# Does Market Power Matter for R&D? A Semi-Parametric Comparison Between the Drugs Industry and High-Tech Sectors


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## Abstract

This study examines the relationship between market power and R&D investment by comparing the pharmaceutical industry with other high-tech sectors using a semi-parametric fixed effects model. Analyzing panel data from high-tech firms in France, Germany, and Great Britain (2010-2018) with Operating Profit Margin as a proxy for the Lerner Index, we find distinct innovation patterns across industries. In pharmaceuticals, the Schumpeterian effect dominates, with higher market power positively associated with R&D investment, reflecting how firms reinvest monopoly profits while strategically acquiring external innovation through purchased intangibles. Conversely, other high-tech sectors exhibit an inverted-U relationship, where moderate market power maximizes innovation, but excessive market dominance weakens R&D incentives. Financially constrained firms with negative operating margins show different innovation strategies compared to profitable enterprises across both sectors. Loss-making pharmaceutical firms rely heavily on equity financing and internal R&D, while profitable ones balance in-house research with strategic acquisitions. These findings highlight how innovation decisions are shaped by industry-specific factors including financial constraints, market structure, and external innovation opportunities. Our results emphasize that competition policies should be tailored to sectoral differences in the market power-innovation relationship rather than applying uniform approaches across industries.


## 1. Introduction

Market power can be defined as the extent to which a firm can influence market prices, either for a specific product or throughout its industry (Schumpeter, 1934; Hahn, 1984). Although there is a general agreement that firms with monopolistic control can benefit from higher profit margins, the impact of market power on innovation remains a subject of debate (Pleatsikas and Teece, 2001; Amable et al., 2010; Sun et al., 2021; Li et al., 2021).

The existing literature on this relationship presents contradictory findings — some studies support a positive association between market power and innovation (Schumpeter, 1942; Gilbert and Newbery, 1982; Aghion et al., 2005; Hashi and Stojcic, 2013), while others suggest a negative relationship, arguing that increased competition stimulates innovation (Arrow, 1962; Schmidt, 1997; Chava et al., 2013; Wadho and Chaudhry, 2018). Additionally, several studies propose a nonlinear relationship, where there is an inverted U-relationship between competition and innovation, indicating that moderate levels of market power is related to maximized innovation incentives (Aghion et al., 2002, 2005; Gilbert, 2006; Dhanora et al., 2018; Sun et al., 2021). Therefore, despite theoretical and empirical advances,


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the debate over whether the association between market power (or competition) and research and development (R&D) performance is positively associated remains unresolved.

The aim of this study is to shed light on the market power-innovation nexus by employing a flexible semi-parametric fixed effects model developed by Baltagi and Li (2002) to account for nonlinear effects. This paper presents one of the first attempts to compare the relationship between market power and innovation in the drug industry and other high-tech sectors using a semi-parametric approach. While previous studies have examined pharmaceutical firms separately, others have focused on the broader high-tech industry. To the best of our knowledge, this is the first study that directly contrasts the drugs industry with the rest of the high-tech manufacturing industries, which primarily consist of industrial machinery, electronics, and electrical components.

Unlike most high-tech industries, where technological advancements are often incremental, pharmaceutical firms rely on long and costly R&D cycles, facing high uncertainty and regulatory barriers before bringing new products to market (Grabowski, 2011; Li et al., 2021). Furthermore, patent protection plays a central role in the drugs industry, providing firms with temporary monopoly power that shapes their R&D investment strategies, whereas other high-tech industries — such as electronics and industrial technology - operate in faster innovation cycles with greater exposure to competitive pressures (Thakor and Lo, 2022; Li et al., 2021). Moreover, the financial structure of pharmaceutical firms differs significantly, given the high risks associated with drug development (Thakor and Lo, 2022; Brown and Petersen, 2009). These distinct characteristics suggest that the relationship between market power and R&D investment may differ fundamentally in the drugs industry compared to other high-tech sectors, making a separate analysis necessary to understand how industry-specific factors influence innovation incentives.

Using panel data from high-tech firms in France, Germany, and Great Britain, we employ operating profit margin (OPM) as a proxy for the Lerner Index (LI) to measure market power. To ensure the robustness of our findings, we also conduct sensitivity analyses using profitability (net profit margin) as an alternative measure of market power.

Our findings provide significant contributions to the literature. First, by incorporating firms with negative operating profit margin (OPM) (i.e. firms operating at a loss), we distinguish the investment behavior of financially constrained firms from those with higher profitability margins. The results suggest that firms operating at a loss exhibit negative estimated coefficients for market power, indicating that within high competitive markets, firms struggle to maintain their R&D investment. This pattern holds in both the drug industry and other high-tech sectors, reinforcing the importance of financial stability for long-term investment in R&D.

Second, firms with higher market power exhibit notable differences between the pharmaceutical sector and other high-tech industries. In the drug industry, the Schumpeterian effect dominates, as firms with greater market power not only increase R&D investment but also acquire external innovation through purchased intangibles, such as patents and technology licenses. This dual strategy allows pharmaceutical firms to leverage monopoly profits from patent protection while accelerating innovation through acquisitions, reinforcing their market dominance and long-term growth potential (Li et al., 2021).

In contrast, an inverted-U relationship appears for the other high-tech industries, where moderate market power is related to the maximum R&D to total assets ratio. But beyond a certain threshold, this association weakens, indicating that higher market power is associated with lower R&D investment ratio (Aghion et al., 2005). This pattern is consistent with the idea that firms with high monopoly power face greater opportunity costs from disruptions caused by switchovers, which inhibits innovation (Holmes et al., 2012). This effect is particularly relevant in electronics and industrial technology sector, where firms must innovate to remain competitive, but may avoid disruptive advancements to protect existing revenue streams.

Overall, our paper highlights an overlooked but critical distinction: industry-specific financial strategies and market structures play a fundamental role in shaping firms' innovation decisions. By identifying these sectoral differences, this study contributes to the broader debate on market power, competition policy, and innovation incentives, demonstrating that uniform competition policies may not be effective across industries. Recognizing the complex relationship between market power, financial stability, and industry dynamics, policymakers can develop targeted strategies that foster technological progress and sustainable economic growth.

The rest of the paper is structured as follows: Section 2 describes the data and empirical methodology. Section 3 discusses the main empirical findings, and Section 4 performs robustness checks, using net profit margin as an alternative measure of market power. Finally, Section 5 concludes the study, discussing policy implications and broader contributions to the competition-innovation debate.

## 2. Theoretical perspectives on market power and innovation

Two competing theoretical frameworks dominate the literature on market power and innovation. The Schumpeterian hypothesis suggests that firms with market power have greater incentives and capabilities to innovate due to their ability to appropriate returns from innovation (Schumpeter, 1911). According to this view, monopolistic profits provide essential resources for firms to undertake costly and uncertain R&D projects (Gilbert and Newbery, 1982). Conversely, Arrow (1962) proposed that competition stimulates innovation through the "escape-competition effect," whereby firms innovate to escape competitive pressure and maintain market position.

Building on these foundational theories, more recent literature has proposed a non-linear relationship between competition and innovation. Aghion et al. (2005) developed a theoretical model predicting an inverted-U relationship, where innovation is maximized at intermediate levels of competition. This model reconciles the competing theories by suggesting that some competition spurs innovation, but excessive competition may reduce innovation incentives by diminishing expected returns.

Empirical research on the relationship between market power and R&D investment has yielded mixed findings. Several studies have found support for the Schumpeterian hypothesis. For instance, Blundell et al. (1999) demonstrated that firms with higher market shares innovate more, particularly in industries with high technological opportunities. Similarly, Hashmi and Van Biesebroeck (2016) found that market concentration positively affects innovation in the global automobile industry.

In contrast, other researchers have provided evidence supporting Arrow's competition-innovation hypothesis. Nickell (1996) found that UK firms operating in more competitive markets experienced faster productivity growth. Similarly, Carlin et al. (2004) observed that modest competition enhances innovation in transition economies, while excessive competition may impede it.

More recent studies have found evidence for the inverted-U relationship proposed by Aghion et al. (2005). Hashi and Stojcic (2013) found an inverted-U relationship between competition and innovation in UK manufacturing firms, although the relationship appeared to be negative in US firms. Dhanora et al. (2018) confirmed non-linearities in the relationship between market power and innovation, with their results suggesting that firms with moderate market power exhibit higher R&D intensity than those with either very high or very low market power.

The literature increasingly recognizes that the relationship between market power and R&D varies across industries due to differences in market structure, technological opportunities, and appropriability conditions (Cohen, 2010). This heterogeneity is particularly evident when comparing the pharmaceutical industry with other high-technology sectors.

In the pharmaceutical industry, several studies have highlighted the importance of market power for sustaining R&D. DiMasi et al. (2016) documented the high costs and risks associated with pharmaceutical R&D, estimating the average cost of developing a new drug at $2.6 billion. These high costs and risks suggest that firms require substantial expected returns to justify R&D investments. Grabowski and Vernon (2000) found that expected returns from patent protection significantly influence pharmaceutical firms' R&D decisions, supporting the Schumpeterian perspective.

Thakor and Lo (2022) provided further evidence for the Schumpeterian effect in pharmaceuticals, demonstrating that firms with greater market power engage more in R&D. They argued that the unique characteristics of the pharmaceutical industry—including long development cycles, high regulatory barriers, and strong patent protection—make market power particularly important for R&D investment.

For other high-technology sectors, Beneito et al. (2015) found that the relationship between competition and innovation varies with the technological intensity of the industry. In high-technology industries such as electronics and industrial machinery, moderate competition appears to stimulate innovation, consistent with the inverted-U hypothesis. Lee (2005) observed that firms in industries with shorter product life cycles, such as electronics, tend to invest more in R&D when facing moderate competition levels.

A significant body of literature examines how financial constraints affect R&D investment across different market structures. Brown and Petersen (2009) documented the importance of equity financing for R&D-intensive firms, noting that financially constrained firms often reduce R&D spending during periods of limited external finance. Hall (2002) provided a comprehensive review of the financing challenges faced by innovative firms, highlighting that information asymmetries and the intangible nature of R&D assets make external financing particularly difficult.

The impact of financial constraints on R&D appears to vary with market power. Czarnitzki and Hottenrott (2011) found that firms with greater market power are less sensitive to financial constraints in their R&D investment decisions. This suggests that market power may mitigate the adverse effects of financial constraints on innovation, particularly in R&D-intensive industries like pharmaceuticals.

This review underscores the need for industry-specific analyses of the market power-innovation relationship, accounting for factors such as financial constraints, regulatory environments, and innovation strategies. Our study contributes to this literature by directly comparing the pharmaceutical industry with other high-technology sectors using a flexible semi-parametric approach that accommodates non-linear relationships.

## 3. Data and empirical approach

Our sample, extracted from the Compustat Global database, includes data from high-tech[1] companies located in three European countries: France, Germany, and Great Britain. The database comprises an unbalanced panel with 1,528 observations, covering the period from 2010 to 2018. We identify firms in the drug industry by selecting those with a three-digit SIC code of 283, which includes medicinals and botanicals, pharmaceutical preparations, diagnostic substances, and biological products (excluding diagnostics).

As a measure of market power, we employ a proxy for the Lerner Index (LI) (Lerner, 1934), which captures the price–cost margin scaled by sales. Since marginal cost data is not directly observable, we approximate marginal cost using the sum of the cost of goods sold (COGS) and selling, general, and administrative expenses (SG&A) following Datta et al. (2013). Based on this approximation, we employ a proxy for the Lerner Index using the Operating Profit Margin (OPM) which roughly measures the price-cost margin and reflects a firm's market power as follows:

$$OPM(LIproxy) = \frac{Sales - COGS - SG\&A}{Sales} \tag{1}$$

The Lerner Index is one of the most commonly used measures of market power due to its intuitive interpretation and firm-level applicability (Shapiro, 1987; Giocoli, 2012). It provides a direct link between a firm's pricing strategy and

[1] To classify firms within high-tech manufacturing industries, we adopt the three-digit firm classification proposed by Kile and Phillips (2009). This classification includes the following Standard Industrial Classification (SIC) codes: 357 (Computer and Office Equipment), 366 (Communication Equipment), 367 (Electronic Components and Accessories), 382 (Laboratory, Optical, Measuring and Control Instruments), and 384 (Surgical, Medical, and Dental Instruments).

competition, making it valuable for analyzing market structure, profitability, and innovation incentives. One limitation of the Lerner Index is that it assumes constant marginal costs, which may not hold in industries with increasing returns to scale or high fixed costs, such as pharmaceuticals and technology (Tirole, 1988). However, its widespread use in empirical research and its ability to capture pricing power at the firm level make it a reliable proxy for competition analysis (Datta et al., 2013; Dhanora et al., 2018; Sun et al., 2021).

To explore nonlinearities in the relation between R&D investment and firm's market power, we modify the traditional investment model in Fazzari et al. (1988) by considering the firm's market power as a non-parametric component in the model:

$$\frac{R\&D_{it}}{AT_{i,t-1}} = \alpha_i + \omega_t + f(MP_{i,t}) + \beta_1 \frac{CF_{it}}{AT_{i,t-1}} + \beta_2 \frac{Debt_{it}}{AT_{i,t-1}} + \beta_3 Size_{it} + \beta_4 SalesGrowth_{it} + \beta_5 IndustryMP_{it} + \epsilon_{it} \tag{2}$$

where the functional form $f(.)$ is unspecified; $R\&D_{it}$ is the R&D expenses of firm $i$ during year $t$; $AT_{i,t-1}$ is the firm's total assets; $MP_{it}$ is the firm's market power represented by the operating profit margin ($OPM$) based on Datta et al. (2013); $CF_{it}$ is firm's cash flow; $Debt_{it}$ is the long term debt; $SalesGrowth_{it}$ is the firm's sales growth; $Size_{it}$ is the firm's size, measured by the natural logarithm of total assets; $IndustryMP_{it}$ is the average market power of the industry in which the firm operates; $\alpha_i$ is a firm-specific effect; $\omega_t$ is the time dummy variables; and $\epsilon_{it}$ is the error term.

We estimate the model in Equation (2) using the assumptions and methodology described by Baltagi and Li (2002) for a partially linear semi-parametric panel data model with fixed effects. The model is specified as follows:

$$y_{it} = \alpha_i + \omega_t + f(\psi_{it}) + X_{it}^T \beta + \epsilon_{it} \tag{3}$$

where $f(\psi_{it})$ represents an unknown function of $\psi_{it}$, which enters the model in a non-parametric manner (e.g., $MP$). The vector $X_{it}$ consists of exogenous linear regressors used as control variables, while $\omega_t$ includes time dummies. Lastly, $\epsilon_{it}$ denotes the idiosyncratic error term, assumed to be independently and identically distributed (i.i.d.).

Based on Baltagi and Li (2002), we approximate $f(\psi_{it})$ using a series expansion of functions $\{p_1(\psi), p_2(\psi), \ldots\}$. By taking first differences to remove fixed effects, we obtain the following equation:

$$\Delta(y_i) = \Delta(X_i^T)\beta + \Delta(\omega_t) + \Delta\{p^K(\psi_{it})\}\delta + \Delta(\epsilon_i) \tag{4}$$

After obtaining the estimates $\hat{\beta}$ and $\hat{\delta}$, we go back to equation (1) and estimate the fixed effects $\hat{\alpha}_i$, and thus obtain the residual component of the error as follows:

$$\hat{u}_{it} = y_{it} - X_{it}^T \hat{\beta} - \hat{\omega}_t - \hat{\alpha}_i = f(\psi_{it}) + \epsilon_{it} \tag{5}$$

In this case, we estimate $f(\psi_{it})$ using the procedure proposed by Libois and Verardi (2012), applying a 4-degree spline interpolation to estimate the function resulting from the first difference, and a 4-degree epanechnikov kernel weighted local polynomial to fit the last stage. In line with Baltagi and Li (2002)'s approach, we assume a fixed number of time periods ($T$) and let the number of firms ($n$) grow indefinitely ($n \to \infty$) to achieve asymptotically valid results.

## 4. Results and discussion

Table 1 presents the mean and standard deviation (SD) of key financial indicators for the entire sample, as well as for firms in the drug industry and other high-tech sectors, highlighting key differences between the two groups. As expected, since the R&D-intensive nature of the drug industry, we observe that R&D investment, calculated as a fraction of total assets, is significantly higher for pharmaceutical firms compared to other high-tech firms.

Interestingly, the average value of cash flow is negative in all groups, but is significantly more negative in the drug industry. This characteristic, coupled with high R&D expenditure and much higher negative profitability than other high-tech firms, suggests that these firms may face greater financial constraints. As Zhang (2015) and Borri et al. (2022) highlight, firms with greater investment in R&D are more likely to suffer financial constraints, indicating a stronger impact of R&D on the risk of difficulties. Debt levels are similar across industries, though slightly higher for other high-tech firms.

In terms of firm size, measured by the log of total assets, both groups are similar. However, sales growth is higher in the drug industry, possibly reflecting market expansion driven by successful drug launches. In contrast, net profit margins, calculated as net income over total revenue, are significantly lower in the pharmaceutical sector, likely due to high R&D costs and long development cycles (Thakor and Lo, 2022). Additionally, stock issues, measured by Common Shares Issued, are higher in pharmaceuticals, suggesting a greater reliance on equity financing (Brown and Petersen, 2009).

**Table 1: Descriptive Statistics**

| | All Sample | | Drugs Industry | | Other High-Tech | |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD |
| R&D | 0.155 | 0.18 | 0.246 | 0.23 | 0.104 | 0.11 |
| Cash Flow | -0.038 | 0.24 | -0.111 | 0.27 | -0.008 | 0.21 |
| Debt | 0.106 | 0.13 | 0.100 | 0.14 | 0.110 | 0.12 |
| Log(Total Assets) | 4.141 | 1.80 | 4.016 | 1.91 | 4.212 | 1.73 |
| Sales Growth | 0.155 | 0.38 | 0.216 | 0.48 | 0.127 | 0.31 |
| Common Shares Issued | 110.264 | 192.41 | 146.842 | 225.66 | 90.467 | 168.56 |
| Stockholders Equity | 0.623 | 0.33 | 0.679 | 0.38 | 0.593 | 0.29 |
| Profit Margin | -0.424 | 1.06 | -0.912 | 1.44 | -0.201 | 0.73 |
| Purchased Intangibles | 5.161 | 10.38 | 6.172 | 12.81 | 4.668 | 8.93 |
| Leverage | 0.339 | 0.46 | 0.253 | 0.44 | 0.387 | 0.47 |
| OPM (LI proxy) | -0.130 | 0.83 | -0.373 | 1.11 | -0.020 | 0.64 |
| Industry Avg. OPM | -1.119 | 1.33 | -2.617 | 0.77 | -0.281 | 0.67 |
| WW Index | -0.246 | 0.10 | -0.250 | 0.12 | -0.244 | 0.09 |
| ROA | -0.087 | 0.21 | -0.171 | 0.23 | -0.041 | 0.19 |
| ROE | -0.113 | 0.36 | -0.214 | 0.39 | -0.059 | 0.33 |
| $N$ | 2075 | | 744 | | 1331 | |

Note: The variables were winsorized at 5th and 95th percentile of their pooled distribution across all firm-years.The variables R&D, Cash flow and Debt are scaled by firm's total assets.

Regarding market power, measured by the operating profit margin, which is a proxy for the Lerner Index (Datta et al., 2013), firms in the drug industry exhibit lower mean market power compared to other high-tech firms, which aligns with the idea that many pharmaceutical firms operate at a loss due to long R&D cycles before achieving profitability (Thakor and Lo, 2022). The industry average market power is also lower in drug industry, reinforcing the idea that competitive pressures and regulatory constraints shape market structures differently across sectors (Grabowski, 2011). Lastly, ROA and ROE are lower for pharmaceutical firms compared to other high-tech firms, further supporting the view that high R&D investment in the drug industry contributes to weaker short-term profitability.

Table 2 shows the estimation results considering the fixed effect model and the partially linear regression (PLR) for the Drugs Industry and other high-tech firms. The columns (1)–(2) report the estimates from the fixed effects model, while column (3) displays the parametric part of the partially linear regression in Equation (2). Column (2) considers the $OPM^2$ variable as an additional regressor to analyze whether the relationship between market power and R&D investment is nonlinear.

**Table 2: Estimation Results**

| | Drugs Industry | | | Other High-Tech | | |
|---|---|---|---|---|---|---|
| | Fixed Effects | | PLR | Fixed Effects | | PLR |
| | (1) | (2) | (3) | (1) | (2) | (3) |
| $CF/AT$ | -0.385*** | -0.407*** | -0.283*** | -0.165*** | -0.161*** | -0.161*** |
| | (0.083) | (0.089) | (0.039) | (0.039) | (0.043) | (0.017) |
| $Debt/AT$ | 0.020 | 0.019 | 0.013 | 0.039* | 0.040* | 0.102*** |
| | (0.073) | (0.073) | (0.048) | (0.022) | (0.023) | (0.020) |
| $Size$ | 0.020 | 0.020 | 0.089*** | -0.020*** | -0.020*** | 0.009 |
| | (0.023) | (0.023) | (0.013) | (0.007) | (0.007) | (0.007) |
| $SalesGrowth$ | 0.000 | -0.002 | 0.012 | 0.050*** | 0.051*** | 0.038*** |
| | (0.022) | (0.022) | (0.011) | (0.009) | (0.009) | (0.005) |
| $IndustryMP$ | 0.006 | 0.007 | -0.002 | 0.002 | 0.003 | 0.000 |
| | (0.008) | (0.008) | (0.008) | (0.004) | (0.004) | (0.004) |
| $OPM$ | 0.055*** | 0.079*** | | -0.002 | -0.008 | |
| | (0.016) | (0.030) | | (0.012) | (0.024) | |
| $OPM^2$ | | 0.006 | | | -0.002 | |
| | | (0.005) | | | (0.005) | |
| Time effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Obs. | 492 | 492 | 382 | 1287 | 1287 | 1061 |
| $R^2$ | 0.292 | 0.297 | 0.284 | 0.190 | 0.191 | 0.207 |

Note: standard errors in parentheses. *, **, *** denote statistical significance at the 5%, 1% and 0,1% levels respectively.

Examining the results in Table 2, we find that cash flow consistently exhibits a negative and statistically significant coefficient for all models. The sensitivity of R&D investment to cash flow is a widely studied topic in the empirical literature on innovation financing. Several studies indicate that firms that are more likely to face financial constraints tend to show a higher sensitivity of investment to cash flow, as external financing limitations restrict their ability to finance R&D activities Mulkay et al. (2000); Hall (2002); Hall et al. (2016). However, Brown and Petersen (2009) highlight that firms with persistent negative cash flows often rely heavily on stock issuance to finance R&D. The failure to account for this external financing source appears to introduce a downward bias in the estimated R&D-cash flow sensitivity, leading to negative cash flow coefficients.

This effect is more pronounced in the drug industry, as evidenced by the higher estimate of the coefficient in the module for these firms compared to other high-tech firms. The higher proportion of shares issued by pharmaceutical firms—exceeding 60% of the value relative to their high-tech counterparts—indicates that these firms are more reliance on equity financing rather than debt for funding investments. This highlights distinct financial strategies between these sectors, as noted by Thakor and Lo (2022). Furthermore, we find that the positive debt estimated coefficient is statistically significant at 5% only for firms in other high-tech sectors. This may suggest that companies operating in competitive pharmaceutical markets tend to invest less in fixed assets and, thereby reducing their collateral base and limiting their access to conventional financing (Thakor and Lo, 2022).

When analyzing the impact of firm size, we find mixed results. For firms in the drug industry, the PLR model yields a positive and significant coefficient at 1%, while for other high-tech firms, the fixed effect models indicate a negative and statistically significant coefficient. This suggests that smaller firms in high-tech industries outside the pharmaceutical sector are associated with more R&D investments to remain competitive, aligning with the escape-competition effect proposed by Arrow (1962).

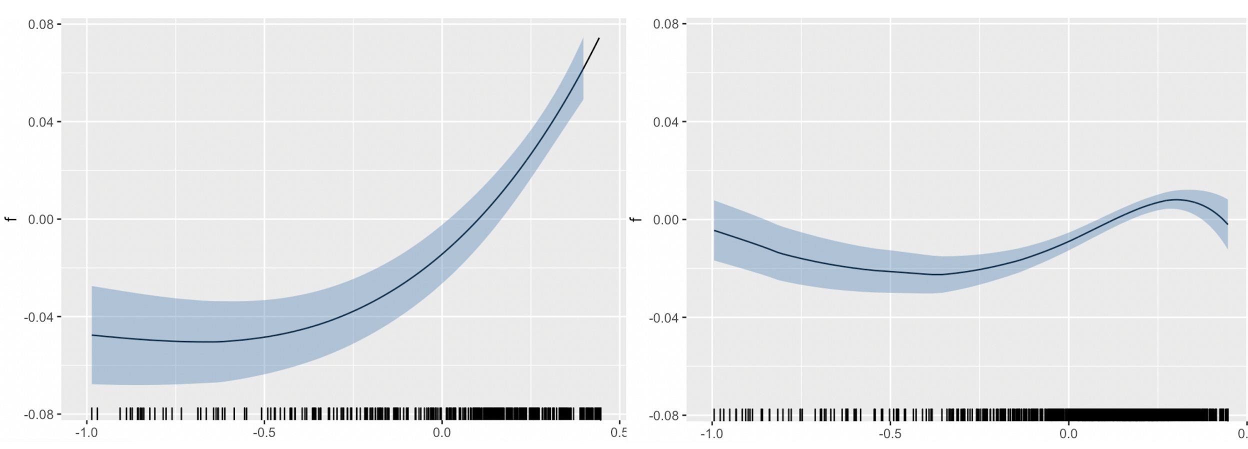
The estimated coefficients for sales growth also show differences in explanning R&D investment. In other high-tech sectors, sales growth — used in the model as a proxy for firm investment opportunities — is positively and significantly correlated with R&D investment. However, for firms in the drug industry, the estimated coefficients are not statistically significant at 5%. Demirel and Mazzucato (2012) argue that the impact of R&D on sales growth depends on firm-specific characteristics such as size, patenting activity, and persistence in patenting. In the drug industry, R&D has a nonsignificant association with sales growth due to the complex interaction of these factors that we mentioned.

Turning our analysis to the non-parametric component, Figure 1 presents the shape of the estimated relationship between R&D investment and firm's market power with 95% pointwise confident bands for firms in the drug industry (Figure 1 (a)) and firms in other high-tech sectors (Figure 1 (b)). The shape of the fitted curves for the two samples are very distinct. For firms in the drug industry, the curve exhibits a convex, upward-sloping shape. Initially, for lower values of market power, particularly in the negative range of operating profit margin (OPM), the function $f$ is slightly negative and relatively flat, possibly due to constraints in accessing external financing for long-term innovation projects (Brown and Petersen, 2009; Hall, 2002). As the market power increases, the curve gradually rises, and for positive OPM, the slope steepens, indicating an accelerating positive relationship.

This finding aligns with the Schumpeterian effect (Schumpeter, 1942), which posits that firms with greater market power benefit from higher profitability and, consequently, a greater ability to reinvest in R&D. In the pharmaceutical sector, where firms are highly dependent on patents and exclusivity rights, market power serves as a strong incentive for innovation by ensuring the long-term profitability of new drug development. Thakor and Lo (2022) argue that firms with high profit margins are more likely to have successful patent-protected drugs on the market, allowing them to maintain monopoly profits and reinvest in innovation, as their products are less vulnerable to competitive erosion. This result supports the view that market exclusivity in pharmaceuticals fosters innovation, as firms with stronger market power have both the financial resources and incentives to engage in long-term R&D efforts.

The convex shape of the estimated relationship suggests that beyond a critical threshold of market power, R&D investment accelerates. In particular, this threshold appears to be near the point where OPM transitions from negative to positive, that is, where firms move from operating at a loss to generating a profit. This reinforces the idea that monopolistic rents fuel innovation, as firms with sufficient market power can afford to undertake costly and uncertain R&D projects, leveraging their competitive advantage to sustain long-term growth.

For firms in other high-tech sectors, the fitted curve initially exhibits a non-monotonic, U-shaped pattern, which differs from the pharmaceutical industry. There are few firms from other high-tech sectors with very negative values of market power, especially where there is no relationship with R&D based on Figure 1 (b). Notably, at very low market power levels (i.e., loss-making firms), R&D investment is lower, indicating that financial stress limits the ability of firms




(a) Market Power - Drug industry

(b) Market Power - Other high-tech

Figure 1: Estimated linear prediction of R&D investment as a function of Market Power with 95% pointwise confidence bands.

to engage in innovation, consistent with the findings of Hall (2002) and Brown and Petersen (2009). As OPM increases from negative to positive values, the relationship becomes positive and ascending, supporting the escape-competition effect proposed by Arrow (1962).

Interestingly, the curve reaches a peak and then declines, forming an inverted-U shape, indicating that at very high levels of market power, R&D investment starts to decline. This pattern suggests that firms with moderate market power invest in R&D as a survival strategy, using innovation to differentiate their products and maintain competitiveness in the market (Aghion et al., 2005). However, beyond a certain threshold, the positive association between market power and R&D diminishes.

This finding aligns with Holmes et al. (2012), who argue that when firms face switchover disruptions, the cost of adoption includes the forgone rents from lost sales during the transition to new technology. These opportunity costs increase with monopoly power, as firms with higher pricing power have more to lose from disruptions, thereby reducing their incentives to innovate. This effect seems to be particularly relevant for industries such as electronics and electrical components, where rapid technological advances require continuous innovation, but firms with strong market power may be reluctant to disrupt their existing revenue streams.

Given the significant differences in the relationship between market power and R&D investment among firms operating at a loss and those with positive operating profit margins, Table 3 presents descriptive statistics for firms in the drug industry and other high-tech sectors, further segmented by negative and positive values of the Lerner Index (LI) proxy. This classification allows for a more detailed comparison of financial characteristics and innovation strategies across industry groups.

Firms with positive OPM (profit-generating firms) show lower R&D intensity, particularly in other high-tech sectors, supporting the escape-competition effect where firms with moderate market power innovate more to remain competitive, but beyond a threshold, market power reduces R&D incentives (Aghion et al., 2005). As we discussed, the inverted-U shape observed in non-pharmaceutical firms aligns with the idea that firms with high market power face greater opportunity costs from switchover disruptions, discouraging innovation (Holmes et al., 2012).

**Table 3: Descriptive Statistics**

| | Drugs Industry | | | | Other High-Tech | | | |
|---|---|---|---|---|---|---|---|---|
| | Negative OPM | | Positive OPM | | Negative OPM | | Positive OPM | |
| | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| R&D | 0.259 | 0.20 | 0.239 | 0.24 | 0.146 | 0.14 | 0.092 | 0.10 |
| Cash Flow | -0.294 | 0.23 | -0.002 | 0.23 | -0.283 | 0.23 | 0.068 | 0.13 |
| Debt | 0.092 | 0.15 | 0.104 | 0.14 | 0.105 | 0.13 | 0.112 | 0.12 |
| Log(Total Assets) | 3.280 | 1.27 | 4.404 | 2.07 | 2.818 | 1.22 | 4.598 | 1.65 |
| Sales Growth | 0.317 | 0.60 | 0.145 | 0.37 | 0.174 | 0.46 | 0.113 | 0.25 |
| Common Shares Issued | 118.860 | 202.39 | 161.851 | 236.06 | 99.355 | 170.57 | 88.153 | 168.05 |
| Stockholders Equity | 0.658 | 0.42 | 0.689 | 0.37 | 0.559 | 0.37 | 0.603 | 0.27 |
| Profit Margin | -2.043 | 1.55 | -0.086 | 0.48 | -0.937 | 1.12 | -0.005 | 0.41 |
| Purchased Intangibles | 0.981 | 2.02 | 8.394 | 14.71 | 1.077 | 2.17 | 5.458 | 9.64 |
| Leverage | 0.194 | 0.40 | 0.284 | 0.45 | 0.397 | 0.51 | 0.384 | 0.46 |
| OPM (LI proxy) | -1.229 | 1.23 | 0.277 | 0.14 | -0.761 | 1.06 | 0.189 | 0.11 |
| Industry Avg. OPM | -2.588 | 0.80 | -2.633 | 0.75 | -0.659 | 0.81 | -0.175 | 0.59 |
| WW Index | -0.164 | 0.07 | -0.305 | 0.11 | -0.154 | 0.07 | -0.269 | 0.08 |
| ROA | -0.293 | 0.18 | -0.105 | 0.23 | -0.279 | 0.19 | 0.021 | 0.12 |
| ROE | -0.371 | 0.36 | -0.129 | 0.38 | -0.428 | 0.38 | 0.038 | 0.23 |
| *N* | 257 | | 487 | | 290 | | 1041 | |

Cash flow is negative for firms with negative Operating Profit Margin (OPM) across industries, with firms in the drug industry experiencing the most severe financial constraints. This reinforces the notion that these firms rely more heavily on equity issuance to finance their operations, as evidenced by their higher volume of common shares issued (Brown and Petersen, 2009; Thakor and Lo, 2022) and their elevated WW index, which indicates greater financial constraints. Additionally, net profit margins are significantly lower for negative OPM firms, with pharmaceutical companies reporting the largest losses. This finding highlights their dependence on long-term investments before reaching profitability, reflecting the capital-intensive and high-risk nature of drug development.

Interestingly, pharmaceutical firms with positive OPM report substantially higher purchased intangibles compared to those with negative OPM. This finding, combined with their lower average R&D investment, supports the argument that profitable pharmaceutical firms acquire external intellectual property (IP), patents, and technology to supplement in-house R&D efforts. Li et al. (2021) highlight that firms in the pharmaceutical sector use acquisitions as a strategic mechanism to sustain innovation, particularly when their ability to protect monopoly power weakens. This approach reflects a distinct innovation strategy employed by large pharmaceutical firms, allowing them to mitigate the risks associated with R&D investments while simultaneously reinforcing their market dominance through the acquisition of external innovation.

Therefore, Table 3 shows important findings. Firms with negative operating profit margin — indicative of lower market power — adopt distinct innovation and financial strategies compared to firms with positive OPM. These firms are smaller, less liquid, and more financially constrained, as reflected in the financial constraint index (WW). They rely more on internal R&D investment, which involves high costs, greater uncertainty, and the need for highly skilled personnel, increasing their financial vulnerability. To mitigate funding gaps, they issue more common stock, yet they still struggle with lower profitability compared to their high-tech counterparts.

In contrast, firms with positive OPM leverage their financial stability to invest in both internal R&D and external innovation through purchased intangibles, resulting in higher profitability. This divergence highlights the association of market power and financial constraint with innovation strategies—while firms with negative OPM focus on survival through internal R&D, those with positive OPM adopt a more balanced approach, combining in-house innovation with strategic acquisitions. This enables them to enhance technological capabilities, sustain long-term growth, and reinforce their market position.

## 5. Robustness Check

We perform robustness check of our results by using net profit margin as an alternative measure of firms' market power, following Dhanora et al. (2018). This profitability measure is calculated as net income over total revenue. Table 4 presents the results of the regressions using this alternative profitability measure. The robustness of the estimates can be checked by comparing Table 2 and Table 4.

For the drug industry, the OLS models confirm that higher market power (net profit margin) is associated with greater R&D investment, reinforcing the Schumpeterian effect. Furthermore, the coefficient associated with the quadratic term is statistically significant at 5% in OLS, indicating an accelerating effect of market power on R&D investment for the drug industry but not for other high-tech companies, which was also observed in Table 2.

Cash flow sensitivity remains negative and statistically significant at 5% across all models. This reinforces that financially constrained firms have lower R&D investment regardless of industry or market power measure. Also, the association with debt remains positive and statistically significant at 5% for other high-tech industries.

Figure 2 shows the shape of the curves for both drug industry (Figure 2(a)) and other high-tech (Figure 2(b)) using profitability as a proxy for market power. The functional form of the relationship between market power and R&D investment is a bit different when using profit margin instead of OPM. In the drug industry, the shape remains convex

**Table 4: Regression Results of the Robustness Tests**

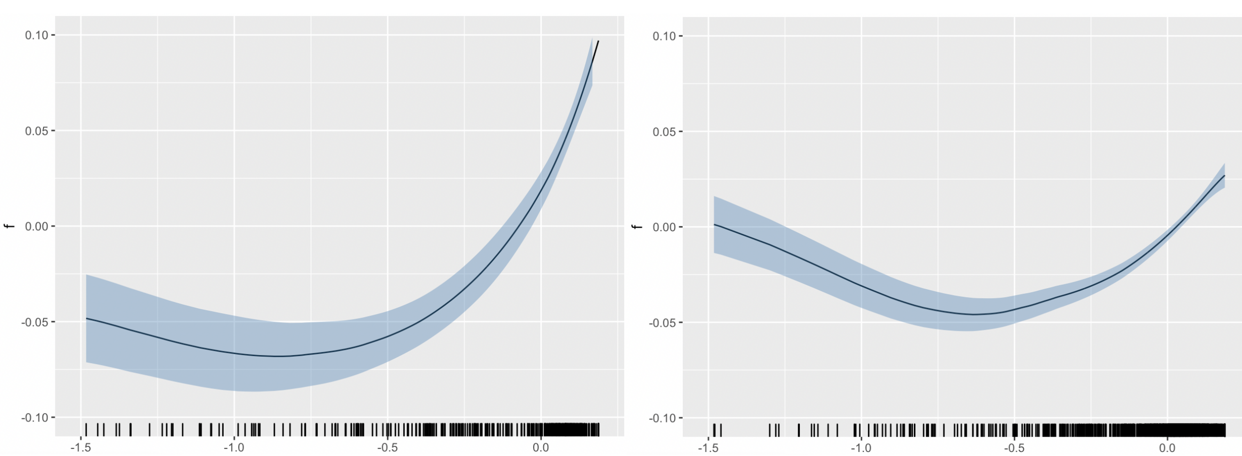
| | Drugs Industry | | | Other High-Tech | | |
|---|---|---|---|---|---|---|
| | Fixed Effects | | PLR | Fixed Effects | | PLR |
| | (1) | (2) | (3) | (1) | (2) | (3) |
| $CF/AT$ | -0.470*** | -0.547*** | -0.455*** | -0.139*** | -0.182*** | -0.194*** |
| | (0.102) | (0.110) | (0.047) | (0.038) | (0.064) | (0.024) |
| $Debt/AT$ | -0.001 | -0.008 | 0.059 | 0.040* | 0.036 | 0.116*** |
| | (0.072) | (0.074) | (0.043) | (0.023) | (0.024) | (0.020) |
| $Size$ | 0.019 | 0.015 | 0.035** | -0.026*** | -0.026*** | 0.004 |
| | (0.017) | (0.016) | (0.014) | (0.008) | (0.008) | (0.007) |
| $SalesGrowth$ | -0.002 | -0.009 | 0.019* | 0.047*** | 0.044*** | 0.034*** |
| | (0.025) | (0.024) | (0.010) | (0.010) | (0.012) | (0.005) |
| $IndustryMP$ | 0.008 | 0.010 | 0.001 | 0.003 | 0.002 | -0.002 |
| | (0.007) | (0.006) | (0.007) | (0.004) | (0.004) | (0.004) |
| $Profitability$ | 0.036** | 0.105** | | -0.007 | 0.036 | |
| | (0.017) | (0.040) | | (0.014) | (0.044) | |
| $Profitability^2$ | | 0.015* | | | 0.010 | |
| | | (0.008) | | | (0.010) | |
| Time effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Obs. | 471 | 471 | 366 | 1221 | 1221 | 1001 |
| $R^2$ | 0.309 | 0.327 | 0.339 | 0.167 | 0.177 | 0.210 |

Note: standard errors in parentheses. *, **, *** denote statistical significance at the 5%, 1% and 0,1% levels respectively.

and upward-sloping, but with a steeper incline, reinforcing the Schumpeterian effect. When the net profit margin approaches zero, the effect of market power on R&D investment becomes positive in the drug industry.

For other high-tech industries, the relationship appears more linear and less pronounced, with no clear U-shaped or inverted-U pattern as observed with the OPM. This suggests that profit margins do not fully capture the competitive dynamics that drive R&D in these industries, whereas the proxy OPM for the Lerner Index better reflects pricing power and market structure variations.

The effect of market power on R&D investment becomes positive as the net profit margin is strictly greater than zero for other high-tech industries. In other words, we need more market power to be associated with higher R&D investments in other high-tech industries than in the drug industry.




(a) Market Power (Profitability) - Drug industry

(b) Market Power (Profitability) - Other high-tech

Figure 2: Estimated linear prediction of R&D investment as a function of Market Power (using Profitability as proxy) with 95% pointwise confidence bands.

The robustness tests indicate that profitability as a measure of market power produces results consistent with the Schumpeterian hypothesis in pharmaceuticals but fails to capture the inverted-U effect observed in other high-tech industries using the operating profit margin. This suggests that while profitability is a strong determinant of R&D investment in the drug industry, it does not fully explain innovation incentives in competitive high-tech industries, where pricing power and competition levels (as captured by the proxy of the Lerner Index) seems to play an important effect.

## 6. Conclusions

This study investigates the relationship between market power and R&D investment by comparing pharmaceutical firms with other high-tech sectors using a semi-parametric fixed effects model. Our findings reveal distinct innovation patterns across industries, emphasizing the role of financial stability, market structure, and external innovation strategies in shaping firms' R&D decisions. In the drug industry, we find evidence of the Schumpeterian effect, where firms with higher market power invest more in R&D, not only through internal expenditures but also by acquiring external innovation via purchased intangibles. In contrast, in other high-tech industries, an inverted-U relationship emerges, where moderate market power fosters R&D investment, but beyond a certain threshold, excessive market power weakens innovation incentives, likely due to reduced competitive pressure and higher opportunity costs from switchover disruptions.

We also find key distinction in the financial and innovation strategies between firms operating at a loss and those with positive profit margins. Loss-making firms invest more heavily in internal R&D, relying on equity issuance to finance their activities, yet struggle with lower liquidity and higher financial constraints. This effect is more pronounced in pharmaceutical firms, which face long innovation cycles and greater uncertainty, leading to a higher reliance on common stock issuance and weaker profitability. In contrast, firms with positive profit margins use their financial stability to diversify innovation strategies, balancing internal R&D with purchased intangibles, particularly in pharmaceuticals, where acquisitions serve as a strategic mechanism to sustain innovation and extend market dominance.

These findings offer key policy insights, highlighting that the relationship between market power and innovation varies between industries, necessitating sector-specific regulatory frameworks instead of uniform competition policies. In the drugs industry, where patent protection and monopoly profits seem to drive R&D investment, policies must strike a balance between fostering innovation and preventing excessive market concentration that could hinder competition and access to new technologies. In contrast, in other high-tech sectors, where we find an inverted-U relationship, policymakers should recognize that moderate competition stimulates R&D, while excessive market dominance may discourage innovation by reducing competitive pressure. By considering the interaction between market power, financial stability, and industry dynamics, policymakers can develop more effective competition and innovation policies, fostering long-term technological progress and sustainable economic growth.

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