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Regent's University London

MSc Finance, Investment and Wealth Management

FINAL PROJECT

What Factors Drive the Financial Performance of Technology Firms Listed on Borsa İstanbul (BIST)? The Role of R&D, Technopark Membership and Leverage

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What Factors Drive the Financial Performance of Technology Firms Listed on Borsa İstanbul (BIST)? The Role of R&D, Technopark Membership and Leverage

Abstract

This study examines how R&D expenditure, Technopark membership, and leverage are associated with the financial performance of technology firms listed on Borsa İstanbul (BIST). Using panel regression on 41 firms over 2015–2025, with Return on Assets (ROA) and Return on Equity (ROE) as performance measures, the study estimates Fixed Effects or Random Effects models as selected by specification-specific Hausman tests. Three hypotheses grounded in the Resource-Based View, Triple Helix, and Trade-off theories are tested. R&D Intensity shows no statistically significant association with either performance measure. Technopark membership is positively associated with ROA in all four specifications and statistically significant in two, while none of the four ROE specifications is statistically significant. The relationship between leverage and financial performance varies according to the leverage measure, performance measure, and model specification. Overall, the findings provide updated evidence on the determinants of financial performance among BIST-listed technology firms during a period extending into Turkey's recent high-inflation years.

INTRODUCTION

1.1 Background

Technology companies create high-value jobs, support innovation, and often grow faster than traditional industries. In Turkey, the government has supported this sector for over two decades through Technology Development Zones (Technoparks), created by Law No. 4691 in 2001 (Republic of Türkiye, 2001), which offer tax exemptions to firms carrying out R&D and software development. As of 1 September 2026, the Ministry of Industry and Technology's official list recorded 114 formally established zones, though this figure reflects formal establishment rather than operational status (Ministry of Industry and Technology, n.d.). Zones offer corporate income tax exemptions on qualifying revenues, VAT exemptions on software-related activities, and income tax support for eligible R&D personnel, subject to the conditions in the legislation.

This kind of state support carries real costs and is not automatic; firms must apply, meet eligibility requirements, and keep proving genuine R&D activity to remain inside a Technopark. Likewise, spending heavily on R&D or financing growth through debt rather than equity are not decisions firms take lightly. Whether any of this pays off in a measurable way is therefore not merely an academic question: it matters to managers allocating scarce capital, to policymakers weighing the cost of incentive programs, and to investors assessing which firms are genuinely more efficient rather than simply better at claiming tax breaks.

Despite this government support, it remains unclear whether Technopark membership, R&D spending, or higher leverage improves a technology firm's financial performance, and the academic literature gives mixed answers depending on which measure is examined. Ağgül, Topal and Yalçın (2025) found R&D intensity has a negative effect on ROA but a positive effect on operating profitability among BIST technology firms, showing the relationship is not simple. Ozkan (2018) tested whether R&D changes leverage among 177 Turkish manufacturing firms from 2007 to 2016 and found no evidence connecting the two, unlike a comparable UK-based study (Aghion et al., 2004), suggesting Turkey needs its own updated evidence. Most Turkish studies in this area also use smaller samples or older periods, ending around 2016-2018, before Turkey's recent high-inflation years.

Leverage decisions raise similar open questions. Trade-off theory suggests debt can help performance up to a point, through tax advantages, before financial distress costs dominate,

while pecking order theory suggests firms turning to more debt may already be under financial strain rather than benefiting from it. International evidence is mixed: some studies report a consistently negative leverage-performance link, while others find the relationship depends heavily on how leverage is measured. The limited Turkish evidence is not much more settled; the one recent study directly examining Turkish listed firms finds a non-linear, inverted U-shaped relationship between capital structure and firm value, a pattern a standard linear model would not capture. Whether leverage helps or hurts Turkish technology firms specifically, and whether this depends on how leverage is defined, remains an open question this study addresses directly.

Past research on technoparks, in Turkey and internationally, does not agree on how much they help firms. Some studies find science parks benefit younger and larger firms more (Anton-Tejon et al., 2024), while others show benefits are unevenly distributed across firms (Díez-Vial & Fernández-Olmos, 2017). It remains unclear whether Technopark membership actually improves financial performance or mostly redistributes money through tax savings without changing how a firm operates.

These three gaps together, the mixed evidence on R&D, the unclear picture on Technopark membership, and the lack of recent Turkish evidence on leverage, form the starting point for this study.

1.2 Research Objectives, Questions and Hypotheses

This study aims to examine, using a single and consistent panel data framework, whether three firm-level factors, R&D spending, Technopark membership, and leverage, help explain the financial performance of technology firms listed on Borsa İstanbul. Specifically, the objectives of this study are:

- To examine whether R&D expenditure has a positive effect on the financial performance of BIST-listed technology firms.
- To investigate whether Technopark membership is associated with a significant difference in financial performance compared to non-member firms.
- To assess whether leverage has a negative effect on the financial performance of BIST-listed technology firms, and whether this effect depends on how leverage is measured.

These objectives are addressed through the following three research questions:

1. Does R&D expenditure positively affect the financial performance of technology firms listed on Borsa İstanbul?

2. Is there a significant difference in financial performance between Technopark member firms and non-member firms listed on BIST?

3. Does leverage negatively affect the financial performance of technology firms listed on Borsa İstanbul?

To test these questions statistically, each one is translated into a pair of hypotheses, a null hypothesis, which assumes no effect or no difference, and an alternative hypothesis, which reflects the relationship this study expects to find based on the literature and theory reviewed in Chapter 2. The panel regression results in Chapter 4 are used to determine whether each null hypothesis can be rejected at the 5% significance level.

H1 (Null): R&D expenditure has no significant effect on the financial performance of BIST-listed technology firms.

$H1_A$ (Alternative): R&D expenditure has a positive and significant effect on the financial performance of BIST-listed technology firms.

This expectation follows from the Resource-Based View and Signaling Theory, both discussed in Chapter 2, which suggest that R&D spending builds valuable internal capabilities and signals firm quality to the market, and should therefore be reflected in stronger financial performance.

H2 (Null): There is no significant difference in financial performance between Technopark member firms and non-member firms listed on BIST.

$H2_A$ (Alternative): There is a significant difference in financial performance between Technopark member firms and non-member firms listed on BIST.

This expectation follows from the Triple Helix model and knowledge spillover theory, which suggest that firms embedded in a university-industry-government ecosystem benefit from shared infrastructure, closer research ties, and preferential tax treatment, and should therefore outperform firms outside this ecosystem.

H3 (Null): Leverage has no significant effect on the financial performance of BIST-listed technology firms.

$H3_A$ (Alternative): Leverage has a negative and significant effect on the financial performance of BIST-listed technology firms.

This expectation follows from Trade-off Theory, which suggests that beyond a certain point, the financial distress costs and higher interest burden associated with debt outweigh any tax benefit, and should therefore be reflected in weaker financial performance among more highly leveraged firms.

To answer these questions and test these hypotheses, this study uses panel data regression on a sample of 41 BIST-listed technology firms over the period 2015 to 2025, with Return on Assets (ROA) and Return on Equity (ROE) used as the two measures of financial performance.

1.3 Contribution of the Study

This study contributes to the literature in several ways. First, it brings R&D spending, Technopark membership, and leverage together into a single set of models, allowing the three factors to be compared rather than studied in isolation. Second, the 2015-2025 sample period is more recent than most prior Turkish studies, which mostly stop around 2016-2018, capturing Turkey's recent high-inflation years that earlier studies could not observe. Third, leverage is measured two ways, interest-bearing debt and total liabilities, with results checked for consistency across both. Fourth, models are estimated using a formal Hausman testing procedure and multicollinearity checks rather than defaulting to one estimator, adding methodological rigor and transparency about estimation challenges, particularly around Technopark membership. Finally, beyond the Turkish context, this study adds to a broader body of research on how emerging-market technology firms are financed and supported, at a time when other governments are experimenting with similar policies. Together, these contributions offer policymakers, managers, and researchers an updated, more carefully tested picture of what drives financial performance in this sector.

1.4 Structure of the Study

The rest of this thesis is organized as follows. Chapter 2 reviews the literature on R&D, Technopark membership, and leverage in relation to firm performance, developing the

theoretical basis for the hypotheses above. Chapter 3 explains the data and panel regression methodology. Chapter 4 presents the findings for each hypothesis. Chapter 5 concludes with the findings' implications, limitations, and recommendations for practice and future research.

1.5 Ethical Consideration

This study relies entirely on secondary data: financial figures sourced from LSEG Workspace and firms' own published annual reports, alongside publicly available Technopark and regulatory records. No primary data was collected from human participants, and no confidential or personally identifiable information was used at any stage. As all data are already in the public domain, this study did not require additional ethical approval beyond the university's standard data-use policies for secondary financial data.

LITERATURE REVIEW

2.1 Introduction

This chapter reviews the theory and prior empirical evidence behind the three hypotheses introduced in Chapter 1. It starts with the theoretical framework for each of the three factors, capital structure theory for leverage, the Resource-Based View and signaling theory for R&D, and the Triple Helix model for Technopark membership, since these theories are what give this study's hypotheses their direction in the first place, rather than just a guess at what might correlate with performance. The chapter then works through the empirical literature on each factor, starting internationally and then narrowing to Turkey specifically, before closing with a comparison of how other countries have approached the technopark model, a short discussion of what these studies mean when read together, and a summary that ties the gaps identified here back to the hypotheses this study tests.

2.2 Theoretical Framework

2.2.1 Capital Structure Theory (Leverage)

The starting point here is the Modigliani-Miller theorem. Modigliani and Miller (1958) showed that in a perfect market, with no taxes and no bankruptcy costs, a firm's value does not depend on how much debt it uses. Real markets do not work this way, which is the main reason later theories exist: once taxes, bankruptcy risk, and information problems get added back into the picture, the irrelevance result breaks down and capital structure starts to matter.

Myers (1984) lays out the two theories that still dominate this literature today. Trade-off theory says firms choose a debt level by weighing the tax advantage of borrowing against the growing risk of financial distress, so in theory there is some optimal debt level for each firm. Pecking order theory tells a different story: firms do not target one ideal ratio at all, they prefer internal funds first, then debt, and equity only as a last resort, because managers know more about the firm than outside investors do, and issuing new equity under that information gap tends to be read by the market as bad news (Myers & Majluf, 1984). There is also a third perspective: Jensen and Meckling (1976) argue debt can work as a discipline tool on managers, since fixed repayment obligations reduce the free cash flow managers might otherwise misuse, though excessive debt creates a different conflict, between shareholders and debtholders. Of the three, pecking order theory is the most directly useful for this study's third hypothesis, since it offers a concrete reason leverage might hurt rather than help performance: firms that are already struggling for cash are often the ones forced to borrow more, so high leverage can be a symptom of weak performance as much as a cause of it.

2.2.2 Resource-Based View and Signaling Theory (R&D)

The Resource-Based View (RBV) argues that a firm builds a lasting competitive advantage when it owns resources that are valuable, rare, hard to copy, and hard to replace (Barney, 1991). R&D fits this description reasonably well, since it can generate knowledge, patents, or technology a competitor cannot simply buy off the shelf.

Signaling theory adds a market-facing explanation that the RBV does not address on its own. Aboody and Lev (2000) point out that R&D is unusually opaque compared to other kinds of investment, it is firm-specific, not traded anywhere, and barely covered by standard financial disclosure, so outside investors have very little independent way of judging whether a firm's R&D spending is productive. Under these conditions, the spending itself becomes a signal: a costly action that only a firm confident about its own prospects would be willing to take (Connelly et al., 2011). Between the two theories, the expectation is clear: R&D should raise financial performance both directly, through better products or processes, and indirectly, through how the market reads the spending itself. This account is cleaner in theory than in the data, as the empirical section below shows.

2.2.3 Triple Helix Model and Knowledge Spillover Theory (Technopark Membership)

The Triple Helix model, developed by Etzkowitz and Leydesdorff (1995), describes how universities, industry, and government work together to drive innovation and economic growth. Technoparks are essentially a physical version of this model: government-backed zones built specifically to put universities and firms in the same place.

Knowledge spillover theory builds on this by arguing that physical closeness to universities and other innovative firms makes it easier for knowledge to move between them, whether through informal contact, shared staff, or joint projects, and this proximity effect is really the main mechanism behind why technoparks are expected to help firm performance at all. But there is a limit built into the theory itself: the benefit only shows up if a firm actually uses the proximity. A firm that joins mainly for the tax exemptions, without engaging in any real knowledge exchange, has no obvious reason to see the same gain, and this is exactly the kind of split result the empirical literature on technoparks keeps running into, discussed next.

2.3 R&D and Financial Performance

2.3.1 International Evidence

Several recent studies do find a positive link between R&D spending and firm profitability, broadly matching what the RBV and signaling theories above would predict. Sulimany (2025) studied 231 S&P 500 firms from 2015 to 2022 and found R&D expenditure has a positive and significant effect on financial sustainability. Herath (2025) looked at firms listed on the Colombo Stock Exchange in Sri Lanka and found a positive and statistically significant relationship between R&D spending and both ROA and ROE, holding even after controlling for firm size, leverage, and sales growth.

Not every study lines up with this, though. Khan et al. (2023) studied Chinese non-state firms and found R&D spending, measured in several different ways (R&D to sales, R&D to assets, R&D capital to assets), actually has a negative effect on firm performance. The authors do not test this directly, but one plausible reading, and this connects back to the agency concerns raised above, is that R&D decisions inside non-state Chinese firms may reflect managerial discretion as much as genuine value creation. Either way, the takeaway is the same: the R&D-performance link is far from universal, and seems to depend a fair amount on country context and ownership structure, not just on the theory itself.

2.3.2 Evidence from Turkey

Turkish evidence on R&D is, if anything, even less settled, and the three studies below do not really agree with each other. Ağgül, Topal and Yalçın (2025) studied seven firms continuously listed in the BIST Technology sector from 2010 to 2023 and found R&D intensity has a negative effect on return on assets but a positive effect on operating profitability, in the same firms, at the same time. Doğan and Yıldız (2016) took a larger sample, 136 BIST manufacturing firms, and found a statistically significant, positive relationship between R&D spending and profitability, with the direction of causality running from R&D to profitability rather than the other way round. Ozkan (2018) approached the question from a different angle entirely, testing whether R&D changes how much debt a firm uses rather than how profitable it is, across 177 Turkish manufacturing firms from 2007 to 2016, and found no evidence connecting the two, a result that does not match what a comparable UK-based study by Aghion et al. (2004) found for the same relationship.

Part of the reason these three studies do not agree probably comes down to what they are actually testing, not just where. Ağgül, Topal and Yalçın study a small, tightly defined group of seven technology-sector firms across a long window, 2010 to 2023, and separate ROA from operating profitability as two distinct outcomes, which is exactly how they end up with two different answers from the same firms. Doğan and Yıldız cast a much wider net across the manufacturing sector as a whole, where R&D is a smaller and more varied share of spending than in a technology-focused sample, and test profitability directly rather than splitting it into asset returns versus operating returns. Ozkan, meanwhile, is not really asking the same question at all: the outcome variable is leverage, not profitability, and the whole point of the paper is to replicate a UK study rather than build an independent Turkish model from scratch. Different sectors, different sample windows, and different outcome variables go a long way toward explaining why three studies using the same national stock exchange can end up telling three different stories.

What stands out reading these three together is less any single finding and more how much the answer seems to shift depending on which performance measure is used, how R&D itself is defined, and which slice of the market is being studied. That inconsistency is a large part of the reason this study tests R&D against both ROA and ROE rather than settling for one, and restricts the sample to technology firms specifically rather than manufacturing more broadly.

2.4 Technopark Membership and Firm Performance

2.4.1 International Evidence

The literature on technoparks, sometimes called science and technology parks or STPs, is similarly mixed. Anton-Tejon et al. (2024) built a database of Spanish patents and found younger and larger firms benefit more from being located inside a science park, and that both very new and older parks tend to have a stronger effect on patent quality than parks somewhere in the middle of their lifecycle. Albahari, Barge-Gil, Pérez-Canto and Modrego (2018) studied 849 firms across 25 Spanish STPs and found firms located in very new or long-established parks show better innovative performance, and that firms based in less technologically developed regions actually benefit more from being on-park than firms in already-advanced regions.

Díez-Vial and Fernández-Olmos (2017) add a time dimension worth noting separately: the benefits of park location are not constant across a firm's life. Younger firms gain more in business growth and innovation capacity than more established firms, since the knowledge-spillover advantages described earlier seem to matter most early on, before a firm has built up its own networks and capabilities independently. Put together, these three studies share a common thread: technopark benefits are not uniform across firms, they depend on firm age, park age, and regional context in ways a single dummy variable cannot fully capture. This is a real limitation to keep in mind here too, since the Turkish sample used in this study includes firms of very different ages and sizes, all coded under the same Technopark dummy.

2.4.2 Technopark Eligibility Criteria in Turkey

Before moving on, it is worth being precise about what "Technopark membership" actually means in this study, since the term covers a fairly specific legal status under Law No. 4691 (2001), not just a firm's physical address.

A firm can only operate inside a Technology Development Zone if its main activity is R&D, software development, or design work, so the zones are not open to just any technology-related business. Before moving in, a company must also pass an evaluation by a jury of academics and industry experts, who check whether the project has genuine R&D content rather than being an ordinary IT or resale business dressed up to qualify (Ministry of Science, Industry and Technology, 2016). Each zone must also be connected to at least one university, higher technology institute, or public R&D center, either physically inside the zone or in the

same province, which is really what creates the university-industry link central to the Triple Helix model discussed earlier. Firms are expected to keep submitting new R&D projects to stay in the zone; finish a project without lining up the next one, and the contract can be terminated. Since 2022, firms must also reinvest 2% of their tax-exempt Technopark earnings into venture capital funds or into supporting entrepreneurs and incubation centers within the zone, up to a cap of TL 20,000,000 per year, a requirement introduced through a 2021 amendment to the original law (Republic of Türkiye, 2021).

These criteria matter for this study for two reasons. First, they explain why Technopark firms may already look different from non-member firms before they even join, since only firms that pass the jury evaluation and keep producing R&D output can remain members. This is the endogeneity concern already raised in the Introduction: firms are not randomly assigned to Technopark status, they are selected based on characteristics that could also independently affect financial performance, so any link this study finds between Technopark membership and performance should be read as an association, not proof that membership itself causes better performance. Second, the criteria clarify that the 19 firms confirmed as Technopark members in this study are not simply firms located near a university, they are firms formally approved and required to keep meeting these R&D conditions over time. Of these 19, 17 are present in the final 41-firm sample used in this study; the remaining two, Netaş (NETAS.IS) and Netaş Cihaz (NETCD.IS), are both confirmed Technopark members but were excluded for the data reasons explained in the Methodology chapter.

2.5 Leverage and Financial Performance

2.5.1 International Evidence

Studies on leverage give inconsistent results too, which more or less mirrors the theoretical tension between trade-off and pecking order predictions covered earlier. Ananto (2025) studied firms across several Southeast Asian countries from 2019 to 2023, 4,229 firms in total, and found leverage-to-equity is consistently negative for ROA, ROE, and Tobin's Q, while leverage-to-assets gives more mixed results depending on exactly which measure is used. Salam and Shourkashti (2019) took a different approach with Malaysian listed companies, using a panel threshold regression model, and identified a critical debt-to-equity point of 1.51, above which leverage's effect on firm value turns significantly negative. That threshold finding fits reasonably well with trade-off theory: leverage can help up to a point, and then the costs of financial distress start to take over.

2.5.2 Evidence from Turkey

Turkey-specific evidence on leverage also points in more than one direction. Karaca, Mensi and Gemici (2025), published in Borsa Istanbul Review, studied manufacturing firms listed on Borsa İstanbul from 2005 to 2023 and found a non-linear, inverted U-shaped relationship between capital structure and firm value using a Method of Moments Quantile Regression approach: higher borrowing increases firm value at the lower end of the distribution, while excessive borrowing beyond a certain threshold reduces it, with the causality running from capital structure to firm value rather than the other way around. In practical terms, this means leverage can help firm value up to a certain point, but past that point, more debt starts hurting performance instead of helping it.

This finding is significant because it suggests the leverage-performance relationship in Turkey may not be a simple straight line the way a standard linear regression assumes. The direction of the effect could plausibly depend on how much debt a firm is already carrying, which a purely linear model, like the one used in this study, may not fully capture. This possibility is addressed again as a limitation in the concluding chapter.

2.6 Technoparks in Other Countries

Turkey is not the only country using Technoparks to support innovation, and putting the Turkish case next to a few others helps make sense of where it fits.

The most obvious starting point is Silicon Valley in the United States, which grew out of a close relationship between Stanford University and private companies, without any large central government plan behind it (Saxenian, 1994). It became the model almost everyone else later tried to copy, but it is not really a close match for Turkey's case, since Turkey's technoparks were planned and built by the government from day one rather than growing organically out of an existing university-industry relationship.

China took the idea and ran with it at a much larger, more centralized scale. The government built Zhongguancun Science Park in Beijing next to Tsinghua and Peking University, now known informally as "China's Silicon Valley," where companies like Lenovo got their start (Zhou, 2005). Chinese universities also went on to create smaller "sister parks" in other cities, so a single university can end up supporting several regional parks at once, a scale well beyond anything Turkey has attempted.

Taiwan built Hsinchu Park near strong universities and government research centers specifically to help bring back Taiwanese engineers who had studied and worked in the US, giving them a way to transfer Silicon Valley-style knowledge home (Saxenian & Hsu, 2001). Hsinchu Park today has more than 200 companies and 72,000 workers, though it remains a single flagship park, again a different structure from Turkey's more spread-out network.

South Korea is the closest match to Turkey on three concrete points. On timing, Korea started its first technoparks in 1998, just three years before Turkey's Law No. 4691 in 2001, so both countries were building their systems at a broadly similar stage of economic development. On structure, Korea built several regional technoparks rather than one central hub, 16 at first, each serving its own region and following the same triple helix logic of university-industry-government collaboration described earlier; this resembles Turkey's nationwide network of Technology Development Zones, for which the Ministry's official list recorded 114 formally established zones as of 1 September 2026 (Ministry of Industry and Technology, n.d.). And on purpose, both countries treated technoparks primarily as a regional development tool rather than an attempt to build one world-famous hub. Research on Korean technoparks found faster employment growth in parks established after 2000, and in parks with more research-intensive tenants (Link & Yang, 2018), a comparison point revisited once this study's own Technopark results are presented.

India offers a different point of comparison. Its Software Technology Parks (STP) scheme, launched in 1991 following the country's economic liberalisation, was built specifically around software exports rather than R&D in general (Vaidyanathan, 2008). Firms registered under the scheme receive duty-free imports of hardware and software and income tax exemptions on export earnings, benefits that closely resemble Turkey's VAT exemption on software exports, though India's scheme predates Turkey's Law No. 4691 by a decade. Unlike Turkey's requirement that a technopark be physically linked to a university, Indian STPs are organised around export infrastructure and single-window regulatory clearance rather than university proximity, which suggests the university link central to the Triple Helix model is not the only way a government can successfully support a technology export sector.

Israel took yet another approach, focusing less on physical, university-anchored parks and more on early-stage financing and incubation. Its Technological Incubators Programme, launched in 1991, and the Yozma venture capital initiative that followed in 1993, together

helped convert government-funded early-stage projects into a self-sustaining private venture capital industry within a few years (Schwartz & Bar-El, 2007). This case is a useful reminder that a physical, university-anchored zone is not the only route to building a competitive technology sector; Israel's model addressed broadly the same early-stage funding gap that Turkey's tax exemptions target, but through direct government co-investment rather than tax relief.

One difference is worth noting before moving on: Turkey's tax exemptions, 0% corporate tax on R&D and software income, are generally seen as more generous than Korea's equivalent system, which may partly explain why Turkey's technopark network has continued to expand steadily over the past two decades.

2.7 Discussion

A few things stand out after working through this literature that are worth stating directly rather than leaving implicit.

First, on methodology: the studies cited above vary enormously in how they measure things and how large their samples are, and this matters more than it might first appear. Some, like Ağgül, Topal and Yalçın (2025) and this study itself, use panel data regression with a formal Hausman test to choose between Fixed and Random Effects, which is a relatively rigorous approach given the sample sizes typically available for Turkish technology firms. Others, like Ananto (2025) with 4,229 firms across several countries, or Sulimany (2025) with 231 S&P 500 firms, work with samples large enough to support more demanding techniques and to detect smaller effects with more confidence. Still others, particularly the earlier Turkish studies on R&D, rely on smaller and less formally specified models. None of this makes the smaller studies wrong, but it does mean that a null result from a seven-firm sample and a null result from a 4,000-firm sample do not carry quite the same evidential weight, and this study has tried to be transparent about where its own sample, 41 firms and, in the Full specification, 27 firms, sits on that spectrum.

Second, a pattern is visible across almost all three factors that is easy to miss if each one is read in isolation: results depend heavily on exactly how the outcome variable is defined. R&D looks negative for ROA but positive for operating profitability in the same Turkish firms (Ağgül, Topal & Yalçın, 2025). Leverage looks negative for ROA but positive for ROE in the NoRnD results of this very study, discussed in Chapter 4. This is not a coincidence, nor

is it a weakness of any single study. ROA and ROE answer genuinely different questions, one about how efficiently a firm uses its total assets, the other about the return available to shareholders once debt is accounted for, and a factor can reasonably move one without moving the other in the same direction. Any study, including this one, that reports results for only one performance measure risks telling only half the story.

Third, and this is the central gap this chapter has been building toward, almost none of the studies reviewed above test R&D, Technopark membership, and leverage together in the same model. Most isolate one factor and control for the others at best, which makes it hard to know whether, for example, an R&D effect reported in one study would survive being tested alongside Technopark status and leverage at the same time, or whether it is partly picking up variation that Technopark membership would otherwise explain. Testing all three together, as this study does, is not just a matter of convenience; it is the only way to see whether each factor holds up once the other two are accounted for in the same specification.

2.8 Summary and Research Gap

Putting all of this together, three gaps stand out clearly enough to justify this study. On R&D, the evidence is genuinely split, both internationally and within Turkey specifically, and appears to depend heavily on which performance measure is used and which slice of the economy is studied, which is exactly why this study tests R&D against both ROA and ROE rather than picking one. On Technopark membership, the international literature agrees the benefits are real but uneven, shaped by firm age, park age, and region, while Turkish evidence on the topic remains thin, most existing work describes the policy rather than testing its financial effect directly. On leverage, Turkish findings point to a non-linear relationship that a simple linear model may not fully capture, and no recent Turkish study has tested leverage, R&D, and Technopark membership together in the same sample.

This study addresses these gaps directly through the three hypotheses set out in Chapter 1, using a panel dataset of 41 BIST-listed technology firms from 2015 to 2025, a period that, unlike most of the Turkish studies cited above, extends into the recent high-inflation years. The next chapter explains how this sample was built and how the panel regression models were specified and estimated.

METHODOLOGY

3.1 Research Design

This study adopts a positivist research philosophy, treating financial performance as an objectively measurable outcome that can be explained through observable, quantifiable firm characteristics rather than through the subjective interpretation of individual actors. This stance fits a study that tests pre-specified hypotheses against secondary financial data using statistical inference, rather than one seeking to understand meaning or lived experience, and it is combined here with a quantitative, deductive research strategy: the study starts from the theory and prior findings covered in the Literature Review, then tests three specific hypotheses using real financial data, mostly sourced from LSEG. No new theory is being built here; the aim is to check whether existing ideas about R&D, Technopark membership, and leverage hold up in the Turkish technology sector.

All the data used is secondary: financial figures that companies have already reported and made public, rather than anything collected first-hand through surveys or interviews.

Panel data analysis is used to test the three research questions. A panel dataset combines a cross-sectional dimension, many different firms, with a time-series dimension, many years for each firm, which lets the model separate out differences between firms that stay fairly constant over time, such as management style, while still capturing how each firm's performance changes from year to year. It also produces more observations than a single cross-section would. This matters here because R&D spending, Technopark status, and leverage can all shift from one year to the next within the same firm, so a single-year comparison would miss most of that variation. Panel data also helps deal with unobserved firm-specific factors that could otherwise bias the results, which ties directly into the endogeneity concern already raised about Technopark membership.

3.2 Sample and Data Source

The final sample includes 41 technology firms listed on Borsa İstanbul (BIST), covering 2015 to 2025. This gives up to 11 years of data per firm, though not every firm has data for the full period (some were listed later than 2015, or had specific years excluded for data quality reasons), so the panel ends up unbalanced rather than balanced, with 348 firm-year observations in total.

The sample was built in three steps, shown in Table 1.

Table 1: Sample Construction

Step	Description	Number of Firms
1	Firms identified via LSEG Workspace Screener (Country of Exchange: Turkey; TRBC Economic Sector: Technology)	36
2	Additional firms added manually (see Table 2)	+11 → 47
3	Firms excluded for methodological reasons (see Table 3)	−6 → 41

The 11 firms added in Step 2 were missed by the initial LSEG sector filter, mostly because they are classified under a different TRBC sector (defense or telecommunications, for example) rather than Technology, even though they fit this study's definition of a BIST-listed technology firm.

Table 2: Firms Added Manually

Ticker	Company Name
ALTNY.IS	Altınay Savunma Teknolojileri A.Ş.
ASELS.IS	Aselsan Elektronik Sanayi ve Ticaret A.Ş.
BINBN.IS	Bin Ulaşım ve Akıllı Şehir Teknolojileri A.Ş.
DOFRB.IS	Dof Robotik Sanayi A.Ş.
ESCOM.IS	Escort Teknoloji Yatırım A.Ş.
FONET.IS	Fonet Bilgi Teknolojileri A.Ş.
MANAS.IS	Manas Enerji Yönetimi Sanayi ve Ticaret A.Ş.
MCARD.IS	Metropal Kurumsal Hizmetler A.Ş.
MOBTL.IS	Mobiltel İletişim Hizmetleri Sanayi ve Ticaret A.Ş.
PKART.IS	Plastikkart Akıllı Kart İletişim Sistemleri Sanayi ve Ticaret A.Ş.
SDTTR.IS	SDT Uzay ve Savunma Teknolojileri A.Ş.

Six firms were then dropped from this 47-firm group, bringing the final sample down to 41. Table 3 lists them along with the reason each one was excluded.

Table 3: Firms Excluded and Reasons

Ticker	Company Name	Reason for Exclusion
TCELL.IS	Turkcell İletişim Hizmetleri A.Ş.	Core business is telecommunications network operation and service provision rather than technology development or R&D-based activity; reports no R&D expenditure, which is inconsistent with an active R&D profile
TTKOM.IS	Türk Telekomünikasyon A.Ş.	Core business is telecommunications network operation, not technology development; very large, state-linked operator whose size and business model differ sharply from the rest of the sample
NETAS.IS	Netaş Telekomünikasyon A.Ş.	Recurring negative shareholders' equity across multiple years, which would distort the ROE figure; unlike Mobiltel's single-year exclusion (see below), the problem was not confined to one year, so the firm was dropped entirely rather than partially
INTEK.IS	İntek Teknoloji A.Ş.	No financial data available in LSEG

NETCD.IS	Netaş Cihaz A.Ş.	No financial data available in LSEG
MCARD.IS	Metropal Kurumsal Hizmetler A.Ş.	No financial data available in LSEG

Mobiltel (MOBTL.IS) was initially considered for exclusion due to negative shareholders' equity in 2019. Unlike Netaş (NETAS.IS), where negative equity recurred across multiple years and the firm was therefore dropped entirely, Mobiltel's negative equity was confined to this single year. Following discussion with the supervisor, the firm was retained in the sample, but with 2019 excluded, along with 2015–2017, since the firm was not yet publicly listed and had no reported data for those years. The remaining seven years (2018, 2020–2025) are included in the panel.

Most financial figures used in this study, including Net Income, Total Assets, Total Equity, Total Liabilities, Total Debt, Revenue, Current Assets, and Current Liabilities, were collected from LSEG Workspace (Refinitiv) through the university's institutional subscription. R&D Expense followed a two-stage collection process because LSEG coverage was incomplete for some firm-years. R&D figures were first collected from LSEG Workspace. Where LSEG did not provide a value, the firm's annual financial reports published on the Public Disclosure Platform (KAP) were reviewed manually. A value was added only when R&D expenditure could be verified directly from a financial report. If neither LSEG nor KAP provided a verifiable figure for a firm-year, the observation was left missing. The list of Technopark member firms was checked against publicly available records from Turkish Technology Development Zone management companies.

3.3 Variables

This section explains exactly what each variable used in the regression models represents, how it is calculated, and which raw figures from the panel data file it is built from. Table 4 gives a quick overview before each variable is explained in detail below.

Table 4: Overview of Variables

Type	Variable (Excel column)	What it measures
Dependent	ROA (net income / total assets)	Overall profitability relative to everything the firm owns
Dependent	ROE (net income / total equity)	Profitability relative to what shareholders have invested
Independent	RnD Intensity (R&D / Revenue)	How much a firm spends on R&D relative to its size
Independent	Technopark	Whether the firm is a Technology Development Zone member (1) or not (0)
Independent	Leverage (Debt/TA)	Interest-bearing borrowing relative to total assets (main measure)
Independent	Leverage (TL/TA)	All liabilities relative to total assets (robustness measure)
Control	FirmSize (ln(TotalAssets_Real))	Firm size, log-transformed and inflation-adjusted
Control	SalesGrowth	Year-on-year real revenue growth
Control	CurrentRatio	Short-term liquidity position

3.3.1 Dependent Variables

Two dependent variables are used to capture financial performance, since a single measure can miss important parts of the picture, as the Literature Review discusses.

ROA (Return on Assets) is calculated as Net Income divided by Total Assets, both taken directly from each firm's reported financial statements for that year. ROA shows how efficiently a firm turns everything it owns, cash, equipment, receivables, and so on, into profit. It does not distinguish between assets financed by debt and assets financed by equity, which is exactly why it is paired with ROE below.

ROE (Return on Equity) is calculated as Net Income divided by Total Equity. Unlike ROA, ROE only looks at the return generated on the portion of the firm's assets that belongs to shareholders, after debt is accounted for. Because ROE is sensitive to how a firm is financed, a firm with high leverage can show a higher ROE than an otherwise identical firm with less debt, simply because equity is a smaller base to divide profit by. This is one of the reasons Leverage is tested against both ROA and ROE separately in this study, rather than against a single blended performance measure.

3.3.2 Independent Variables

R&D Intensity is calculated as R&D Expense divided by Revenue for each firm-year. R&D Expense is based on disclosed research and development spending reported in LSEG Workspace or, where the LSEG value was unavailable, verified manually from the firm's annual financial reports on KAP. A reported value of zero was retained as genuine zero R&D expenditure. A blank observation means that no verifiable R&D figure was available from either LSEG or KAP; it was treated as missing rather than being recoded as zero. This distinction is important because a firm that reports no R&D spending is different from a firm for which the amount cannot be observed. The missing observations explain why the Full and NoRnD specifications described later in this chapter are needed. Scaling R&D Expense by Revenue, rather than using the raw R&D figure on its own, means the variable reflects R&D effort relative to the size of the business, so a large firm and a small firm spending the same absolute amount on R&D are not treated as equally R&D-intensive.

Technopark is a dummy variable equal to 1 if the firm is a confirmed, active member of a Technology Development Zone under Law No. 4691 in a given year, and 0 otherwise. For 39 of the 41 firms in the sample, this status does not change across the panel: a firm is coded 1 for every year if it is a Technopark member throughout the sample period, and 0 for every year if it never is, based on verified membership status. For two firms, LINK.IS and VBTYZ.IS, firm-level verification against KAP disclosures and each firm's own public announcements found a specific, dated entry into Technopark status during the sample period, so Technopark is coded 0 in the years before entry and 1 from the year of entry onward for these two firms only. This means Technopark is mostly, but not entirely, time-invariant in this dataset, a distinction that matters for the Estimation Method section below.

Leverage is measured in two different ways, using two separate columns in the panel data file, so that the results can be checked for robustness against how leverage is defined. Leverage (Debt/TA) is Total Debt divided by Total Assets, where Total Debt only includes interest-bearing borrowing, such as bank loans and issued bonds, both short and long-term. This is the main leverage measure used throughout this study. Leverage (TL/TA) is Total Liabilities divided by Total Assets, where Total Liabilities includes everything a firm owes, interest-bearing debt as well as non-interest-bearing items like trade payables, accrued expenses, and other short-term obligations. This second measure is used only as a robustness check, reported in the Robustness Checks section, since a firm with a lot of trade payables but no bank debt at all would show very different values under the two measures despite carrying no interest-bearing risk.

3.3.3 Control Variables

Three control variables are included to reduce the risk that the results for R&D, Technopark, and Leverage are actually picking up the effect of something else.

FirmSize is the natural log of TotalAssets_Real. TotalAssets_Real is Total Assets divided by (CPI_Index / 100), which converts each firm's nominal Total Assets figure into a value expressed in constant 2015 prices, removing the effect of Turkey's high and uneven inflation over the sample period. CPI_Index is built from official year-end inflation figures published through the TCMB Electronic Data Delivery System and the TÜİK Data Portal, with 2015 set to 100 as the base year (Central Bank of the Republic of Türkiye, n.d.; Turkish Statistical Institute, n.d.); by 2025 the index reaches 1,303.61, reflecting how much prices rose in Turkey over the eleven-year sample period. Without this adjustment, a firm's Total Assets would appear to grow every year simply because of inflation, even if the firm's real size stayed the same. The natural log is then taken because firm size in this sample ranges very widely, from small recently listed firms to large firms like Aselsan, and a log transformation compresses this range so that a few very large firms do not dominate the regression results.

SalesGrowth is the year-on-year percentage change in Revenue_Real, calculated as (Revenue_Real in year t minus Revenue_Real in year t-1) divided by Revenue_Real in year t-1. Revenue_Real is calculated the same way as TotalAssets_Real, Revenue divided by (CPI_Index / 100), again to remove the effect of inflation. Because this variable needs the previous year's figure to be calculated, it is missing for the first year a firm appears in the

panel, which is why the estimation sample starts from 2016 rather than 2015 in most of the regression output shown in Chapter 4. It is also missing for any year that immediately follows a gap in a firm's panel history; for example, Mobiltel (MOBTL.IS) has no observation for 2019, which was excluded due to negative shareholders' equity, so SalesGrowth cannot be calculated for 2020 either, since there is no prior-year figure in the panel for it to be compared against.

CurrentRatio is Current Assets divided by Current Liabilities, both taken directly from each firm's balance sheet for that year, with no inflation adjustment needed since both figures are measured at the same point in time. It captures a firm's short-term liquidity position, its ability to cover obligations coming due within the next year using assets that can reasonably be converted to cash in the same timeframe.

3.3.4 Identification and Supporting Variables

A small number of additional columns in the panel data file are not used directly in the regression models but support the variables described above. Identifier and CompanyName record the stock ticker and full legal name of each firm. Year identifies which of the 2015 to 2025 fiscal years a given row refers to. Country and Sector record firm-level classification information used during sample construction, described in the Sample and Data Source section. NetIncome, TotalAssets, TotalEquity, TotalLiabilities, TotalDebt, Revenue, CurrentAssets, and CurrentLiabilities are the raw, nominal financial statement figures collected from LSEG Workspace for each firm-year. RnD was also collected from LSEG where available and was supplemented with figures verified manually from annual financial reports published on KAP when LSEG coverage was missing. These figures are the direct inputs used to calculate ROA, ROE, RnD Intensity, both Leverage measures, and CurrentRatio. CPI_Index, TotalAssets_Real, and Revenue_Real, explained above, are intermediate calculations used only to build FirmSize and SalesGrowth.

3.4 Model Specifications

Using the variables above, two panel regression models are estimated, one per dependent variable. Because R&D expenditure data is not available for all 41 firms, each model is estimated in two versions: a Full specification, which includes RnD_Intensity and contains 27 firms and 157 usable firm-year observations, and a NoRnD specification, which excludes RnD_Intensity and uses all 41 firms. The main Debt/Assets NoRnD models contain 305 usable

firm-year observations, while the Liabilities/Assets robustness models contain 306 because availability differs by one firm-year across the two leverage measures. The estimation samples are not independent: the Full sample is a subset of the NoRnD sample. This design makes it possible to test Research Question 1, which needs R&D data, while still testing Research Questions 2 and 3 on the largest sample available.

Model 1 (ROA), Full specification:

$$ROA_{it} = \beta_0 + \beta_1(\text{R\&D Intensity})_{it} + \beta_2(\text{Technopark})_{it} + \beta_3(\text{Leverage})_{it} + \beta_4(\text{Firm Size})_{it} + \beta_5(\text{Sales Growth})_{it} + \beta_6(\text{Current Ratio})_{it} + \mu_i + \varepsilon_{it}$$

Model 1 (ROA), NoRnD specification:

$$ROA_{it} = \beta_0 + \beta_2(\text{Technopark})_{it} + \beta_3(\text{Leverage})_{it} + \beta_4(\text{Firm Size})_{it} + \beta_5(\text{Sales Growth})_{it} + \beta_6(\text{Current Ratio})_{it} + \mu_i + \varepsilon_{it}$$

Model 2 (ROE), Full specification:

$$ROE_{it} = \beta_0 + \beta_1(\text{R\&D Intensity})_{it} + \beta_2(\text{Technopark})_{it} + \beta_3(\text{Leverage})_{it} + \beta_4(\text{Firm Size})_{it} + \beta_5(\text{Sales Growth})_{it} + \beta_6(\text{Current Ratio})_{it} + \mu_i + \varepsilon_{it}$$

Model 2 (ROE), NoRnD specification:

$$ROE_{it} = \beta_0 + \beta_2(\text{Technopark})_{it} + \beta_3(\text{Leverage})_{it} + \beta_4(\text{Firm Size})_{it} + \beta_5(\text{Sales Growth})_{it} + \beta_6(\text{Current Ratio})_{it} + \mu_i + \varepsilon_{it}$$

Where:

i indexes the firm (1 to 41), and t indexes the year (2015 to 2025)

β_0 is the constant term

β_1 to β_6 are the coefficients to be estimated, capturing the direction and size of each variable's effect on performance

μ_i is the firm-specific effect, capturing unobserved traits of each firm that stay constant over time (management quality, for instance)

ε_{it} is the error term, capturing random variation the model does not explain

Both the Full and NoRnD versions of each model are run twice for Leverage, once with Leverage (Debt/Assets) and once with Leverage (Liabilities/Assets), to check whether the choice of leverage measure changes the conclusions. This gives eight estimated equations in total: two dependent variables, two samples (Full and NoRnD), and two leverage measures.

Each coefficient lines up with one research question:

β_1 (R&D Intensity) answers Research Question 1, and is only estimated in the Full specification

β_2 (Technopark) answers Research Question 2

β_3 (Leverage) answers Research Question 3

For 39 of the 41 firms, Technopark status does not change over time, and for these firms the coefficient cannot be separated from the firm-specific effect in a Fixed Effects model. Because two firms do have time-varying Technopark status, the coefficient is not automatically dropped from Fixed Effects models estimated on the full sample, but its estimation relies almost entirely on the variation from these two firms, which is discussed further in the Estimation Method and Findings chapters.

3.5 Estimation Method

Panel regression is used to estimate both models. There are two standard approaches here: Fixed Effects (FE) and Random Effects (RE). Which one fits better is decided with a Hausman test, which checks whether the firm-specific effects (μ_i) are correlated with the explanatory variables. If the test is not significant, Random Effects is consistent and can be used. If the test is significant, Random Effects is biased, and Fixed Effects should be used instead.

A separate Hausman test was run for each main Debt/Assets specification. Technopark was included because the corrected coding for LINK.IS and VBTYZ.IS makes it time-varying, although only for two firms. The test selects Random Effects for ROA Full, with the p-value close to the 5% threshold, and Fixed Effects for both ROE models, while Random Effects also remains appropriate for ROA NoRnD. The Liabilities/Assets robustness models were checked with their own specification-specific Hausman tests rather than simply assumed to follow the corresponding Debt/Assets decision. For ROE Full with Liabilities/Assets, the check also rejects Random Effects (chi-square = 13.493, df = 6, p = 0.0358), confirming the Fixed Effects

choice already used for Debt/Assets. For ROA Full with Liabilities/Assets, however, the check produces the opposite decision from its Debt/Assets counterpart: it also rejects Random Effects, narrowly (chi-square = 12.619, df = 6, p = 0.0495), so Fixed Effects is used for this one robustness model even though Random Effects is used for the main ROA Full Debt/Assets specification. The remaining two Liabilities/Assets models, ROA NoRnD and ROE NoRnD, use the same estimator as their Debt/Assets counterparts. The main-specification results are shown in Table 5.

Table 5: Hausman Test Results

Model	Chi-Sq. Statistic	df	p-value	Decision
ROA Full	12.356	6	0.0545	Random Effects
ROA NoRnD	6.568	5	0.2548	Random Effects
ROE Full	23.197	6	0.0007	Fixed Effects
ROE NoRnD	22.317	5	0.0005	Fixed Effects

The estimator decision is close to the threshold for ROA Full. The Hausman p-value is 0.055, just above the conventional 5% cutoff, so Random Effects is retained, the same choice made for ROA NoRnD. Both ROE models have p-values well below 0.05 and therefore use Fixed Effects. Because the ROA Full decision is this close to the threshold, the result should be treated as a marginal case rather than a clear-cut one, and this is noted again where the ROA Full findings are discussed in Chapter 4.

For 39 of the 41 firms, Technopark status is constant across the panel; only LINK.IS and VBTYZ.IS show a verified change in status within the sample period. Technopark is therefore not automatically dropped from Fixed Effects models, but where Fixed Effects is used, as in both ROE specifications, the coefficient is identified almost entirely from the limited within-firm variation supplied by these two firms and must be interpreted cautiously. Under the main Debt/Assets specification, ROA uses Random Effects in both the Full and NoRnD models, drawing on both within-firm and between-firm variation, which gives a more solidly identified estimate, though it remains associational because Technopark membership is not randomly assigned. The ROA Full Liabilities/Assets model is the exception to this pattern, using Fixed Effects instead, as detailed above.

Unless stated otherwise, a 5% significance level is used to judge whether a coefficient is statistically significant or not.

3.6 Multicollinearity Check

Before interpreting the regression results, all independent variables were checked for multicollinearity using the Variance Inflation Factor (VIF), including Technopark alongside the continuous variables. A VIF value above 10 is generally taken as a sign of a serious multicollinearity problem, and some studies use a stricter threshold of 5 (Gujarati & Porter, 2009). VIF was calculated separately for the Full and NoRnD explanatory-variable sets. Table 6 reports the main Debt/Assets specifications; the Liabilities/Assets sets were also checked as part of the robustness analysis.

Table 6: Variance Inflation Factors

Variable	Full (Debt/Assets)	NoRnD (Debt/Assets)
RnD Intensity	1.119	—
Technopark	1.246	1.055
Leverage (Debt/Assets)	1.165	1.135
Firm Size	1.083	1.123
Sales Growth	1.016	1.009
Current Ratio	1.363	1.230

All VIF values are well below both the 5 and 10 thresholds. In the Full Debt/Assets specification they range from 1.016 to 1.363, including a VIF of 1.246 for Technopark. In the NoRnD Debt/Assets specification they range from 1.009 to 1.230. The Liabilities/Assets robustness sets also remain low, with maximum VIF values of 1.707 in the Full sample and 1.697 in the NoRnD sample. Multicollinearity is therefore not a concern. Because the same explanatory-variable sets are used for ROA and ROE, the corresponding VIF results apply to both dependent variables.

3.7 Robustness Checks

To check whether the results depend on how leverage is measured, every model is estimated twice: once with Leverage (Debt/Assets), the main measure, and once with Leverage (Liabilities/Assets), the robustness measure. Each Liabilities/Assets model was checked with its own specification-specific Hausman test. Three of the four confirm the same estimator as the corresponding Debt/Assets specification: Random Effects for ROA NoRnD and Fixed Effects for both ROE models. The fourth, ROA Full, is the exception: its Liabilities/Assets Hausman test narrowly rejects Random Effects ($p = 0.0495$), so this one model uses Fixed Effects even though its Debt/Assets counterpart uses Random Effects. The Full models contain 157 observations under either leverage measure; the NoRnD Debt/Assets models contain 305 observations and the NoRnD Liabilities/Assets models contain 306. Table 7 compares the Leverage coefficient across the two measures for all four models.

Table 7: Leverage Results Across the Two Measures

Model	Debt/Assets (main)	Liabilities/Assets (robustness)	Consistent?
ROA Full	Not significant ($p = 0.721$)	Not significant ($p = 0.157$)	Yes
ROA NoRnD	Not significant ($p = 0.965$)	Significant, negative ($p = 0.009$)	No
ROE Full	Not significant ($p = 0.198$)	Not significant ($p = 0.314$)	Yes
ROE NoRnD	Significant, positive ($p = 0.002$)	Not significant ($p = 0.666$)	No

The results remain measure-dependent. In the Full specification, neither Debt/Assets nor Liabilities/Assets is significant for ROA or ROE. In the NoRnD models, Debt/Assets is significant and positive for ROE but not for ROA, whereas Liabilities/Assets is significant and negative for ROA but not for ROE. Research Question 3 therefore cannot be answered with a single measure-independent conclusion.

FINDINGS AND ANALYSIS

4.1 Introduction

This chapter presents the panel regression results and discusses what they mean for the three research questions and corresponding hypotheses set out in Chapter 1. Results are organized by hypothesis rather than by model, since each hypothesis draws on a specific coefficient across all four models (ROA Full, ROA NoRnD, ROE Full, ROE NoRnD), and grouping the discussion this way makes the overall pattern easier to follow than repeating the same interpretive work model by model. Each section reports the coefficient, its statistical significance, and, where relevant, its economic meaning, meaning how large and practically meaningful the effect actually is, not just whether it is statistically different from zero, and closes with an explicit decision on whether the corresponding null hypothesis can be rejected at the 5% significance level. Reporting a coefficient without discussing its size risks treating statistical significance as the only question worth asking, when a precisely estimated but tiny effect and an imprecisely estimated but large one can both be misleading if read through significance alone. The discussion also connects each finding back to the theories and prior studies covered in the Literature Review, and flags where results differ across specifications, since these differences are informative in their own right rather than simply inconvenient inconsistencies to be explained away.

Before turning to the regression results, Table 8 reports descriptive statistics for the variables used in the Full specification (N = 157, the 27 firms with non-missing R&D data). The larger NoRnD sample (N = 305 under Debt/Assets, 306 under Liabilities/Assets, across 41 firms) draws on the same underlying panel but necessarily excludes R&D Intensity.

Table 8: Descriptive Statistics (Full Sample, N = 157)

Variable	Mean	Median	Std. Dev.	Min	Max	N
ROA	0.094	0.093	0.108	-0.233	0.512	157
ROE	0.163	0.148	0.233	-0.790	0.968	157
Leverage (Debt/Assets)	0.131	0.080	0.144	0.000	0.561	157
Leverage (Liabilities/Assets)	0.416	0.411	0.186	0.069	0.882	157
R&D Intensity	0.052	0.016	0.076	0.000	0.344	157
Technopark	0.656	1.000	0.477	0.000	1.000	157
FirmSize (ln TotalAssets_Real)	19.398	19.172	1.561	16.767	24.268	157
Sales Growth	0.232	0.111	0.559	-0.599	4.099	157
Current Ratio	2.406	1.707	2.255	0.478	14.658	157

The sample spans a wide range of firm sizes (FirmSize, the log of real Total Assets, runs from 16.8 to 24.3) and includes both loss-making and highly profitable firm-years, with ROA ranging from -0.233 to 0.512 and ROE from -0.790 to 0.968. Technopark membership is common in this Full-sample subset, with a mean of 0.656 reflecting that roughly two-thirds of these firm-years belong to member firms. Sales Growth and Current Ratio are the most right-skewed variables, consistent with typical firm-level panel data; Jarque-Bera tests reject normality for most variables individually. However, Fixed Effects and Random Effects estimation does not require the explanatory variables themselves to be normally distributed; the reliability of inference depends more on the properties of the regression errors and on the model specification than on the marginal distribution of any single regressor.

4.2 Model Fit

Before turning to the individual hypotheses, it is useful to look at how well each of the eight estimated models fits the data overall. R-squared reports the proportion of the variation in ROA or ROE that the model explains; a higher R-squared means the independent and control variables together account for more of the differences in performance across firms and years. This is a different question from statistical significance: a coefficient's p-value indicates whether that specific variable's effect can be distinguished from zero with confidence, while

R-squared speaks to how much of the overall picture the whole model captures. A variable can be highly significant in a model with a low R-squared, and a model can have a relatively high R-squared even where several individual variables are not significant, since R-squared reflects the joint explanatory power of every variable together, not any single coefficient on its own. Table 9 reports the R-squared value for all eight models.

Table 9: R-squared Across All Models

Model	Leverage Measure	R-squared
ROA Full	Debt/Assets	0.161
ROA Full	Liabilities/Assets	0.464
ROA NoRnD	Debt/Assets	0.110
ROA NoRnD	Liabilities/Assets	0.131
ROE Full	Debt/Assets	0.431
ROE Full	Liabilities/Assets	0.428
ROE NoRnD	Debt/Assets	0.407
ROE NoRnD	Liabilities/Assets	0.385

Model fit varies by both dependent variable and estimator. The ROA Full Debt/Assets model has an R-squared of 0.161, close to the ROA NoRnD models at 0.110 and 0.131; all three use Random Effects. The ROA Full Liabilities/Assets model is the exception among the ROA models: its own specification-specific Hausman test selects Fixed Effects rather than Random Effects, and its R-squared of 0.464 sits closer to the four ROE Fixed Effects models (0.385 to 0.431) than to the other Random Effects ROA models, because Fixed Effects absorbs time-invariant differences between firms into firm-specific intercepts. R-squared should not be compared mechanically across FE and RE specifications. In every case, it describes overall model fit rather than whether a particular coefficient is statistically significant. All eight models are jointly significant overall: for example, the ROA Full Debt/Assets model has an F-statistic of 4.78 ($p = 0.0002$), and the ROE Full Debt/Assets model an F-statistic of 2.94 ($p = 0.00001$). The Random Effects models also provide a variance decomposition. For ROA Full with Debt/Assets, the cross-section random effect accounts for roughly 12% of total variance (Rho = 0.1176), with the remaining 88% attributed to idiosyncratic, firm-year-level

variation. Rho is descriptive and does not itself determine whether Random Effects is appropriate; estimator selection rests on the Hausman test.

4.3 H1: R&D Expenditure and Financial Performance

H1 (Null) states that R&D expenditure has no significant effect on the financial performance of BIST-listed technology firms; H1 (Alternative) states that the effect is positive and significant. R&D Intensity is estimated only in the Full specification, which contains 27 firms and 157 firm-year observations. Table 10 summarizes the coefficient under the main Debt/Assets models selected by the Hausman tests.

Table 10: R&D Intensity Results

Model	Coefficient	p-value	Significant?
ROA Full (RE)	0.028	0.814	No
ROE Full (FE)	0.322	0.429	No

R&D Intensity is not statistically significant for either performance measure at the 5% level. In the main Debt/Assets models, the coefficient is 0.028 for ROA ($p = 0.814$) and 0.322 for ROE ($p = 0.429$). The Liabilities/Assets robustness models reach the same conclusion, with coefficients of 0.194 for ROA ($p = 0.292$) and 0.254 for ROE ($p = 0.534$). These estimates are imprecise and do not provide sufficient evidence against the null hypothesis; the p-values do not represent the probability that the coefficients are due to chance. A coefficient of 0.028 for ROA implies that a 10 percentage point increase in R&D Intensity is associated with under 0.3 percentage points higher ROA if read at face value, although the estimate cannot be distinguished from zero with confidence. The ROE point estimates are larger but have correspondingly wide standard errors. H1 (Null) therefore cannot be rejected: this sample provides no statistically reliable evidence that contemporaneous R&D intensity is associated with higher ROA or ROE.

This result differs from Khan et al. (2023), who report a significant adverse relationship between R&D expenditure and firm performance among Chinese listed firms, with the

negative relationship weaker for state-owned firms. Ozkan (2018) examines a different outcome: whether R&D intensity is associated with firms' financial structure and leverage, rather than whether R&D improves profitability. Ozkan finds no evidence of an inverted U-shaped relationship or a significant effect of R&D intensity on leverage among Turkish manufacturing firms. These studies therefore should not be treated as direct null-result comparisons for this study's R&D-performance models. One possible explanation for the insignificant coefficients found here is that R&D is a long-horizon investment: spending in a given year may not generate revenue or cost savings within that same year. Firms may also differ widely in how efficiently they convert R&D spending into commercial outcomes. The Full specification, with 157 observations, remains considerably smaller than the NoRnD specification's 305 observations, which reduces statistical power. Broader data or lagged R&D measures could produce different results.

4.4 H2: Technopark Membership and Financial Performance

H2 (Null) states that there is no significant difference in financial performance between Technopark member and non-member firms; H2 (Alternative) states that a significant difference exists. Technopark status changes within the panel for only LINK.IS and VBTYZ.IS, so any Fixed Effects estimate for Technopark relies almost entirely on these two switcher firms. The updated Hausman tests select Random Effects for the main Debt/Assets specifications of ROA Full and ROA NoRnD, and Fixed Effects for both ROE models; the Liabilities/Assets robustness check for ROA Full, discussed below, instead selects Fixed Effects. Under the main Debt/Assets specification, ROA uses Random Effects in both the Full and NoRnD models, so its Technopark coefficient there draws on both within-firm and between-firm variation, while the ROE Fixed Effects estimates remain weakly identified.

For ROA under Debt/Assets, both the Full and NoRnD models use Random Effects, making the two estimates more directly comparable than in earlier specifications, although selection into Technopark membership still prevents a causal interpretation. Table 11 reports the main Debt/Assets results.

Table 11: Technopark Results (ROA)

Model	Coefficient	p-value	Significant?
ROA Full (RE)	0.085	0.0001	Yes
ROA NoRnD (RE)	0.050	0.027	Yes

Technopark has a positive and statistically significant coefficient in the ROA Full Random Effects model with Debt/Assets (coefficient = 0.085, p = 0.0001). In the larger ROA NoRnD Debt/Assets model, the coefficient is also positive and significant (coefficient = 0.050, p = 0.027). Replacing Debt/Assets with Liabilities/Assets changes the selected estimator for the Full sample: a specification-specific Hausman test rejects Random Effects for this model (chi-square = 12.619, df = 6, p = 0.0495), the opposite decision from the corresponding Debt/Assets model (p = 0.0545). Under the resulting Fixed Effects estimate, the Full-sample Technopark coefficient falls to 0.033 and is no longer statistically significant (p = 0.582). The NoRnD Liabilities/Assets coefficient remains positive but is not significant at 5% (coefficient = 0.037, p = 0.090). Thus, the ROA association is positive in all four combinations and statistically significant in two: both Debt/Assets models. The two significant estimates imply differences of roughly five to eight and a half percentage points in ROA, which are economically meaningful relative to typical ROA levels in the sample. H2 (Null) is rejected for ROA in both main Debt/Assets models, but not in either Liabilities/Assets robustness model. Both the ROA Full Debt/Assets and ROA Full Liabilities/Assets Hausman decisions sit close to the 5% threshold, on opposite sides of it (p = 0.0545 and p = 0.0495 respectively), so these ROA Full results in particular remain associational and should be interpreted with appropriate caution.

For ROE, Technopark is estimated in the Fixed Effects models across all four combinations and is not statistically significant in any of them. With Debt/Assets, the coefficient is 0.041 (p = 0.763) in the Full sample and -0.022 (p = 0.853) in the NoRnD sample; with Liabilities/Assets, it is 0.091 (p = 0.497) in the Full sample and 0.033 (p = 0.782) in the NoRnD sample. Because only two firms contribute within-firm variation in Technopark status, these Fixed Effects estimates are weakly identified across all four ROE combinations.

They do not provide evidence of a Technopark association with ROE, and their imprecision reinforces the need for caution.

Taken together, H2 (Null) is rejected primarily by the ROA results. Technopark membership has a positive coefficient in all four ROA combinations and is significant in two, the Debt/Assets models, while none of the four ROE estimates is significant. The overall pattern is compatible with the Triple Helix and knowledge-spillover mechanisms discussed in the Literature Review, but selection into Technopark membership means the result should be read as an association rather than a causal effect. The evidence therefore rejects H2 (Null) for ROA under the Debt/Assets measure, supporting H2A in those two specifications, but H2 (Null) cannot be rejected for ROA under Liabilities/Assets or for ROE.

4.5 H3: Leverage and Financial Performance

H3 (Null) states that leverage has no significant effect on the financial performance of BIST-listed technology firms; H3 (Alternative) states that the effect is negative and significant, consistent with Trade-off Theory's prediction that financial distress costs eventually outweigh the tax advantages of debt. Leverage is tested using two measures across all four models: Leverage (Debt/Assets), which only counts interest-bearing borrowing and is treated as the main measure throughout this study, and Leverage (Liabilities/Assets), which includes all liabilities including trade payables and is used as a robustness check. Testing both measures matters here specifically because the two capture conceptually different things, deliberate financing decisions versus the full range of a firm's obligations, and a result that holds under one but not the other is not necessarily a contradiction so much as evidence that the two measures are picking up different underlying phenomena. Table 12 summarizes the significance and direction of the Leverage coefficient across all eight resulting model-measure combinations.

Table 12: Leverage Results Across All Models and Measures

Model	Debt/Assets (main)	Liabilities/Assets (robustness)
ROA Full	Not significant (p = 0.721)	Not significant (p = 0.157)
ROA NoRnD	Not significant (p = 0.965)	Significant, negative (p = 0.009)
ROE Full	Not significant (p = 0.198)	Not significant (p = 0.314)
ROE NoRnD	Significant, positive (p = 0.002)	Not significant (p = 0.666)

The results for H3 are mixed. In the Full specification, Debt/Assets is insignificant for both ROA (p = 0.721) and ROE (p = 0.198). With Liabilities/Assets, the ROA coefficient is also insignificant (p = 0.157), and the ROE Fixed Effects coefficient is positive but insignificant (coefficient = 0.179, p = 0.314). In the NoRnD models, Debt/Assets remains insignificant for ROA but is significantly positive for ROE (coefficient = 0.442, p = 0.002), whereas Liabilities/Assets is significantly negative for ROA (coefficient = -0.113, p = 0.009) and insignificant for ROE (p = 0.666). The two significant effects are sizeable but point in opposite directions across performance measures, so the leverage results remain dependent on definition, outcome, and sample.

The ROA NoRnD result, negative and significant under the Liabilities/Assets measure, is consistent with H3 (Alternative) and with Trade-off Theory's central prediction: as firms take on more debt-like obligations relative to their asset base, the costs associated with financial risk, higher interest burden, and a greater probability of financial distress, begin to outweigh any benefit, dragging down asset returns. This is also broadly consistent with Pecking Order Theory, under which more profitable firms tend to rely less on external liabilities in the first place, producing a negative association between the two variables even without a strict causal mechanism. Because Liabilities/Assets captures the full range of a firm's obligations, including trade payables and accrued expenses rather than only interest-bearing debt, this result may also partly reflect operational strain: firms that are slow to pay suppliers or that carry heavy short-term obligations relative to their assets could simply be firms already

struggling operationally, in which case the negative ROA relationship reflects weak performance driving liabilities upward as much as liabilities driving performance downward. Disentangling these two directions of causality is not possible with the data and model used here, and this is acknowledged as a limitation in the concluding chapter.

The ROE NoRnD result, positive and significant under the Debt/Assets measure, runs counter to H3 (Alternative). One plausible explanation, also raised in the Literature Review, is the tax shield effect central to Trade-off Theory: interest payments on debt are tax-deductible under Turkish corporate tax law, which can raise the return available to equity holders even as the firm's overall risk increases, provided leverage has not reached a level high enough to trigger meaningful distress costs. This is not the only possible explanation, however. Because ROE divides profit by equity rather than by total assets, it is mechanically sensitive to capital structure: a firm that finances more of its assets with debt operates with a smaller equity base, which can raise ROE even without any genuine improvement in operating performance. The positive coefficient found here should therefore be read as evidence of a capital-structure effect on the return available to shareholders, not as direct evidence that leverage makes the firm operate more efficiently. Since Debt/Assets only counts interest-bearing borrowing, this measure may be capturing firms making deliberate, moderate use of tax-advantaged debt financing, whereas the broader Liabilities/Assets measure dilutes this signal by mixing in non-interest-bearing obligations like trade payables that carry no tax shield benefit.

In the Full sample under Liabilities/Assets, the leverage coefficient for ROE is positive but not statistically significant in the selected Fixed Effects model (coefficient = 0.179, $p = 0.314$). The earlier Random Effects estimate is not used because the specification-specific Hausman test rejects Random Effects at the 5% level ($p = 0.0358$). Consequently, this model does not provide an additional significant leverage result.

Overall, H3 cannot be given a single decision. Significant results appear in two of the eight model-measure combinations: a negative ROA association under Liabilities/Assets in the NoRnD sample and a positive ROE association under Debt/Assets in the NoRnD sample. No single leverage measure or performance outcome dominates. The negative ROA result is consistent with H3 (Alternative), whereas the positive ROE result runs counter to it and may partly reflect ROE's mechanical sensitivity to the equity denominator. The remaining six combinations are not statistically significant. The relationship between leverage and

performance is therefore measure-, outcome-, and sample-dependent rather than a stable negative effect.

4.6 Control Variables

Firm Size (the natural log of real Total Assets) is negative and statistically significant across every one of the eight main model-measure combinations estimated in this study, at the 1% level in most cases. This makes Firm Size the single most consistent result in the entire analysis, more consistent even than Technopark membership. Larger firms in this sample tend to show lower ROA and ROE. This is broadly consistent with a diminishing-returns-to-scale explanation, in which very large technology firms find it harder to sustain the same percentage returns on an already large asset base, but it may equally reflect the composition of this specific sample: several of the smaller, more recently listed firms in the sample are growing quickly off a small base, which can mechanically produce higher percentage returns even without superior underlying profitability. Because Firm Size is included specifically as a control variable rather than a variable of direct interest to any research question, this result is not itself a finding this study set out to test, but its strength and consistency across every specification suggest that any future extension of this model should continue to control for size carefully, since a specification that omitted it could easily misattribute a size effect to R&D, Technopark, or Leverage instead.

Sales Growth is positive and statistically significant in the NoRnD models (both ROA and ROE) but generally falls short of significance in the smaller Full-specification models. This pattern suggests a real, if modest, link between revenue growth and profitability that becomes easier to detect with the larger sample size, consistent with the general expectation that growing firms are also becoming more profitable, though the relationship is not strong enough to be considered a primary driver of performance in this study. The loss of significance in the Full specification is most plausibly a power issue rather than evidence that the relationship disappears for R&D-active firms specifically: the Full sample is roughly half the size of the NoRnD sample, and a coefficient of similar magnitude estimated with fewer observations is mechanically less likely to clear the 5% threshold, even if the underlying relationship is unchanged.

Current Ratio, included as a working-capital and liquidity control variable, shows no consistent pattern across the eight models and is statistically significant in only isolated cases.

This suggests that, within this sample of BIST-listed technology firms, short-term liquidity position is not a strong independent driver of either ROA or ROE, once firm size, leverage, and growth are already accounted for. This is a plausible result for a technology-sector sample specifically: unlike capital-intensive manufacturing firms, where working-capital management can meaningfully affect returns, many of the technology firms in this sample carry relatively light physical inventory and receivables burdens, which may explain why liquidity position adds little explanatory power once the other controls are in the model.

4.7 Robustness and Reliability of Findings

Before summarizing the results against the three hypotheses, it is worth stepping back and asking how much confidence each finding actually deserves, since not all of the results in this chapter carry the same evidential weight. Three factors matter most in judging this: how many distinct specifications a result survives, how large the coefficient is relative to its standard error, and how plausible the underlying identification is given the data available.

Judged against these criteria, the R&D finding is the most straightforward: no statistically significant contemporaneous association appears under either leverage measure or performance outcome, although this does not prove that the true effect is zero. The Technopark finding is strongest for ROA: the coefficient is positive in all four combinations and significant in two, the Debt/Assets models, while none of the four ROE estimates nor either Liabilities/Assets ROA estimate is significant. The leverage evidence is less stable, with only two significant results and opposite directions across ROA and ROE. These patterns support cautious, outcome-specific conclusions rather than treating isolated p-values as equally reliable evidence.

This uneven reliability across findings is itself a reasonable outcome for a study of this scale and should not be read as a weakness of the analysis. A 41-firm, 11-year panel of Turkish technology firms is not large enough to identify every effect with equal precision, particularly once the sample is split further by R&D data availability or by which firms happen to have changed Technopark status during the sample period. The alternative, reporting only the results that are cleanly identified and omitting the rest, would give a falsely tidy picture of what this data can and cannot support. Presenting the full range of findings, including the ones that rest on thinner identification, is judged here to be the more honest and more useful choice for readers who may wish to build on this work.

4.8 Summary of Findings

Table 13 summarizes how the evidence from this chapter maps onto the three hypotheses set out in Chapter 1.

Table 13: Summary of Hypothesis Testing Results

Hypothesis	ROA	ROE	Decision	Overall Conclusion
H1: R&D Intensity	Not significant	Not significant	Fail to reject H1 (Null)	H1A not supported
H2: Technopark	Positive; significant in 2 of 4	Not significant (all four combinations)	Reject in 2 ROA models; fail to reject in all four ROE combinations	H2A supported for ROA under Debt/Assets only; not supported under Liabilities/Assets or for ROE
H3: Leverage	Mixed across measures	Mixed across measures	Mixed; depends on model and measure	Inconclusive / measure-dependent

The updated results do not identify one factor that is uniformly significant across every specification, but Technopark comes closest. R&D Intensity is not statistically significant for either ROA or ROE, so H1 (Null) cannot be rejected. Technopark is positive in all four ROA combinations and significant in two, the Debt/Assets models, but it is not significant for ROE or for either Liabilities/Assets model; H2 (Null) is therefore rejected for ROA under the Debt/Assets measure, supporting H2A in those two specifications, but H2 (Null) cannot be rejected for ROA under Liabilities/Assets or for ROE. Leverage remains measure- and outcome-dependent, with significant results in two of eight combinations pointing in opposite directions, so H3 cannot be resolved with a single decision. The Full sample is nested within the NoRnD sample, so consistency between them is not independent replication. Overall, Technopark membership provides the most defensible association in this study, particularly

for ROA, while R&D remains statistically undetected and leverage remains unsettled. None of these associational results proves causality.

CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter brings together the results reported in Chapter 4 and considers their implications for the research questions and objectives set out in Chapter 1. The study examined whether R&D spending, Technopark membership, and leverage help explain the financial performance of technology firms listed on Borsa İstanbul between 2015 and 2025. Eight panel regression models were estimated using ROA and ROE, Full and NoRnD samples, and two leverage definitions. The discussion below relates the findings to the literature reviewed in Chapter 2, addresses the main limitations, and sets out recommendations for firms, policymakers, and future research.

5.2 Conclusions in Relation to the Research Questions

The first research question asked whether R&D expenditure positively affects financial performance. R&D Intensity had a positive coefficient in both the ROA and ROE Full models, but neither coefficient was statistically significant; the alternative leverage measure produced the same conclusion. H1 (Null) therefore cannot be rejected. The study does not provide sufficient evidence of a positive contemporaneous association between R&D intensity and either performance measure. This is not evidence that R&D has no value. It indicates that any effect could not be distinguished from zero in the available sample and within a specification that relates current R&D expenditure to current profitability. Delayed returns to R&D are one possible explanation, but this mechanism was not tested directly.

The second research question considered whether the performance of Technopark member firms differs significantly from that of non-members. The evidence is strongest for ROA. The Technopark coefficient is positive in all four ROA combinations and significant in two: both Debt/Assets models. It is not significant in either Liabilities/Assets model (Full: $p = 0.582$; NoRnD: $p = 0.090$). None of the four ROE Fixed Effects coefficients is statistically significant. Since only two firms changed Technopark status during the panel, the ROE estimates depend on very limited within-firm variation. H2 (Null) is therefore rejected for ROA under the Debt/Assets measure specifically, supporting H2A in those two specifications, but H2 (Null) cannot be rejected for ROA under Liabilities/Assets or for ROE. The results describe associations rather than causal effects because firms are not randomly assigned to Technopark membership.

The third research question asked whether leverage negatively affects financial performance. The results do not support a general, measurement-independent negative relationship. Significant coefficients appear in two of the eight model-measure combinations and point in opposite directions: Liabilities/Assets is negatively associated with ROA in the NoRnD sample, whereas Debt/Assets is positively associated with ROE in the NoRnD sample. The other six combinations are not significant. H3 therefore cannot be resolved with a single directional conclusion.

These findings answer the three study objectives directly. No statistically reliable positive contemporaneous R&D effect was identified; Technopark membership showed the clearest and most consistent association, particularly for ROA; and the leverage results demonstrated why its composition and measurement must be considered. The Full sample is contained within the larger NoRnD sample, so consistency across the two specifications should not be interpreted as independent replication.

5.3 Comparison with Prior Research

5.3.1 R&D Expenditure

The insignificant R&D coefficients occupy a middle position within a divided literature. Sulimany (2025) and Herath (2025) report positive effects internationally, whereas Khan et al. (2023) find a negative effect among Chinese non-state firms. Turkish evidence is also mixed: Doğan and Yıldız (2016) identify a positive relationship, while Ağgül, Topal and Yalçın (2025) report a negative effect on ROA but a positive effect on operating profitability. The present results do not confirm any one of these directions. They are consistent with the broader observation in Chapter 2 that R&D findings vary with country, sector, ownership structure, time horizon, and the performance measure used. The smaller Full sample also gives this null result less evidential weight than a comparable result from a substantially larger panel.

5.3.2 Technopark Membership

The Technopark findings align more closely with the international literature. Anton-Tejon et al. (2024), Albahari et al. (2018), and Díez-Vial and Fernández-Olmos (2017) report positive but heterogeneous outcomes associated with science and technology park location. In this study, the ROA coefficient is positive across both leverage definitions and nested samples and significant in two of four combinations, extending the literature to BIST-listed Turkish

technology firms while also showing that the result is not uniform. The ROE estimates are not significant.

5.3.3 Leverage

The leverage results are less stable. Ananto (2025) finds a consistently negative relationship when leverage is measured against equity, but more varied results for asset-based measures closer to those used in this study. The negative ROA and positive ROE coefficients reported here resemble that mixed asset-based pattern. Karaca, Mensi and Gemici (2025) identify an inverted U-shaped relationship between capital structure and firm value in Turkish manufacturing firms. The present linear models cannot test that relationship, although the sensitivity of the coefficients to measure and sample suggests that a single straight-line effect may be too restrictive.

5.3.4 Broader Contribution

The study contributes an integrated test of R&D intensity, Technopark membership, and leverage in the same panel of Turkish technology firms. It also uses two profitability measures and two leverage definitions over a period extending into Turkey's recent high-inflation years. The results show why conclusions based on one performance measure or one definition of leverage can be incomplete: ROA and ROE capture different dimensions of performance, while interest-bearing debt and total liabilities represent different financing structures.

5.4 Theoretical and Practical Implications

5.4.1 Theoretical Implications

The absence of a significant contemporaneous R&D coefficient does not provide the expected empirical support for the Resource-Based View or Signaling Theory. It does not reject either theory, since the models cannot capture delayed returns or differences in firms' ability to commercialise R&D. The positive but specification-dependent Technopark association with ROA, significant in two of the four combinations, is compatible with the Triple Helix model and knowledge-spillover theory, although no significant ROE association is identified. The leverage results remain compatible with competing mechanisms: broader obligations may weaken asset returns, while interest-bearing debt may raise measured returns to equity. No one mechanism dominates.

5.4.2 Practical Implications

For managers, Technopark membership merits consideration because its association with ROA is consistent across the reported specifications. Membership should not be treated as a guaranteed source of profitability: the analysis cannot separate the effects of tax relief, infrastructure, university links, or the selection of stronger firms into the programme. Financing decisions should also distinguish interest-bearing debt from broader liabilities. The results suggest that the composition of obligations may be more informative than a single headline leverage ratio.

For policymakers, the ROA evidence supports further evaluation of the policy logic behind Technology Development Zones. It does not establish that the programme caused higher performance. A credible programme assessment must address selection into membership and compare the benefits with fiscal and administrative costs.

5.5 Limitations of the Study

The principal limitation is the reduction from 41 firms and 305 observations in the main NoRnD Debt/Assets specification to 27 firms and 157 observations in the Full specification. The NoRnD Liabilities/Assets robustness models contain 306 observations because one additional firm-year is usable under that leverage definition. R&D expenditure was frequently absent from LSEG Workspace and was checked against annual reports available through KAP. Where neither source provided a separately verifiable amount, the value was left missing rather than recorded as zero. This treatment avoids misclassification but reduces statistical power so that a modest R&D effect may remain undetected.

The availability of annual reports also affected a small number of core firm-year observations. When Total Assets, Net Income, or another required item could not be verified, that observation was excluded. In addition, some data-cleaning decisions required judgement, including the treatment of zero reported debt and the exclusion of abnormal early observations for firms that were not yet listed or had recently completed an IPO. These decisions are documented in Chapter 3 but remain a source of measurement uncertainty.

Technopark status is time-invariant for 39 firms and changes for only two. The Random Effects ROA models (Full and NoRnD under Debt/Assets, and NoRnD under Liabilities/Assets) use both between- and within-firm variation, whereas the ROE Fixed Effects models and the ROA Full Liabilities/Assets Fixed Effects model depend heavily on

those two switcher firms and are not statistically significant. More broadly, membership is endogenous: firms apply and satisfy eligibility criteria, and unobserved differences between members and non-members may also affect performance. The positive ROA coefficients cannot be interpreted causally.

Finally, the study is confined to listed Turkish technology firms over an eleven-year period that includes unusually high and variable inflation. Although inflation-adjusted figures were used, the findings remain specific to this market, sample, and period.

5.6 Recommendations

5.6.1 For Technology Firms

Firms considering Technopark membership should undertake a firm-specific cost-benefit assessment covering tax advantages, university and infrastructure access, eligibility requirements, and continuing compliance costs. The positive ROA association strengthens the case for considering membership but does not guarantee a return. Financial managers should monitor interest-bearing debt and broader liabilities separately and assess their effects against both ROA and ROE rather than relying on one leverage ratio.

5.6.2 For Policymakers

Policymakers should evaluate Technopark outcomes using designs that address selection into membership and compare programme benefits with tax expenditure and administrative costs. More consistent disclosure of R&D expenditure by listed firms would also improve the assessment of innovation investment. Standardised reporting should distinguish a genuine zero from an undisclosed or unidentifiable amount.

5.6.3 For Future Research

Future studies should estimate lagged R&D effects over one-, two-, and three-year horizons and test whether the relationship differs by sector, firm age, or innovation intensity. A longer panel containing more firms that enter or leave Technoparks would improve identification; alternative estimators for variables with limited within-firm variation and methods addressing selection into membership should also be considered. Research on leverage should test non-linear relationships and retain separate measures of interest-bearing debt and total liabilities. Expanding the sample beyond listed firms could alleviate the R&D data constraint, while interviews with finance managers could clarify why Technopark results differ between ROA and ROE and why leverage coefficients change across definitions and samples.

5.7 Concluding Remarks

This study provides an integrated assessment of how R&D intensity, Technopark membership, and leverage relate to the financial performance of technology firms listed on Borsa İstanbul between 2015 and 2025. No statistically reliable contemporaneous association is identified between R&D intensity and either ROA or ROE. Technopark membership produces the strongest pattern: its ROA coefficient is positive in all four model-measure combinations and significant in two, the Debt/Assets models, whereas none of the four ROE coefficients nor either Liabilities/Assets ROA coefficient is significant. The relationship between leverage and performance also varies by definition and outcome, with only two significant results pointing in opposite directions. These relationships are associational rather than causal, and the nested Full and NoRnD samples should not be treated as independent replications.

References

Aboody, D., & Lev, B. (2000). Information asymmetry, R&D, and insider gains. *Journal of Finance*, 55(6), 2747-2766.

Aghion, P., Bond, S., Klemm, A., & Marinescu, I. (2004). Technology and financial structure: Are innovative firms different? Journal of the European Economic Association, 2(2-3), 277-288. https://doi.org/10.1162/154247604323067989

Ağgül, S., Topal, B., & Yalçın, S. (2025). Investigating the effect of research and development intensity on firm profitability with panel data analysis. Research Square (preprint). https://doi.org/10.21203/rs.3.rs-6725041/v1

Albahari, A., Barge-Gil, A., Pérez-Canto, S., & Modrego, A. (2018). The influence of science and technology park characteristics on firms' innovation results. *Papers in Regional Science*, 97(2), 253-279.

Ananto, P. (2025). Capital structure effects: The role of sales growth in shaping firm performance across Southeast Asia. JASF: Journal of Accounting and Strategic Finance, 8(2), 344-362.

Anton-Tejon, M., Barge-Gil, A., Martinez, C., & Albahari, A. (2024). Science and technology parks and their heterogeneous effect on firm innovation. *Journal of Engineering and Technology Management*, 73, 101820.

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, 17(1), 99-120.

Central Bank of the Republic of Türkiye. (n.d.). Electronic Data Delivery System (EVDS). Retrieved September 1, 2026, from https://evds3.tcmb.gov.tr/

Connelly, B. L., Certo, S. T., Ireland, R. D., & Reutzel, C. R. (2011). Signaling theory: A review and assessment. *Journal of Management*, 37(1), 39-67.

Díez-Vial, I., & Fernández-Olmos, M. (2017). The effect of science and technology parks on a firm's performance: A dynamic approach over time. *Journal of Evolutionary Economics*, 27(3), 413-434.

Doğan, M., & Yıldız, F. (2016). Araştırma ve geliştirme harcamalarının (Ar-Ge) firma kârlılığı üzerindeki etkisi: BİST'te işlem gören imalat sanayi firmaları üzerine bir araştırma. Kastamonu Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, 14, 178-187.

Etzkowitz, H., & Leydesdorff, L. (1995). The Triple Helix - University-Industry-Government relations: A laboratory for knowledge-based economic development. *EASST Review*, 14(1), 14-19.

Gujarati, D. N., & Porter, D. C. (2009). Basic econometrics (5th ed.). McGraw-Hill/Irwin.

Herath, H. M. M. K. M. (2025). Evaluating the influence of R&D investment on corporate profitability: A sectoral analysis. Available at SSRN: https://ssrn.com/abstract=5237938

Jensen, M. C., & Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics*, 3(4), 305-360.

Karaca, S. S., Mensi, W., & Gemici, E. (2025). Inverted U-shaped dynamics of capital structure and firm value: Evidence from an emerging market. *Borsa Istanbul Review*.

Khan, M. A., Bin, M., Wang, C., Bilal, H., Khan, A. A., Ullah, I., Iqbal, A., & Rahman, M. U. (2023). Impact of R&D on firm performance: Do ownership structure and product market competition matter? SAGE Open, 13(3). https://doi.org/10.1177/21582440231199560

Link, A. N., & Yang, U. Y. (2018). On the growth of Korean technoparks. *International Entrepreneurship and Management Journal*, 14(2), 405-410.

Ministry of Industry and Technology. (n.d.). TGB listesi [Technology Development Zone list]. Retrieved September 1, 2026, from https://teknopark.sanayi.gov.tr/home/tgblistesi

Ministry of Science, Industry and Technology. (2016). Technology Development Zones Implementation Regulation [Teknoloji Geliştirme Bölgeleri Uygulama Yönetmeliği]. Official Gazette No. 29797, August 10, 2016. https://www.resmigazete.gov.tr/eskiler/2016/08/20160810-8.htm

Modigliani, F., & Miller, M. H. (1958). The cost of capital, corporation finance and the theory of investment. *American Economic Review*, 48(3), 261-297.

Myers, S. C. (1984). The capital structure puzzle. *Journal of Finance*, 39(3), 575-592.

Myers, S. C., & Majluf, N. S. (1984). Corporate financing and investment decisions when firms have information that investors do not have. *Journal of Financial Economics*, 13(2), 187-221.

Ozkan, N. (2018). Replicating the R&D investments and financial structure relationship: Evidence from Borsa İstanbul. Management Review Quarterly, 68(4), 399-411. https://doi.org/10.1007/s11301-018-0145-7

Republic of Türkiye. (2001). Technology Development Zones Law (Law No. 4691). Official Gazette No. 24454, July 6, 2001. https://www.mevzuat.gov.tr/mevzuatmetin/1.5.4691.pdf

Republic of Türkiye. (2021). Law Amending the Technology Development Zones Law and Certain Other Laws (Law No. 7263). Official Gazette No. 31384, February 3, 2021. https://www.resmigazete.gov.tr/eskiler/2021/02/20210203-11.htm

Salam, Z. A., & Shourkashti, R. (2019). Capital structure and firm performance in emerging market: An empirical analysis of Malaysian companies. *International Journal of Academic Research in Accounting, Finance and Management Sciences*, 9(3), 70-82.

Saxenian, A. (1994). Regional advantage: Culture and competition in Silicon Valley and Route 128. Harvard University Press.

Saxenian, A., & Hsu, J.-Y. (2001). The Silicon Valley-Hsinchu connection: Technical communities and industrial upgrading. Industrial and Corporate Change, 10(4), 893-920.

Schwartz, D., & Bar-El, R. (2007). Entrepreneurial high-tech cluster development: Israel's experience with venture capital and technological incubators. European Planning Studies, 15(9), 1181-1198.

Sulimany, H. G. H. (2025). Effect of research and development expenditure on the financial sustainability of Standard and Poor listed firms. *Humanities and Social Sciences Communications*, 12(1), 1267.

Turkish Statistical Institute. (n.d.). Consumer Price Index. Data Portal. Retrieved September 1, 2026, from https://data.tuik.gov.tr/

Vaidyanathan, G. (2008). Technology parks in a developing country: The case of India. Journal of Technology Transfer, 33(3), 285-299.

Zhou, Y. (2005). The making of an innovative region from a centrally planned economy: Institutional evolution in Zhongguancun Science Park in Beijing. Environment and Planning A, 37(6), 1113-1134.

APPENDICES

Appendix A: Firms Included in the Panel Dataset

Table A1 lists the 41 Borsa İstanbul-listed technology firms included in the panel dataset. The underlying panel covers 2015-2025 and is unbalanced because some firms entered the sample after 2015 and certain firm-year observations were unavailable. The main NoRnD Debt/Assets specification contains all 41 firms and 305 usable firm-year observations; the NoRnD Liabilities/Assets robustness specification contains 306. The Full specifications

contain 27 firms and 157 usable firm-year observations. The '.IS' suffix follows the LSEG Workspace convention for securities listed on Borsa İstanbul.

Table A1: Firms Included in the Panel Dataset

No.	Panel Identifier	Company Name
1	AGROT.IS	AGROTECH YÜKSEK TEKNOLOJİ VE YATIRIM A.Ş.
2	ALCTL.IS	ALCATEL LUCENT TELETAŞ TELEKOMÜNİKASYON A.Ş.
3	ALTNY.IS	ALTINAY SAVUNMA TEKNOLOJİLERİ A.Ş.
4	ARDYZ.IS	ARD GRUP BİLİŞİM TEKNOLOJİLERİ A.Ş.
5	ARENA.IS	ARENA BİLGİSAYAR SANAYİ VE TİCARET A.Ş.
6	ASELS.IS	ASELSAN ELEKTRONİK SANAYİ VE TİCARET A.Ş.
7	ATATP.IS	ATP YAZILIM VE TEKNOLOJİ A.Ş.
8	AZTEK.IS	AZTEK TEKNOLOJİ ÜRÜNLERİ TİCARET A.Ş.
9	BINBN.IS	BİN ULAŞIM VE AKILLI ŞEHİR TEKNOLOJİLERİ A.Ş.
10	DESPC.IS	DESPEC BİLGİSAYAR PAZARLAMA VE TİCARET A.Ş.
11	DGATE.IS	DATAGATE BİLGİSAYAR MALZEMELERİ TİCARET A.Ş.
12	DOFRB.IS	DOF ROBOTİK SANAYİ A.Ş.
13	EDATA.IS	E-DATA TEKNOLOJİ PAZARLAMA A.Ş.
14	EMPAE.IS	EMPA ELEKTRONİK SANAYİ VE TİCARET A.Ş.
15	ESCOM.IS	ESCORT TEKNOLOJİ YATIRIM A.Ş.
16	FONET.IS	FONET BİLGİ TEKNOLOJİLERİ A.Ş.
17	FORTE.IS	FORTE BİLGİ İLETİŞİM TEKNOLOJİLERİ VE SAVUNMA SANAYİ A.Ş.
18	HTTBT.IS	HİTİT BİLGİSAYAR HİZMETLERİ A.Ş.
19	INDES.IS	İNDEKS BİLGİSAYAR SİSTEMLERİ MÜHENDİSLİK SANAYİ VE TİCARET A.Ş.
20	INGRM.IS	INGRAM MİCRO BİLİŞİM SİSTEMLERİ A.Ş.

21	KAREL.IS	KAREL ELEKTRONİK SANAYİ VE TİCARET A.Ş.
22	KFEIN.IS	KAFEİN YAZILIM HİZMETLERİ TİCARET A.Ş.
23	KRONT.IS	KRON TEKNOLOJİ A.Ş.
24	LINK.IS	LİNK BİLGİSAYAR SİSTEMLERİ YAZILIMI VE DONANIMI SANAYİ VE TİCARET A.Ş.
25	LOGO.IS	LOGO YAZILIM SANAYİ VE TİCARET A.Ş.
26	MACKO.IS	MACKOLİK İNTERNET HİZMETLERİ TİCARET A.Ş.
27	MANAS.IS	MANAS ENERJİ YÖNETİMİ SANAYİ VE TİCARET A.Ş.
28	MIATK.IS	MİA TEKNOLOJİ A.Ş.
29	MOBTL.IS	MOBİLTEL İLETİŞİM HİZMETLERİ SANAYİ VE TİCARET A.Ş.
30	MTRKS.IS	MATRİKS FİNANSAL TEKNOLOJİLER A.Ş.
31	OBASE.IS	OBASE BİLGİSAYAR VE DANIŞMANLIK HİZMETLERİ TİCARET A.Ş.
32	ODINE.IS	ODİNE SOLUTIONS TEKNOLOJİ TİCARET VE SANAYİ A.Ş.
33	ONRYT.IS	ONUR YÜKSEK TEKNOLOJİ A.Ş.
34	PAPIL.IS	PAPİLON SAVUNMA TEKNOLOJİ VE TİCARET A.Ş.
35	PATEK.IS	PASİFİK TEKNOLOJİ A.Ş.
36	PENTA.IS	PENTA TEKNOLOJİ ÜRÜNLERİ DAĞITIM TİCARET A.Ş.
37	PKART.IS	PLASTİKKART AKILLI KART İLETİŞİM SİSTEMLERİ SANAYİ VE TİCARET A.Ş.
38	REEDR.IS	REEDER TEKNOLOJİ SANAYİ VE TİCARET A.Ş.
39	SDTTR.IS	SDT UZAY VE SAVUNMA TEKNOLOJİLERİ A.Ş.
40	SMART.IS	SMARTİKS YAZILIM A.Ş.
41	VBTYZ.IS	VBT YAZILIM A.Ş.

Source: Author's compilation based on LSEG Workspace and company information verified through the Public Disclosure Platform (KAP).

Table A2: Descriptive Statistics EViews Output

Descriptive Statistics

Sample: 2015–2025

	ROA	ROE	LEV_DEBT	LEV_TL	RND_INTENSITY	TECHNOPARK	FIRMSIZE	SALES_GROWTH	CURR_RATIO
Mean	0.093615	0.162770	0.131442	0.415769	0.052050	0.656051	19.39784	0.232435	2.405799
Median	0.093376	0.148300	0.079876	0.410607	0.016479	1.000000	19.17154	0.111181	1.707476
Maximum	0.511990	0.968265	0.561111	0.881656	0.343650	1.000000	24.26811	4.098989	14.65780
Minimum	-0.233030	-0.790030	0.000000	0.069145	0.000000	0.000000	16.76676	-0.599180	0.478398
Std. Dev.	0.108068	0.233073	0.144289	0.185848	0.076073	0.476544	1.560958	0.559226	2.255019
Skewness	0.427153	-0.174950	1.274828	0.231980	1.961876	-0.657023	1.031793	3.055035	3.393825
Kurtosis	4.691541	7.383453	3.623784	2.354501	6.354366	1.431679	4.598255	18.30462	15.59599
Jarque-Bera	23.49210	126.4968	45.07111	4.133863	174.3197	27.38569	44.56708	1776.484	1339.284
Probability	0.000008	0.000000	0.000000	0.126574	0.000000	0.000001	0.000000	0.000000	0.000000
Sum	14.69748	25.55492	20.63646	65.27571	8.171853	103.0000	3045.460	36.49237	377.7105
Sum Sq.	3.197761	12.63397	5.960336	32.52779	1.328133	103.0000	59455.45	57.26859	1701.973
Sum Sq. Dev.	1.821862	8.474386	3.247829	5.388184	0.902788	35.42675	380.1082	48.78647	793.2770
Observations	157	157	157	157	157	157	157	157	157

Source: EViews output; Full specification sample (N = 157).