta))r^{\eta}$. Equation (18) generalizes equation (11) when customer awareness is subject to depreciation. In particular, because the term ρ only depends on the interest rate r and parameters, the properties of the steady state values of $\{s_i\}_{i=1,2}$ are also summarized by Proposition 1.

Equation (18) implies an equilibrium relationship between the long-run industry concentration and the policy interest rate. Industry concentration is measured by the Herfindahl-Hirschman Index (HHI):

$$HHI = \sum_{i=1,2} \tilde{D}_i^2, \tag{19}$$

where $\tilde{D}_i \equiv \frac{D_i}{s_i + s_j - s_i s_j}$ is the steady-state market share of firm i, defined as the ratio between the firm's customer base and total consumer awareness in the industry. [27] A corollary of Proposition 1 is that a decline in interest rates will lead to higher market concentration, due to its effect on firms' strategic incentives to invest. In the next section, we further explore these long-run dynamics through numerical simulations.

[27] This normalization is such that the sum of market shares of the two firms sum to one.

3.5 Discussion

The results in this section do not depend on simplifying assumptions such as linear marginal advertising costs, exogenous flow profits, or random assignment of the "overlapping" buyers to firms. The model's results are also robust to alternative formulations of the search frictions, such as purely random search, or alternative formulations of competition in the product market, such as a sequential game.[28]

A notable extension of the model worth mentioning in more detail is price competition among firms. In Online Appendix C, we develop an extension of the baseline model where firms affect consumer awareness through advertising. Still, they can also use pricing schedules to expand their customer base, given a customer awareness level. In this extended model, prices act as an allocative force in the "competitive" segment of demand where buyers are aware of more than one firm: rather than randomly choosing from whom to buy, consumers make an informed decision based on the firm's posted price and taste shocks.

The result of a heterogeneous investment response to an interest rate shock by large and small firms is robust to allowing firms to compete over prices. Differences in elasticities are even more significant when prices are endogenous. More advertising leads to fewer profits in this model as it enlarges the competitive segment of demand, triggering a price competition between firms (Fershtman and Muller, 1993). This gives the small, low-valuation firm a sizable incentive to stay small and avoid engaging in a price war with the "top" firm (Doraszelski and Markovich, 2007). For the same reason, the small firm's investment response to a change in interest rate is dampened in a model with endogenous prices.

Notably, in the model with endogenous prices, industry concentration is positively related to aggregate profits, thus negatively correlated to interest rates in the steady-state equilibrium. Using the baseline calibration of the model's parameters, we find that a

[28]Full derivations and results are available upon request.

decline in the real interest rate equal to the one observed in the U.S. since 1980 leads to an increase in the aggregate profit shares of about the same magnitude. In this sense, the extended model can also accommodate the fact that while interest rates have secularly declined, the private return to capital, which is a function of both the real interest rate and the profit share, has not (Eggertsson, Robbins, and Wold, 2018; Gomme, Ravikumar, and Rupert, 2011, 2015).

To conclude, the fundamental assumptions behind the core theory result are that: *(i)* potential customers are *randomly* exposed to firms' advertising, and *(ii)* the two products are substitutes. These assumptions are reasonable in the context of advertising, especially in markets characterized by a large number of customers and differentiated products. This is the empirically relevant case for U.S. firms in Compustat.

4 Customer Capital and Industry Dynamics

This section investigates the impact of advertising competition on the long-run (steady-state) industry structure and transitional dynamics.

4.1 Parameterization

A period is taken to be a year and parameters are calibrated accordingly. The firm's and buyer's discount rate elasticities are set equal to $\nu = 1$ and $\eta = 0.35$, respectively. The former is a common choice in the literature; it sets the firm's internal discount rate equal to the (inverse of the) policy interest rate. The latter resonates with standard estimates of the households' elasticity of inter-temporal substitution (Hubbard, Skinner, and Zeldes, 1995); it is also close to existing estimates of the pass-through of interest rate shocks to households' consumption (Di Maggio et al., 2017).

A critical parameter for the model's long-run implications is the depreciation (churn) rate of customer awareness, δ. The lower δ, the more long-term are customer relationships for firms, the more critical advertising competition becomes for long-term industry dynamics. The churn rate δ is set equal to 41%, in line with other related studies in the literature (e.g., Doraszelski and Markovich, 2007; Dinlersoz and Yorukoglu, 2012). Below, we perform a sensitivity analysis on this parameter choice and discuss the empirical evidence on firm customer capital depreciation rates.

The marginal valuation terms, $\tilde{\pi}_i$, $i = 1, 2$, which in the baseline model are exogenously given, are chosen such that the equilibrium log difference in sales of the two firms equal one standard deviation of (log) sales in the Compustat sample. [29] Table 5 summarizes the parameter choice.

To evaluate the model's performance, we compare the the relative long-run elasticity of SG&A to interest rates expressed as a function of log firm size differences in the model and the data. To obtain the data-implied elasticities, we use the estimate of regression (1) at a horizon of 20 quarters. We then extrapolate the implied elasticity difference as a function of log size differentials using the regression model's implied linear relationship. The model-implied elasticities are computed numerically by solving the steady-state values of advertising expenditures under different values of firm size differences.

Figure 3 plots the results. The model-implied elasticity differences are within the 90% confidence interval implied by the reduced-form estimates, which shows that the model's parameters yield reasonable magnitudes of the main elasticities of interest. The model-implied estimates are on the lower-end of the data-implied confidence interval, suggesting that the baseline calibration is a conservative one.

[29] The marginal customer valuation parameter $\tilde{\pi}_i$ corresponds to the ratio between the profit-per-customer π_i, and the advertising efficiency k_i of firm $i = 1, 2$. As we argued above, what matters for long-run dynamics is the ratio between sales and advertising efficiency. We normalize the cost parameters $k_i, i = 1, 2$ to one and calibrate the ratio $\tilde{\pi}_i, i = 1, 2$, which under the normalization is also equal to sales efficiency terms. While this choice is *not* without loss of generality, it does not affect the main results in a significant way.

4.2 Transitional Dynamics

Figure 4 plots the transitional dynamics implied by the model with perfect foresight and intertemporally optimizing behavior. Starting from a steady-state equilibrium, we show the impulse response functions of some critical variables, both when firms consider the effect of advertising on the competitor's future investment and when not. The full (dashed) line in both graphs represents the outcomes in the "full internalization" ("no internalization") case. Both the impact of a one-time permanent shock to the interest rate and a temporary shock that reverts to its initial level after ten periods are considered.

Panel (a) and (c) plot the relative advertising-to-customer stock ratio of the large firm, in the case of a permanent and temporary shock to r, respectively. Panel (b) and (d) plot the relative elasticity of advertising expenditures of the large firm (compared to the small firm). Note that the large firm reacts more following both an increase and a decrease in the interest rate. While results are qualitatively similar in the two scenarios, they are magnified when firms internalize their impact on the competitor's future actions, as expected from the envelope condition. This result highlights that the mechanism plays a role in equilibrium even when agents are not sophisticated in their strategic decision-making.

Figure 4 shows that following an interest rate shock that lasts for more than one period, the responses of firm-level advertising can grow over time: as large firms' customer base expands in response to the initial shock, they exert a larger and larger externality on small firms, which amplifies the initial elasticity differences. Therefore, the theoretical model can reconcile an endogenous amplification mechanism, similar to the reduced-form patterns observed in Figure 1. If the peak happens depends on how transitory is the interest rate shock, as shown by the different patterns in Panel (b) and (d).

4.3 Effect on Industry Concentration and Market Power

The model implies a relationship between interest rates and long-run industry concentration, as measured by the HHI index, which we defined in equation (19).

Figure 5 plots the results under different assumptions on firms' behavior. Interest rates are negatively related to long-run industry concentration. In the baseline "internalization" case, the long-run HHI index is about 0.59 when the real interest rate is at 9%, and it goes up to 0.63 when the interest rate is equal to 2%. Panel (b) of Figure 5 reports the level change in long-run concentration. The red lines mark the benchmarks of 9% and 2% interest rates, which corresponds to the change observed in the period 1985-2019. The evidence from Compustat data shows that over the same period, the average HHI of firms in the sample went up by about 5 pp (Gutiérrez and Philippon, 2017). The results above thus show that the mechanism could generate an increase of this magnitude.

Notably, the concentration dynamics do not qualitatively change with if the firms do not internalize their effects on their competitor's future actions. However, in line with the transitional dynamics, long-run industry concentration is highest when firms advertise strategically.

The Role of Customer Capital Depreciation The effect of advertising competition on long-run industry dynamics crucially depends on δ, the customer awareness' depreciation rate. Despite its influence on firm-level outcomes, empirical evidence on customer capital depreciation is relatively scarce. A recent exception is Baker, Baugh, and Sammon (2020), which constructs customer churn rates at the firm level using matched individual financial transaction data and firm-level financial accounts.

Online Appendix A discusses our results' robustness to alternative picks for this parameter based on Baker et al. (2020)'s estimates, retrieved from the authors' websites.[30]

[30]Mapping the model to the data, we note that these churn rate estimates are an upper bound of the parameter δ, which is the depreciation of customers that *know about* the firm, yet do not necessarily purchase from it in each period.

Values of churn rates vary substantially across the firms in their sample. Firms in 25th percentile have a churn rate of 46%, while firms in the 75th percentile have a churn rate of 73% annually. The model's quantitative analysis implies meaningful changes in long-run concentration for most values of this parameter. If we were to set δ equal to these values, the model implies that the decrease in real interest rates from 1980-2020 would lead industry HHI to increase by approximately 0.04 and 0.02, respectively.

4.4 Uncertainty

Even without ex-ante firm heterogeneity, ex-post differences in firms' market shares that result from idiosyncratic shocks can generate a negative relationship between the interest rate and long-run industry concentration.

In Online Appendix D, we consider a version of our model based on the dynamic advertising competition model in Doraszelski and Markovich (2007). To make the two models consistent, we abstract from price competition and assume an exogenous flow of profits in each period that depends on the industry state. Firms are ex-ante identical in the model, but firms' advertising is subject to uncertainty shocks: advertising efforts translate into a higher customer base only with some probability.[31]

We use the model to investigate the effect of a permanent reduction in interest rates on industry concentration in the long run. We consider steady-state implications of interest-rate shocks that hit when firms are ex-ante identical, but they happen to have different market shares due to idiosyncratic shocks. Lower interest rates are associated with a more concentrated industry structure in this model too. The further apart the firms are initially, the higher the concentration in the long run.

To summarize, our results are robust to allowing for uncertainty shocks to play a role in the model. Most importantly, this section shows that the simple model with exogenous differences across firms can be micro-founded in a more realistic setting where firms'

[31] See Online Appendix D for more details on the model's assumptions.

actions are subject to uncertainty.

5 Alternative Transmission Channels

This section explores alternative explanations for the heterogeneous pass-through of interest rate shocks to firm-level SG&A besides strategic investment. It evaluates the role of financial frictions and economies of scale, both of which may lead to heterogeneous investment elasticities through a cost-of-capital channel. The evidence is hard to square with the results being driven by either of these channels.

5.1 The Role of Financial Frictions

By and large, existing studies documenting a differential firm response to monetary policy shocks underscore the role of financial factors in shaping firm investment behavior. Gertler and Gilchrist (1994), for instance, show that small firms account for a disproportionate share of the manufacturing decline that follows a tightening of monetary policy and interpret the results in light of the financial propagation mechanism. Similarly, Cloyne, Ferreira, Froemel, and Surico (2018) and Jeenas (2018) find that firms that respond more to an unexpected shock to interest rates are the younger non-dividend payer and those with higher leverage, respectively, interpreting the results as evidence of financial constraints being at play. Finally, Ottonello and Winberry (2020) find that firms with low default risk, as measured by distance-to-default, are the most responsive to monetary shocks. They interpret the findings in a model where monetary policy increases the expected returns on investment more for firms that are not financially constrained.

Unlike these studies, financial frictions do not seem to be the most important factor generating the results in this paper. Panel (b) of Figure 6 replicates the main specification in equation (1), controlling for the interaction of firm-level distance-to-default with the monetary policy shock. Panel (c) shows the result when the regression includes an interaction between firm age and the monetary policy shock. Both distance-to-default and age are critical correlates of financial constraints (Ottonello and Winberry, 2020; Cloyne, Ferreira, Froemel, and Surico, 2018). The heterogeneous response of firm SG&A by size is qualitatively unchanged when controlling for these proxies of financial frictions.[32]

The focus of this study on investment in customer capital is a second reason why the financial channel may have little to do with the results. When firms invest in intangibles, their ability to access external capital markets is restricted due to information asymmetries and lack of collateral value.[33] As a result, U.S. firms typically finance intangible through internal finance or external equity issuances, rather than through more traditional forms of debt financing (Haskel and Westlake, 2018).[34] This conclusion may not apply to firms in countries where external debt is the predominant form of firm financing (Altomonte, Favoino, Morlacco, and Sonno, 2020).

5.2 The Role of Scale Effects

Heterogeneous investment elasticities to an interest rate change may arise due to scale effects associated with intangible capital investment. Scalability is a well-known distinguishing feature of intangible capital, which increases the appeal of investment to firms (Haskel and Westlake, 2018). Because firms are heterogeneous in their ability to scale up, firms that manage to create and manipulate intangibles can gain a competitive advantage over their rivals, endogenously leading to heterogeneous investment returns (Autor, Dorn, Katz, Patterson, and Van Reenen, 2020; Akcigit and Ates, 2019, 2020).

In Online Appendix E, we consider two different models where intangibles affect firm-level decisions via scale effects. We first develop a model where intangibles are

[32]While firm size has been considered itself a proxy of financial frictions, recent studies have argued against this tradition (Dinlersoz, Kalemli-Ozcan, Hyatt, and Penciakova, 2018; Crouzet and Mehrotra, 2020; Cloyne, Ferreira, Froemel, and Surico, 2018).

[33]See, e.g., Hall and Lerner (2010); Loumioti (2012); Lim, Macias, and Moeller (2020).

[34]For instance, U.S. software firms, whose capital structure is mostly accounted for by intangible assets, have debt that is only about 10% of book equity. By contrast, the debt-to-book value of restaurants is nearly 95% (Cecchetti and Schoenholtz, 2018).

isomorphic to a fixed-cost technology, as in Hsieh and Rossi-Hansberg (2019); De Ridder (2019).[35] In this model, firms' adoption decision involves a trade-off between a proportional reduction in variable costs and an increase in the fixed costs. Firms differ in their efficiency to deploy intangible inputs, leading to a heterogeneous investment valuation. The second model allows instead for exogenous differences in the firms' cost and demand elasticities.

A simple sufficient statistic that captures heterogeneity across firms in both models is the ratio of SG&A over sales or operating profits. In other words, the theory predicts that had the heterogeneous effects been driven by scale effects, firms' size would have a negligible impact on the elasticities once we control for the ratio of SG&A over operating profits in the main regressions.

This prediction is tested on the data. Panel (d) of Figure 6 shows that controlling for the interaction of this model-implied elasticity in the main specification in equation (1) does not affect the the baseline results on size in significant ways. Similarly, Table 6 reports estimates when we only include this interaction in equation (1), and exclude the size interaction. In line with the results in Figure 6, the coefficients on the interaction of SG&A over sales are not statistically significant. Therefore, we find no evidence that scale effects are driving the main result.

6 Concluding Remarks

Imperfect competition over frictional customer capital magnifies the response of advertising expenditures for large firms to interest rate shocks and may induce a negative correlation between interest rates and industry concentration and market power in the long run. This article developed this argument in several steps. First, we provided direct em-

[35] Arguably, the idea of intangibles as fixed-cost intensive inputs is more appealing for software or IT systems than for customer capital. However, it is sometimes hard to distinguish the two types of expenses in the data, which means that we cannot rule out this theoretical possibility *a priori*.

pirical evidence of a heterogeneous response in selling and marketing expenses to interest rate shocks by firms of different sizes. We then developed a model with product market frictions where heterogeneous firms compete over customer attention, and customer relationships are long-term. A standard externality entailed by advertising competition gives large firms a competitive advantage when interest rates decline, implying a negative steady-state correlation between interest rates and market power when customer relationships are long-term.

The results in this article relate to two distinct open debates. On the one hand, they have important implications for monetary policy's distributional effects across firms. Given the perceived importance of credit constraints for firm investment, it is often believed that policy-induced reductions in interest rates may increase aggregate investment by expanding credit opportunities for the more financially-constrained firms. This paper's results show that an unintended consequence of expansionary monetary policy may be to increase the larger firms' market power through its effect on non-traditional forms of investment. On the other hand, this article provides a new explanation for the collective behavior of declining interest rates, rising market power, and increasing market concentration based on intangible capital properties. A promising direction for future research is to further investigate the role of intangible capital dynamics, particularly customer capital, for the observed increase in market concentration and market power and its macroeconomic consequences.

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Online Appendix

The Online Appendix is divided into five sections: Appendix A describes the construction of the main variables and shows results based on alternative measures of monetary policy shocks. Appendix B includes the proofs of the main theoretical results. Appendix C develops an extension of our baseline model where firms influence customer acquisition through both advertising and pricing. The steady-state equilibrium of the extended model with price competition features a negative correlation between long-term real interest rate and average (private) return on capital, as in (Eggertsson, Robbins, and Wold, 2018). Section D of this Online Appendix considers a version of the model where firms are ex-ante identical, but the effect of advertising is subject to uncertainty shocks, building on Doraszelski and Markovich (2007). We argue that this model constitute a microfoundation for our baseline model where differences across firms are taken as given. Finally, Section E considers a version of the model without strategic interactions, where heterogeneity in the elasticity across firms may arise due to the existence of scale effects. We show that a simple sufficient statistic that captures heterogeneity across firms in this model is the ratio of SG&A over operating profits. This model serves as a foundation for the exercise in Section 5.2 of the main Text.

A Data Appendix

A.1 Alternative Measures of Monetary Policy Shocks

Figure A1 presents the estimate of the coefficient on the interaction of monetary policy shocks and size in specification (1) using eight alternative measures of monetary policy shocks. Panel (a) uses our baseline measures. Panel (b) uses 4 month maturity fed funds futures shocks from Gertler and Karadi (2015) (dataset runs from 1990-2012). Panel (c) uses the policy news shock of Nakamura and Steinsson (2018), panels (d)-(f) use the 3

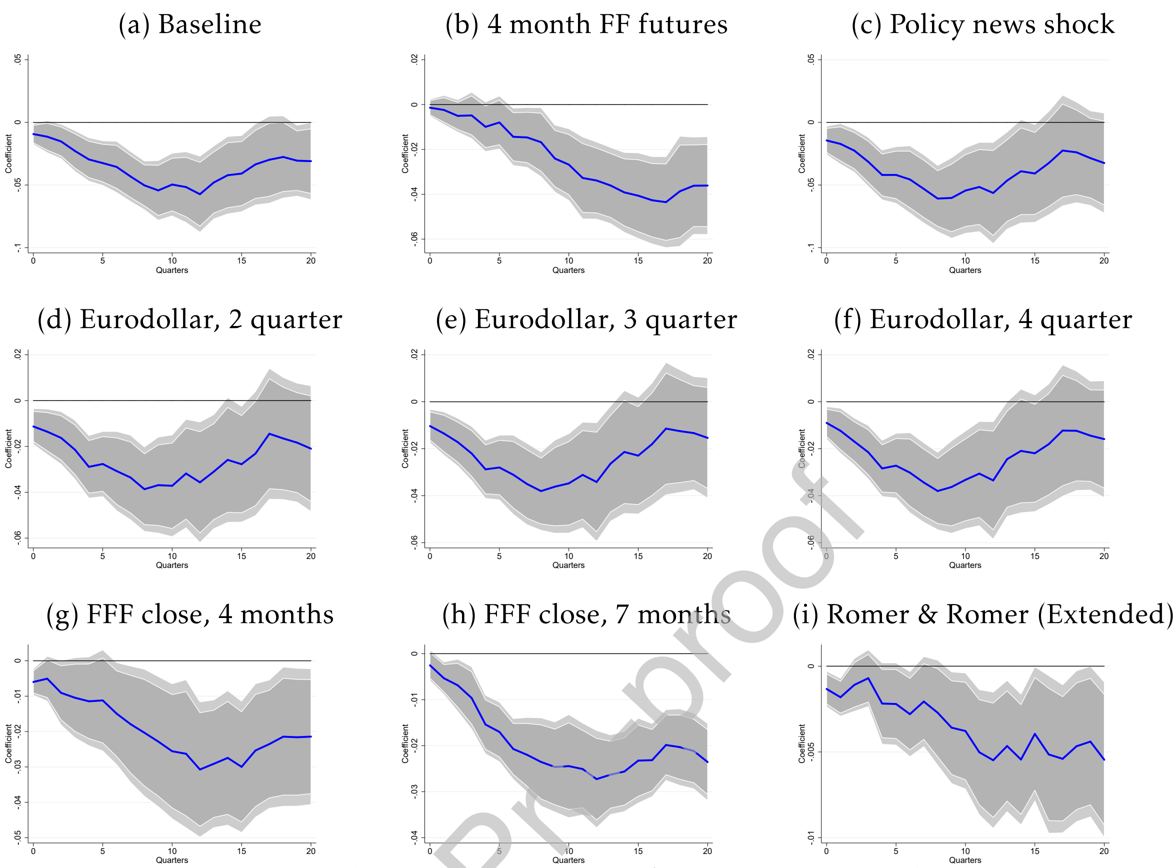


Figure A1: Alternative Measures of Monetary Policy Shocks

Appendix A details each measure considered. The dark shaded area represents the 90% confidence interval, while the light grey shaded area represents the 95% confidence interval. Standard Errors are clustered by firm and date. In all specifications firm by quarter-of-year fixed effects are included to account for heterogeneous firm growth trends and seasonality, while industry-by-time fixed effects are included account for heterogeneous cyclicality and interest rate sensitivities of industries.

month eurodollar interest rate future changes in 30 minute window at maturities of 2,3, and 4 quarters, respectively.[36] Panels (g) and (h) use changes in close-to-close fed funds futures data, pulled from Bloomberg, from 1988-2018. Panel (i) uses Romer and Romer (2004) measure of fed funds rate changes residualized on greenbook forecasts, extended to last until the ZLB begins to bind (after which it becomes problematic, as the policy-implied residuals are negative). Under all of these alternative measures, the estimated coefficients are negative and significant for several quarters.

[36]These measures are taken from the replication files of Nakamura and Steinsson (2018), which include the computed intraday surprises in 30 minute windows around FOMC announcements from 1995-2014.

Tables and Figures

Measures	mean	s.d.	10%	50%	90%
Firm-Level Measures					
log($SG\&A$), net of R&D	2.61	1.82	0.32	2.47	5.10
log($Sales$)	4.13	2.28	1.23	4.18	7.10
log($Sales$), demeaned		1.92	-2.38	0.01	2.41
Industry Ratios					
Advertising/Sales	.036	0.028	0.012	0.032	0.065
Intangible Spend/Sales	.403	0.273	0.096	0.352	0.789

Notes: An observation for the firm-level measures is a firm-quarter in quarterly Compustat. All firm-level observations are trimmed at the 1% level. An observation for the industry-measures is an industry-year, where each observation is the average of the ratio for firms that report it in that given year, from Annual Compustat.

Table 1: Summary Statistics

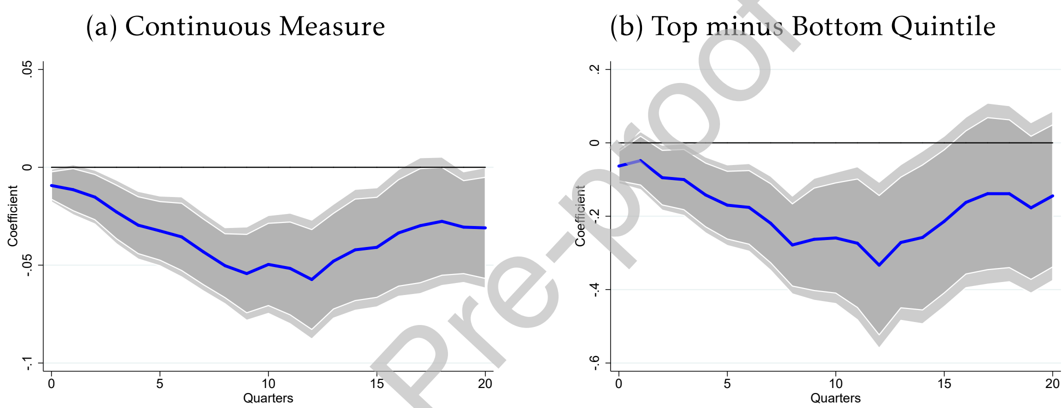


Figure 1: Heterogeneous Effects of Monetary Policy Shocks on SG&A

Notes: The figure displays the estimate of $\hat{\beta}_k$ from regression (1), which measures how the elasticity of firm SG&A (net of R&D) to interest rate shocks varies with firm size. All regressions control for both firm-by-quarter and industry-time fixed effects. Panel (a) displays the coefficient on the interaction of monetary policy shocks with firm sales. Panel (b) displays the difference in the coefficient on the top and bottom size quintile, using the specification in (1) where $s_{j,t-1}$ is a size dummy. The dark shaded area represents the 90% confidence interval, while the light grey shaded area represents the 95% confidence interval. Standard errors are clustered by firm and date.

Quarters since shock	0	4	8	12	16
Panel (a): Regression specification (1)					
Size × i_{ϵ}^{FF}	-0.00931**	-0.0296***	-0.0503***	-0.0573***	-0.0335**
	(-2.19)	(-3.35)	(-5.06)	(-3.70)	(-2.03)
Observations	241350	215486	194350	176446	161596
Panel (b): Regression specification (2)					
Size × i_{ϵ}^{FF}	0.00171	0.00697	0.00464	-0.0113	0.00290
	(0.27)	(0.54)	(0.27)	(-0.59)	(0.15)
$\frac{\text{Advertising}}{\text{Sales}} \times i_{\epsilon}^{FF} \times \text{Size}$	-0.244**	-0.989***	-1.440***	-1.495***	-1.109**
	(-2.47)	(-3.32)	(-3.23)	(-2.71)	(-2.14)
Observations	112922	100281	90110	81564	74403
Panel (c): Regression specification (3)					
Size × i_{ϵ}^{FF}	0.00314	0.0106	0.00777	-0.0212	-0.00737
	(0.34)	(0.63)	(0.36)	(-0.88)	(-0.33)
$\frac{\text{Advertising}}{\text{Sales}} \times i_{\epsilon}^{FF} \times \text{Size}$	-0.233*	-0.979***	-1.455***	-1.595***	-1.241**
	(-1.91)	(-3.04)	(-3.03)	(-2.74)	(-2.23)
$\frac{\text{Intangibles}}{\text{Sales}} \times i_{\epsilon}^{FF} \times \text{Size}$	-0.00346	-0.00685	-0.00327	0.0256	0.0295
	(-0.17)	(-0.24)	(-0.08)	(0.65)	(0.76)
Observations	112808	100167	90011	81476	74324

Notes: The table displays estimated coefficients for regressions of changes in firm log SG&A (net of R&D) on monetary policy shocks and its interactions with firm size and related variables. Significance levels are denoted by: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. T statistics in parenthesis, standard errors are clustered by firm and time. In all specifications firm by quarter-of-year fixed effects are included to account for heterogeneous firm growth trends and seasonality, while industry-by-time fixed effects are included account for heterogeneous cyclicality and interest rate sensitivities of industries. See section 2.1 for the details of variable construction.

Table 2: Heterogeneous Effects of Monetary Policy Shocks on SG&A (net of R&D)

	(1)	(2)	(3)	(4)
Size × i_{ϵ}^{FF}	-0.00323**	-0.00220*	-0.00527**	-0.00535**
	(-2.56)	(-1.93)	(-2.02)	(-2.05)
$\frac{\text{Advertising}}{\text{Sales}}$ × Size × i_{ϵ}^{FF}			-0.0550***	-0.0507***
			(-3.24)	(-3.20)
$\frac{\text{Intangibles}}{\text{Sales}}$ × Size × i_{ϵ}^{FF}			0.00876**	0.00872**
			(2.51)	(2.50)
Observations	519720	519720	265586	265582
Industry-Time Fixed Effects	Y	Y	Y	Y
Firm Fixed Effects	N	N	N	Y
Firm Size Control	N	Y	Y	Y

Notes: The table displays estimated coefficients for regressions of firm stock returns on monetary policy shocks. Significance levels are denoted by: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. T statistics in parenthesis, standard errors are clustered by firm and time. The dependent variable are the average firm daily log gross stock returns the week of scheduled FOMC announcements. See section 2.1 for the details of variable construction.

Table 3: Heterogeneous Effects of Monetary Policy Shocks on Stock Returns

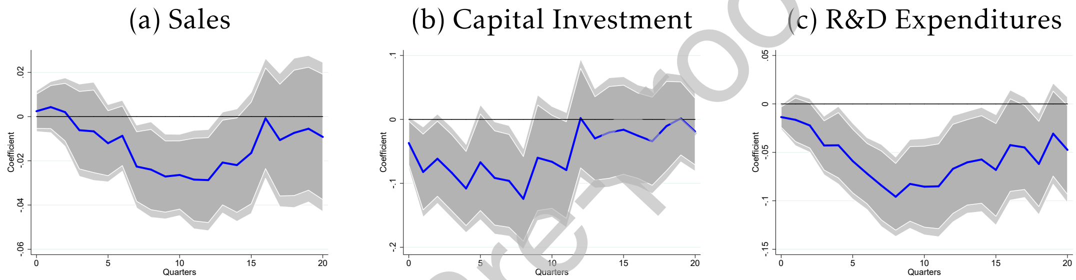


Figure 2: Heterogeneous Responses in Other Variables

The figure shows the estimated coefficients on the interaction of monetary policy shocks with firm size, from specifications of the form (1), for various dependent variables. The dependent variable is the log change in sales in panel (a), the log change in capital expenditures in panel (b), and the log change in R&D expenditures in panel (c). The dark shaded area are the 90% confidence intervals; the light grey shaded area are the 95% confidence intervals. Standard Errors are clustered by firm and date. All specifications include firm by quarter-of-year fixed effects to account for heterogeneous firm trends and seasonality, and industry-by-time fixed effects to account for heterogeneous cyclicality and interest-rate sensitivity of industries.

Quarters since shock	0	4	8	12	16
Size $\times\ i_{\epsilon}^{FF}$	-0.00212	0.00980	0.00799	-0.0159	0.00840
	(-0.30)	(0.76)	(0.41)	(-0.72)	(0.37)
$\frac{\text{Advertising}}{\text{Sales}} \times i_{\epsilon}^{FF} \times \text{Size}$	-0.272**	-0.970***	-1.435***	-1.375**	-1.036*
	(-2.47)	(-2.95)	(-2.90)	(-2.27)	(-1.81)
$\frac{\text{R\&D}}{\text{Sales}} \times i_{\epsilon}^{FF} \times \text{Size}$	0.00456	-0.00200	-0.00293	0.00152	-0.00962
	(1.24)	(-0.39)	(-0.41)	(0.14)	(-0.70)
Observations	101309	89697	80438	72655	66127

Notes: The table shows the results from a regression similar to (2) where we control for interactions of size and monetary policy shocks with industry R&D intensity. Significance levels are denoted by: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. T statistics in parenthesis, standard errors are clustered by firm and time. All specifications include firm by quarter-of-year fixed effects to account for heterogeneous firm trends and seasonality, and industry-by-time fixed effects to account for heterogeneous cyclicality and interest-rate sensitivity of industries.

Table 4: Industry Heterogeneity in R&D, Advertising and Monetary Policy Shocks

Parameter	Description	Value	Moment
A. **Assigned**			
ν	Firms' discount rate elasticity	1	
η	Buyers' search elasticity	0.35	Hubbard et al. (1995)
δ	Customer stock's depreciation rate	0.41	Baker et al. (2020)
B. **Calibrated**			
$(\tilde{\pi}_i, \tilde{\pi}_j)$	Firms' marginal customer valuation$^{(a)}$	(0.145,0.201)	Std. dev. of log sales

Notes: The table reports annual values. $^{(a)}$ The values for $\tilde{\pi}_i$ and $\tilde{\pi}_j$ are chosen such that in equilibrium, the log difference in firm sales in equilibrium is equal to one standard deviation in log sales (1.86) of firms in Compustat.

Table 5: Parameterization

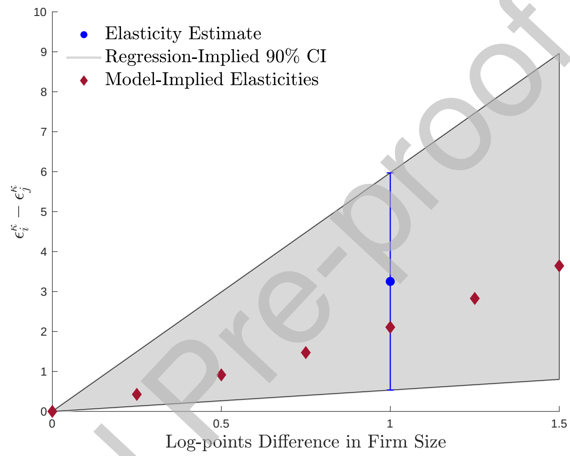
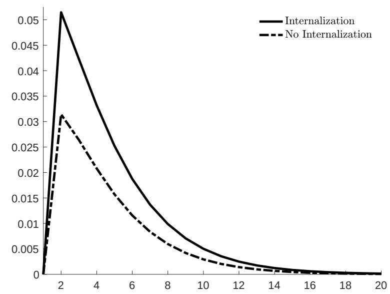


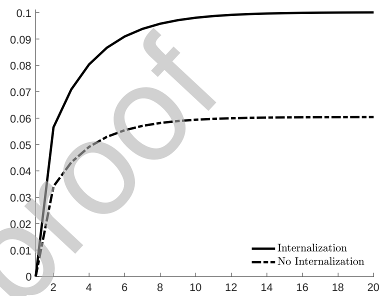
Figure 3: Model fit: Heterogeneous SG&A Elasticities

Notes: The figure compares the long-run elasticity of SG&A to interest rates, expressed as a function of log firm size differences, in the model and the data. The blue circle is the data-implied elasticity differential, obtained from regression (1) at a horizon of 20 quarters. The grey area indicates the regression's implied 90% confidence interval, extrapolated to other size quintiles using the regression model's implied linear relationship. The red diamonds are the model-implied elasticities, which are computed numerically by solving the steady-state values of advertising expenditures for different values of firm size differences.

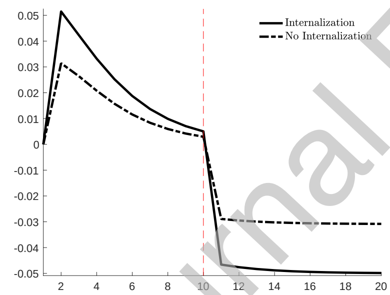
(a) Advertising/Customer Stock (Relative)



(b) Relative Advertising ($\epsilon^{\kappa}_{i,t+k} - \epsilon^{\kappa}_{j,t+k}$)



(c) Advertising/Customer Stock (Relative)



(d) Relative Advertising ($\epsilon^{\kappa}_{i,t+k} - \epsilon^{\kappa}_{j,t+k}$)

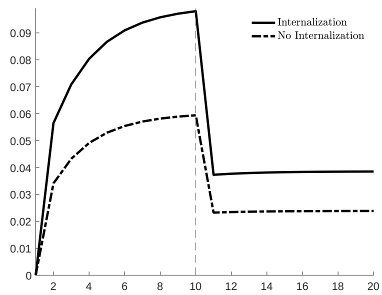
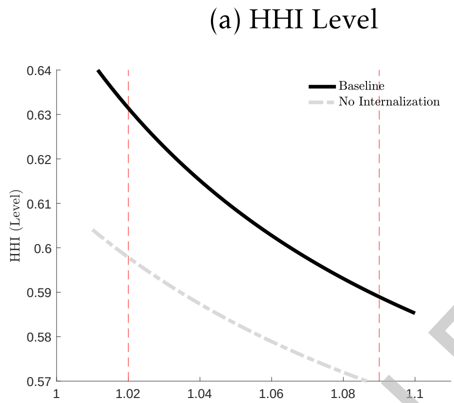


Figure 4: Impulse Responses to Interest Rate Shock

Notes: The responses are in percentage deviations from the steady state. The top two panels show the response to a one-time permanent shock to the interest rate. The bottom two panels show the response to a temporary shock to r, that reverts back to its initial value after 10 periods. The initial interest rate is set to be initially equal to 1.09, and the shock reduces it to 1.02.



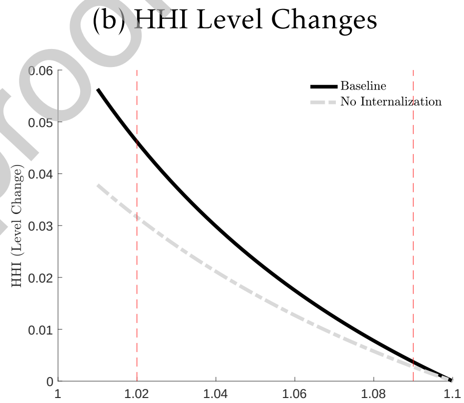


Figure 5: Interest Rates and Steady-State Industry Concentration

Notes: The figure plots the steady state HHI as a function of the policy interest rates under different assumptions on the firms' behavior. The black line corresponds to the baseline assumption of "full internalization" in the model without price competition. The grey dashed line is the case "no internalization" in a model without price competition. The blue line shows the case with price competition and no firm internalization.

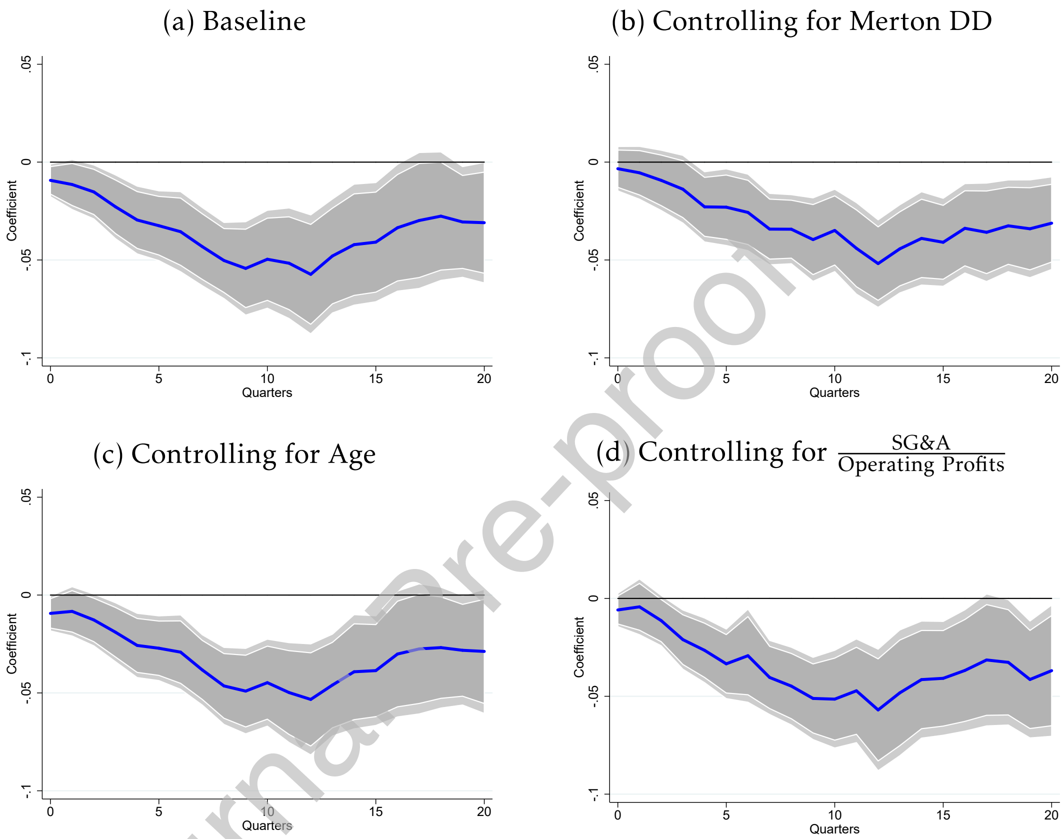


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Figure 6: Heterogeneous Effects of Monetary Policy Shocks, Additional Controls

Panel (a) plots the coefficient of the regression of the log change in SG&A (net of R&D) on the interaction of the monetary policy shock with firm size, as in Figure 1. Panel (b) plots the same coefficient in a specification which adds controls for the interaction of distance-to-default with the monetary policy shock. Panel (c) adds controls for the interaction of age with the monetary policy shock. Panel (d) adds controls for the interaction of the model-implied measure of firm elasticity, lagged SG&A to operating profits, with the monetary policy shock. See Online Appendix A for details on the construction of these measures. The dark shaded area represents the 90% confidence interval, while the light grey shaded area represents the 95% confidence interval. Standard Errors are clustered by firm and date. All specifications include firm by quarter-of-year fixed effects and industry-by-time fixed effects

Quarters Since Shock	0	4	8	12	16
$\frac{\text{SG\&A}}{\text{Operating Profits}} \times i_{\epsilon}^{FF}$	0.0171	0.0331	0.00162	-0.0257	-0.0189
	(1.55)	(1.54)	(0.07)	(-0.75)	(-0.45)
Observations	204072	183131	165918	151132	138937

Notes: This table reports results from a regression on the change in firm log SG&A (net of R&D) on the interaction of monetary policy shocks and firm SG&A intensity. Significance levels are denoted by: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. T statistics in parenthesis, standard errors are clustered by firm and time. In all specifications firm by quarter-of-year fixed effects are included to account for heterogeneous firm growth trends and seasonality, while industry-by-time fixed effects are included account for heterogeneous cyclicality and interest rate sensitivities of industries.

Table 6: Test of Models with Scale Effects