FIRM MARKET VALUATION AND INTELLECTUAL PROPERTY ASSETS: A SINGAPORE STUDY

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ABSTRACT

This study examines the relationship between intellectual property rights (IPR) and stock market valuation of firms listed on Singapore Exchange (SGX Group). We analyse a sample of over 570 SGX-listed firms and their globally filed patents and trade marks between 2008 and 2022. Building on Dosso and Vezzani's (2020) methodology, we differentiate between within-firm effects (i.e., effects derived from a firm's additional IPR) and between-firm effects (i.e., effects derived from a firm holding more IPR than its competitors) on market value.

Our findings suggest that investors consider both patent and trade mark filings when forming expectations of firms' future value. Notably, investors are more influenced by comparing a firm's IPR with their competitors' IPR. This study also finds that the impact of patents and trade marks on market valuation varies across industries. This research enhances our understanding of IPR's influence on market valuation in the Singapore context and provides insights into investor behaviour regarding IPR.

FOREWORD

In the face of global uncertainty and geopolitical tensions, global stock markets have experienced heightened volatility. Investors are searching for better information and cues to accurately determine firms' financial performance and prospects, to ensure healthy returns on their investments.

Amid this turbulence, intangible assets, including Intellectual Property (IP), can offer a window into a firm's business health and growth potential. Even though intangible assets traditionally make up a small part of a firm's balance sheet, they represent an increasingly important consideration for investors in a knowledge-based economy.

Singapore recognises the growing importance of IP and other intangible assets, such as data, brands, and know-how in driving enterprise and economic growth. One focus area of the Singapore IP Strategy 2030 (SIPS 2030), released in April 2021, is to support innovative enterprises to use their intangible assets, including IP for growth. This study underscores Intellectual Property Office of Singapore (IPOS)'s commitment in evidence-based policy making, and the close collaboration between IPOS and Singapore Exchange (SGX Group).

SGX Group is Asia's leading and trusted securities and derivatives market infrastructure, operating equity, fixed income, currency and commodity markets to the highest regulatory standards. SGX is committed to facilitating economic growth in a sustainable manner leveraging our roles as a key player in the ecosystem, a business, regulator and listed company. It aims to drive the exchange of capital and ideas to create value for people, businesses and economies.

This study seeks to understand the relationship of IP rights ownership with firm market valuation of firms listed on SGX. In so doing, we hope to uncover insights on how investors of SGX-listed firms view and perceive IPRs and understand how firms in different sectors differ in their attitudes to IPR ownership.

This study builds on IPOS' past collaborations with SGX, to help firms better understand and disclose their intangible assets in support of business growth and optimal valuations. We would like to express our appreciation to Thomson Medical Group Ltd, which is profiled in this report, for sharing their real-world insights. These invaluable inputs will go a long way to help us in our onward journey to unlock the value of intangible assets for companies.

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President
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CONTENTS

KEY TAKEAWAYS

- This study examines the correlation between Intellectual Property Rights (IPRs) and stock market valuation of firms listed on Singapore Exchange (SGX Group). At the broadest level, the findings indicate that patents and trade mark filings are associated with increased firm market valuation.

- The study analysed a sample of over 570 SGX-listed firms and their global portfolio of patents and trade marks filed between 2008 and 2022.

- The study found that investors consider the filing activities of both patents and trade marks when evaluating firms. Specifically, investors tend to focus more on comparing firms' IPR filing activities against those of competitors, rather than examining individual firms' IPR activities in isolation.

- Moreover, the study suggests that investors perceive IPRs differently across various industries, with both IPR types being associated with higher market capitalisation in the ‘Industrials’ and ‘Consumer Discretionary’ sectors, but not in the ‘Real Estate’ sector.

- The findings support the notion that IPRs are linked to firms’ market value. Patents are typically more directly associated with technological innovation, whilst trade marks add value by enhancing brand identity and consumer loyalty. Collectively, IPRs serve as indicators of a firm's future profitability and competitive position.

- By providing a Singapore context, this study contributes to the growing body of literature internationally giving evidence to the role of IPRs as drivers of firm value in an increasingly knowledge-based global economy.

INTRODUCTION

About Intellectual Property (IP) and intangible assets

Intellectual Property (IP) refers to creations of the mind, such as inventions, works of art, designs, computer programmes and logos. These can be protected by law through IP rights (IPRs) such as patents, registered designs, and trade marks. IP is part of the broader category of intangible assets, which includes non-physical resources that hold value for a business, such as brand value and customer relationships.

Investment in intangible assets, including IP, improves companies' financial performance. McKinsey (2021) found that top-growth companies invest 2.6 times more in intangible assets than low-growth companies. Research has shown that globally, firms which owned IP consistently performed better. In Europe, IPR owners had close to 1.5 times the revenue per employee (EPO and EUIPO, 2025) compared to those without. In Australia, IPR owners have more than twice the profit per invested capital (IPAU, 2020). Among Singaporean firms, IPR ownership contributed to over 20% increase in profit per invested capital annually (IPOS, 2023). This shows the importance of intangible assets at the firm level.

Beyond individual firms, intangible assets also play a crucial role in driving the economy, contributing substantially to Gross Domestic Product (GDP) and employment. IPR-intensive industries account for close to half of US and EU GDP, and about one-third of their employment (USPTO, 2022; EPO and EUIPO, 2022). In Singapore, the share of intangible assets in the economy has steadily increased. Between 2009 and 2017, the growth of Gross Fixed Capital Formation in intangible assets outpaced that of physical assets, rising by an average of 12.4% annually compared to 3.6% for physical assets (Ministry of Trade and Industry Singapore, 2022). IPR-intensive industries make up a third of all industries and gross value-added to the economy (IPOS, 2024), underscoring its importance as a national economic driver.

Intangible assets also play a significant role in global financial markets. According to Brand Finance (2024), the total value of intangible assets among publicly traded firms worldwide is estimated at US$79.4 trillion, surpassing global tangible net assets, which stand at US$68.8 trillion. For S&P 500 firms, 90% of their market value resides in intangible assets (Ocean Tomo, 2020). Amongst the world’s top 100 largest listed companies, those with the most valuable brands or held the largest patent portfolios generated more than twice the market capitalisation, and the number is at close to three times for Singapore’s SGX-listed companies (IPOS, 2023b).

About firm market valuation

Firm market valuation is a basic measure in business valuation that represents the value of a firm based on how much investors are willing to pay for the firm's equity. A well-known measure of firm market value is market capitalisation, calculated by multiplying the current share price by the number of outstanding shares.

However, studies have also adopted other measures, such as Tobin's Q, in place of market capitalisation. In this study, following Dosso and Vezzani (2020) and to align with Tobin's Q, firm market valuation is calculated as market capitalisation adjusted for long-term debt and current liabilities. For simplicity, we use the terms firm market valuation and market capitalisation interchangeably.

Firm Market Valuation = No. of Outstanding Shares x Current Share Price + Long Term Debt + Current Liabilities

Firm market valuation is affected by a multitude of factors, such as firms' size (Hirschey & Spencer, 1992), past performance, growth opportunities, profitability and solvency (Gharaibeh & Qader, 2017). Macro variables such as interest rates also affect firm market value. Firm market valuation is influenced by both actual performance and investor expectations of future performance.

The link between IP and firm market valuation

There is a growing literature in the field of IP and firm market valuation. In financial markets, the link between IP and firm market valuation is reflected in the importance that investors place on IPRs. Numerous studies exploring the relationship between Research & Development (R&D) expenditures, patents and market capitalisation have found that patents positively impact the market value of listed firms (Griliches, 1981; Hall, 2000; Hall, Thoma and Torrisi, 2007). Studies have also expanded to include trade marks – while patents are often seen as indicators of innovation output, trade marks reflect brand strength and consumer recognition, and signal non-technical forms of innovation. These studies have found that trade marks, like patents, enhance the market value of firms (Greenhalgh and Rogers 2006, 2012; Sandner and Block, 2011; Dosso and Vezzani, 2020; Thoma, 2021).

Other studies have posited that investors face information asymmetry regarding firms' innovation activities (Aboody and Lev, 2000; Healy and Palepu, 2000). Investors perceive R&D information reported in financial statements as a key indicator of a firm's innovative potential and future value generation but are concerned that current accounting treatments do not fully capture the long-term benefits or future economic value associated with innovation activities (Lev and Zarowin, 1999; ACCA and Deloitte, 2019; Mazzi, et al., 2022; ACCA, 2023). Some studies have proposed that investors should examine other indicators of the innovation process, such as patent filings, when assessing a firm's innovation activities (Deng, et al, 1999.; Ballardini, et al., 2005; Koh and Reeb, 2015). These studies further emphasise the role that IPRs play in investors' valuation of firms.

A study by Dosso and Vezzani (2020) (Annex 1), provides evidence of the role IP assets play in the valuation of top publicly listed R&D firms worldwide on financial markets. To provide a Singapore context, this study analysed over 570 firms listed on Singapore Exchange (SGX Group), and their global portfolio of patents and trade marks filed between 2008 and 2022. The authors expanded upon the empirical framework of Dosso and Vezzani (2020), which had also distinguished between within-firm effects (impact of additional IPR within a firm) and between-firm effects (impact of holding more IPR than competitors).

The findings show that investors consider both IPR types when evaluating firms. Notably, investors are more focussed on comparing firms to competitors (between-effect) rather than just examining individual firms (within-effect). We also find that the impact of patents and trade marks on market valuation varies by industry. Overall, the findings suggest that IPRs are linked to firms' market value and serve as indicators of the firms' future profitability and competitive positions.

This research contributes to the literature on the influence of IP assets on firm market valuation in the Singapore context, offering insights into investor behaviour in relation to IPRs.

DATA AND METHODOLOGY

This study amalgamated company, financial, stock price, patent and trade mark data from diverse sources.

Firms listed on SGX Mainboard and Catalist boards as of November 2023 constituted the initial sample. We limited the sample to exclude secondary listings and counters that were not stocks or real estate investment trusts (REITs), thereby omitting business trusts, exchange traded funds (ETFs), and other instruments.

Financial and stock price data were sourced from SGX's database, S&P Global Compustat, and various company annual reports. We extracted the financial data of sample firms for the financial years ending January 2008 to December 2022. The month-end adjusted stock close-price for the month of the firm's financial year closure was recorded. For example, if the firm's financial year for FY2010 ended in December, month-end adjusted stock close-price for December 2010 was included in our dataset. Foreign currency exchange rates published on the Monetary Authority of Singapore's (MAS) website were used to convert values in foreign currencies to Singapore Dollars (SGD).

Patent data were sourced from PatSnap Analytics. Patents were analysed at the simple patent family level[1]. Patent family count was measured at the corporate group level, encompassing all patent families held by the firm and its subsidiaries. Corporate tree information was sourced from PatSnap Discovery.

Trade mark data were sourced from Markify. Data of trade mark applications filed in IP offices worldwide were used. For comparability across IP offices, class counts were employed[2]. Using the same corporate tree information as that used for patents, we matched the company names (of the firm and its subsidiaries) in the corporate tree dataset to trade mark applicant names in the Markify dataset using a matching approach that broadly aligns with Dernis, et al. (2015).[3]

SGX Group is Asia's leading and trusted securities and derivatives market infrastructure, operating equity, fixed income, currency and commodity markets to the highest regulatory standards. As Asia's most international, multi-asset exchange, providing listing, trading, clearing, settlement, depository, data and index services, with about 40% of listed companies and over 80% of listed bonds originating outside of Singapore (SGX Group, 2025). As Asia's leading marketplace, many foreign firms listed on SGX, including Multinational Corporations (MNCs), are likely to register their IPRs with the Intellectual Property Office of Singapore (IPOS) and in various other IP offices. Global patent and trade mark filings were hence included in this study to capture their IPRs more comprehensively, rather than capturing a smaller subset of their IPRs that are intended for use in Singapore and confounding the effect of MNCs who decide to site their IP activities in Singapore.

[1]*A patent family refers to a set of patents filed in various jurisdictions to protect a single invention across multiple countries. In a simple patent family, the technical content covered by all applications is identical.*

[2]*A trade mark application may encompass various classes of goods or services. Numerous offices employ the Nice Classification, an international system for categorising goods and services used in trade mark registration. Certain offices permit only single class filing, requiring applicants to submit separate applications for each class. Others allow multi-class filing, enabling applicants to submit a single application specifying multiple classes. To enhance international comparisons of application numbers, it is beneficial to compare class counts across offices.*

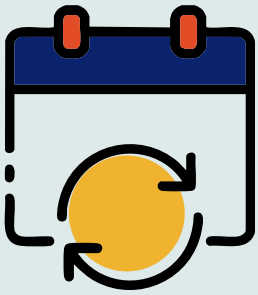
[3]*Section 2.2 of Dernis, et al. (2015). Broad steps involved the harmonisation of names, use of string-matching algorithms, and manual post processing review.*

The final dataset encompassed over 570 SGX-listed firms with fifteen years of data (from 2008 to 2022). As some firms were listed after 2008, had changed their financial year end (annual financial statements that overlapped were omitted) or had periods suspended from trading, the dataset is unbalanced (i.e., not all firms had data for all years). The final dataset comprised over 6,400 observations (in firm-years, where 2 firms with 10 years of data would provide 20 observations).

Figure 1: Study sample

> 6,400
Observations

From:
> 570
SGX-listed firms



Observed over:
15 years
From 2008 to 2022

IP Data:

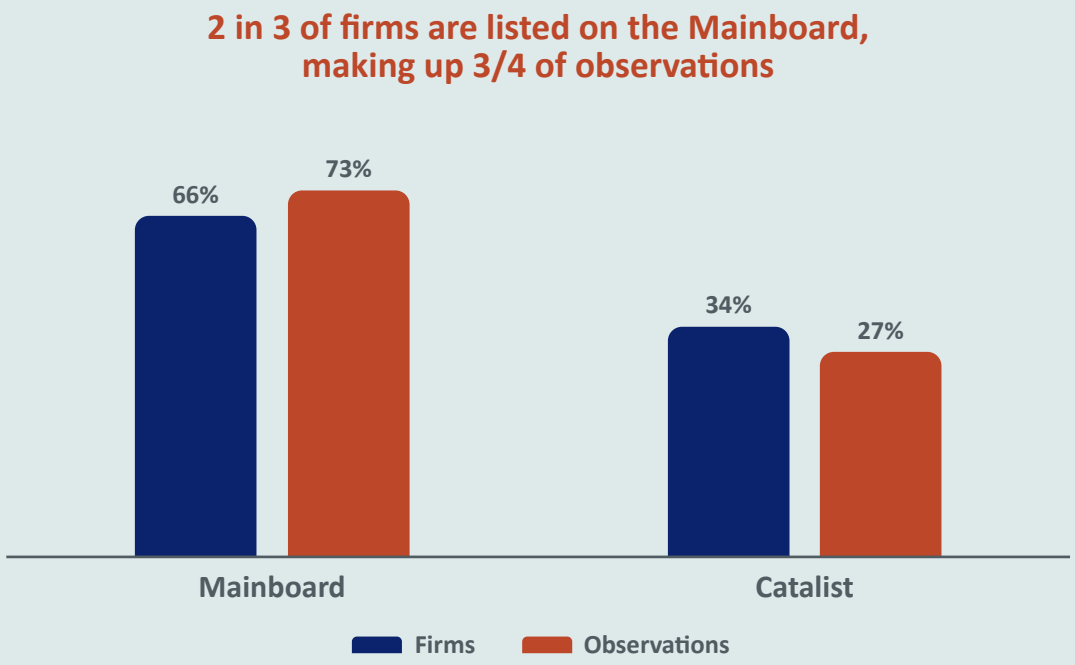
Global patent filings

Global trade mark filings

SUMMARY STATISTICS

SGX's Mainboard-listed firms accounted for about two-thirds of firms and close to three-quarter of observations in our sample (Figure 2).

Figure 2: By exchange

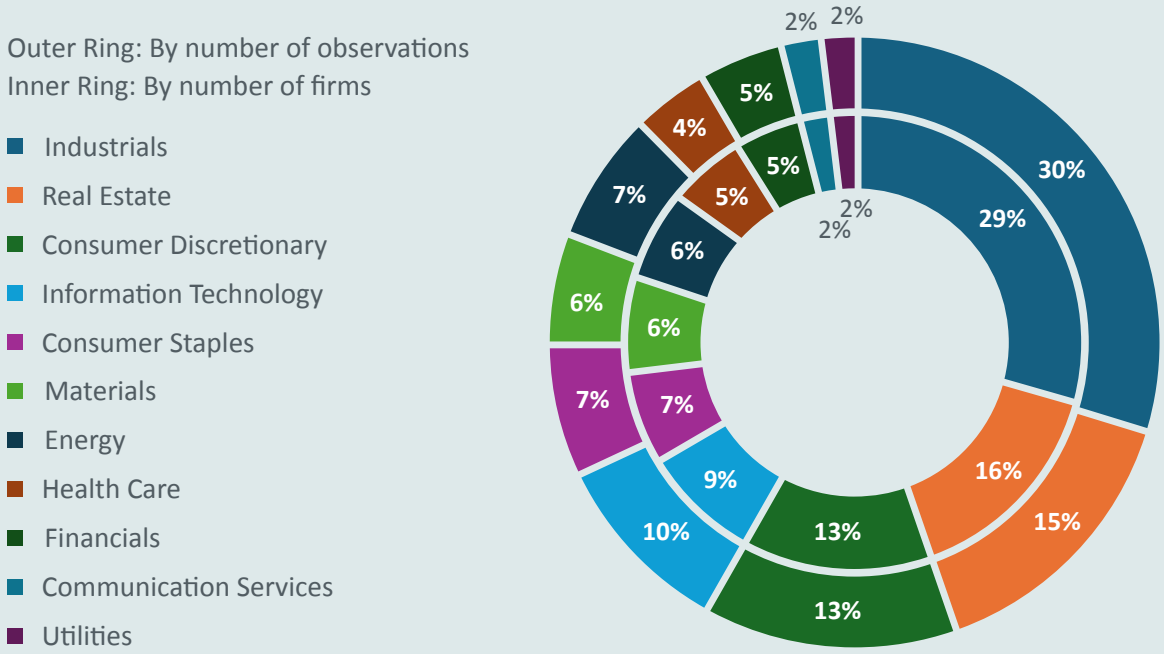


Firms were grouped into industries based on the Global Industry Classification Standard (GICS). Close to a third of firms and observations in our sample were from the 'Industrials' sector[4]. This was followed by the 'Real Estate' sector[5] and 'Consumer Discretionary' sector[6] (Figure 3).

Figure 3: By industry sector

Most firms came from the Industrials, Real Estate, and Consumer Discretionary sectors

Outer Ring: By number of observations
Inner Ring: By number of firms



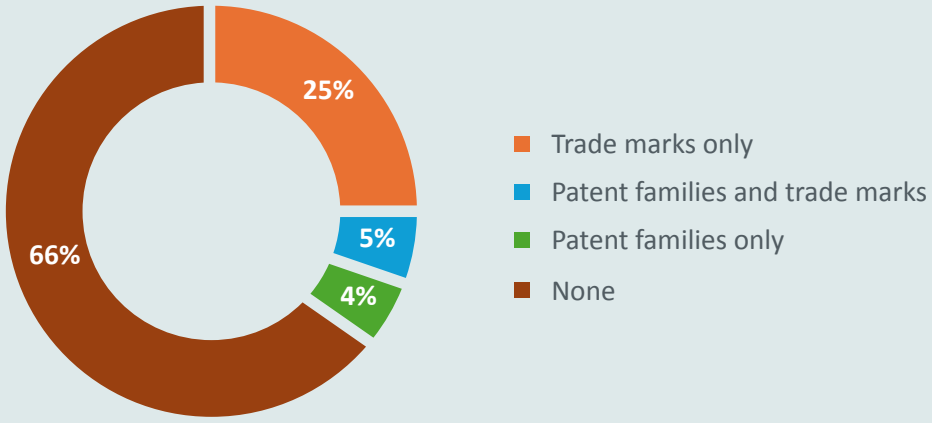
For this study, patent counts were by simple patent families dated based on the earliest publication date among the patent family members, while trade marks were in class counts dated based on the application date. The dates approximated the point to which information about the firms' action to seek protection for new inventions (simple patent families) or new trade marks were made public. In our sample, about 34% of observations saw an SGX-listed firm seek protection for at least one new invention or one new trade mark during the financial year, with about 30% of observations having sought protection for new trade marks and 9% having sought protection for new inventions (Figure 4).

[4]The 'Industrials' sector encompasses firms in the 'Capital Goods', 'Commercial and Professional Services', and 'Transportation' industry groups and includes firms like Keppel Corp, Jardine Cycle & Carriage, Singapore Airlines, ST Engineering, SATS, Singapore Post, and VICOM.

[5]The 'Real Estate' sector encompasses firms in the 'Real Estate Management & Development' and 'REITs' industry groups and includes firms like CapitaLand Investments, City Developments, UOL Group, CapitaLand Ascendas REIT, and Suntec REIT.

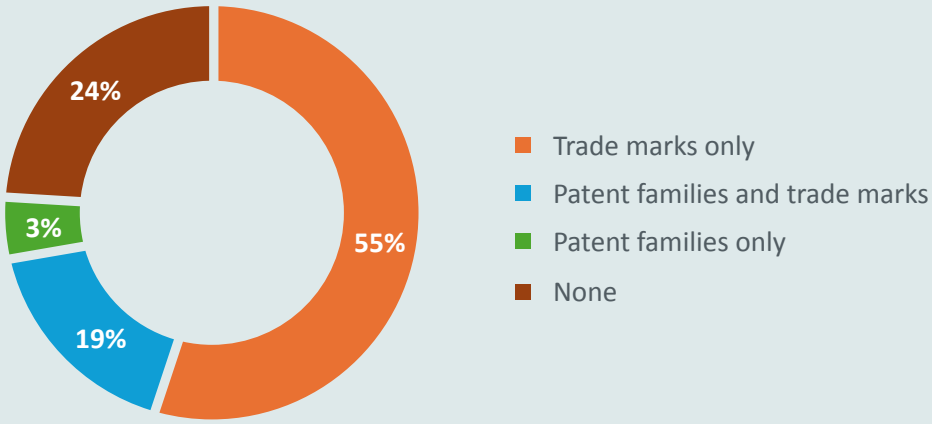
[6]The 'Consumer Discretionary' sector encompasses firms in the 'Automobiles and Components', 'Consumer Durables and Apparel', 'Consumer Services, Consumer Discretionary Distribution and Retail' industry groups and includes firms like Genting Singapore, Banyan Tree, Metro Holdings, Hour Glass, and Aspial Lifestyle.

Figure 4: By IPRs applied



To provide a view of the use of IPRs by SGX-listed firms, we expanded the analysis to estimate the proportion of observations that had IPRs that were "alive" or "in-force". An IPR is deemed to be "alive" from the point an IPR application was made to when the IPR expires.[7] Among SGX-listed firms in our sample, we estimated that approximately 76% of observations had IPRs that were "alive", with about 73% of observations that had at least one "alive" trade mark and about 21% of observations that had at least one "alive" patent family (Figure 5).[8]

Figure 5: By IPRs "alive"



[7]For an IPR that goes through a full life cycle, an IPR would be "alive" from application, to grant, and to the eventual expiry of the IPR (i.e., when the IPR is no longer in-force). Specifically, for patent families, it would be "alive" from the earliest application date up to the furthest expiry date among members of the patent family. For trade marks, it would be "alive" from the application date to the eventual expiry date of each trade mark.

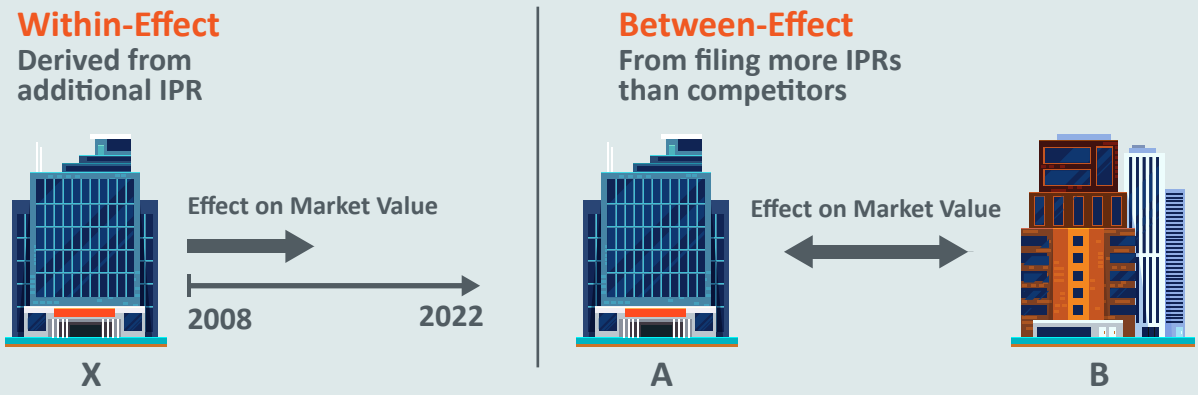
[8]We caveat that our approach was limited by the IPR data extracted and should be deemed as a conservative estimate. Our analysis was limited to the study of landmark dates (i.e., application, grant/registration, publication, and actual/estimated expiry dates of the IPRs). This approach would result in gaps. For example, should an IPR have an application date but not a publication date, the IPR is deemed to be "alive" only in the financial year the application was made even if the duration of the IPR application process exceeded it. We therefore view our estimates as conservative (i.e., the proportion of observations with "alive" IPR could exceed the estimated 76%).

EMPIRICAL METHODOLOGY

We expanded upon the empirical methodology of Dosso and Vezzani (2020), which modelled a firm's market value based on indicators influencing market perception of the firm's actual worth and potential future performance.

The study employed a correlated panel random effects approach (Mundlak, 1978; Neuhaus and Kalbfleisch, 1998; Schunk, 2013; Bell and Jones, 2015). This approach allowed for the estimation of within-effects and between-effects (Figure 6). As Dosso and Vezzani (2020) noted, "This approach reflects, in a more realistic manner, the behaviour of investors as they do not only consider specific company's performances, but also benchmark them against the performance of other companies". The effects can be incorporated by decomposing the IPR variables into a between-component ($\overline{IPR_i} = 1/n_i \times \sum_{t=1}^{n_i} IPR_{i,t}$) and a within-component ($IPR_{i,t} - \overline{IPR_i}$).

Figure 6: Within and between effects



It is worth noting that the correlated panel random effects model can be applied to an unbalanced dataset. Bell and Jones (2015) observed that a correlated panel random effects model with an unbalanced panel (simulated for 50% missingness) performed similarly to a balanced panel (no missingness).

The econometric regression model used in this study is given by:

$$\ln(mcap_{i,t}) = \alpha + \beta_{wpat}(\ln(Pat_{i,t}) - \ln(\overline{Pat_i})) + \beta_{wTM}(\ln(TM_{i,t}) - \ln(\overline{TM_i})) + \beta_{bpat}\ln(\overline{Pat_i}) + \beta_{bTM}\ln(\overline{TM_i}) + \gamma\chi_{i,t} + \delta\text{controls} + \mu_i + \varepsilon_{i,t}$$

where:

- $mcap_{i,t}$ represents market capitalisation, or firm market valuation, derived as market price multiplied by outstanding shares plus the long-term debts and current liabilities
- ***Pat*** represents the number of patent families published
- ***TM*** represents the number of trade marks applied by class count
- β_w represents the within-effects of the IPRs
- β_b represents the between-effects of the IPRs
- $\chi_{i,t}$ represents the explanatory control variables
- controls represents the set of binary variables introduced as controls for year, industry and the exchange (Mainboard vs Catalist)
- μ_i represents the unobserved company-specific factors
- $\varepsilon_{i,t}$ represents the error term
- $\ln$ refers to the logarithmic transformation of the outcome variables.

In line with Dosso and Vezzani (2020) and consistent with Tobin's Q, we calculated firm market value as the product of stock price and outstanding shares, plus long-term debts and current liabilities. Total assets were included as a control variable. Both market capitalisation and total assets were incorporated into the model using logarithmic transformation.

Other controls adopted from Dosso and Vezzani (2020) included the impact from the annual sales growth for both the individual firm and its industry. We also included binary control variables for year, industry (using GICS industry group classifications), and the specific exchange where the firm was listed (to control for differences between being listed on the Mainboard or on the Catalist bourse).

Our study differed from Dosso and Vezzani's (2020) in several aspects such as the sample characteristics. While Dosso and Vezzani (2020) focussed on top R&D performing firms, our study looked at all firms listed on SGX. This would mean a larger spectrum of innovative activity for our sample, and hence more zero values for IPR ownership.

Instead of using the R&D to capital expenditure ratio to measure investment efficiency, we used the R&D to total assets ratio. We also omitted the labour productivity ratio due to insufficient employment data. The rationale for replacing the R&D to capital expenditure ratio is discussed in Annex 2.

We introduced two new control variables: the capital expenditure to total assets ratio and the asset turnover ratio. We propose that the capital expenditure to total assets ratio represents a firm's investment in new assets, either to expand their asset stock or to replace depreciating assets. A comparatively high or increasing ratio may indicate expansion of a firm's operations, which investors might view favourably. The asset turnover ratio (also known as the revenue to total assets ratio) reflects how efficiently a firm utilises its assets to generate revenue. Investors may interpret a comparatively high or increasing asset turnover ratio positively, seeing it as a sign of productive asset utilisation.

The R&D to total assets ratio, capital expenditure to total assets ratio, and asset turnover ratio were all incorporated into the model with a one-year lag.

Korkeamäki and Takalo (2013), observed increases in stock prices following the publication of patent applications, and suggested that this effect was due to new information made available to the market through patent applications. Following the same rationale, we analysed patents based on their publication date (specifically, the earliest publication date of patents within the patent family), whilst trade marks were analysed based on their application date. These approximate the point at which financial and IPR application information became public, where investors would be able to access the information and make investment decisions based on this available information.

The application of logarithmic transformations to the IPR variables, coupled with the fact that approximately two-thirds of our observations lacked IPR applications, presented a 'log of zero' problem. Bellégo, Benatia, and Pape (2022) noted that among empirical papers using log-specifications, 36% encountered this issue. Of these, 69% retained zero observations, whilst the remainder discarded non-positive values. To address the 'log of zero' problem, 48% of papers that retained zero observations added a positive discretionary value to the variable, 35% employed Poisson-type estimators, and 15% applied the inverse hyperbolic sine (IHS) transformation. Notably, about 20% of studies compared different methods to assess result robustness.

Our study chose to retain zero observations as they were conceptually relevant. Understanding how IPRs influence investor perceptions of firm value should encompass the valuation differences between firms with and without IPR applications. Discarding zero observations would also raise representativeness concerns, given that only a small portion of observations had both patent and trade mark applications. This could lead to questions about whether firms with such observations might be systematically different and unrepresentative of the average SGX-listed firm.

To address the 'log of zero' problem, we employed the commonly used approach of adding a positive discretionary value. Whilst the choice of this constant is arbitrary, we preferred a value of one, as the minimum value for the IPR variables was zero, each incremental unit is one, and the natural logarithm of one is zero. It is worth noting that this approach introduces some bias to the results, and selecting a smaller constant does not necessarily reduce this bias. The impact of this adjustment on the rigour and interpretation of the IPR coefficients is further explored in Annex 3.

We would also note that outliers, identified using Grubbs' test, were adjusted using winsorisation.

RESULTS

This study, based on a sample of SGX-listed firms, found that patent and trade mark filings were associated with increased market capitalisation.

Specifically:

- The study, employing regressions with varying numbers of controls (ranging from "no controls" to "all controls"), found that Intellectual Property Rights (IPR) variables were statistically significant in explaining market capitalisation. These IPR variables demonstrated a positive effect on market capitalisation.

- The study found that between-effects were more pronounced in magnitude than within-effects.

- The study found that the IPR variables influenced market capitalisation differently across industries. IPRs exhibited a strong association with market capitalisation for the 'Industrials' and 'Consumer Discretionary' sectors, but not the 'Real Estate' sector.

Estimates for the whole sample

The overall results are presented in Table 1. The "main" specification aims to replicate the controls used in Dosso and Vezzani (2020), with two exceptions: 'R&D-Capital Expenditure ratio (t-1)' is replaced with 'R&D-Total Assets ratio (t-1)', and 'Labour Productivity ratio (t-1)' is omitted. The "all controls" specification builds upon the "main" specification by incorporating two additional controls: 'Capital Expenditure-Total Assets ratio (t-1)' and 'Asset Turnover ratio (t-1)'. The "no controls" regression, consistent with Dosso and Vezzani (2020), includes only 'Log Total Assets' and the binary variables as controls.

For all three model specifications, both the within and between effects of the IPR variables were found to be statistically significant in explaining increases in market capitalisation. The between-effects were larger in magnitude than the within-effects. Controls applied were also all statistically significant and with the expected direction of association.

Table 1: Market value regressions – Full sample

Market value regressions			
	Main	**All controls**	**No controls**
IP rights - within effect			
Log Patents#	0.035*	0.035*	0.042**
Log Trade marks#	0.031***	0.030***	0.031***
IP rights - between effect			
Log Patents#	0.228***	0.228***	0.244***
Log Trade marks#	0.234***	0.233***	0.242***
Control variables			
Log Total Assets	0.710***	0.712***	0.696***
Sales Growth^	0.042***	0.040***	
Sector Sales Growth^	0.070**	0.053*	
R&D-Total Assets ratio (t-1)	0.714**	0.759**	
Capital Expenditure-Total Assets ratio (t-1)^		0.136***	
Asset Turnover ratio (t-1)		0.036***	
Catalist market dummy	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
Constant	1.380***	1.254***	1.335***
Observations	6,546	6,421	6,664
Groups (firms)	574	573	574
R-squared (overall)	0.900	0.902	0.896
R-squared (between)	0.548	0.551	0.553
R-squared (within)	0.923	0.923	0.920

Standard errors: *** p<0.01, ** p<0.05, * p<0.1
^ Adjusted for outliers using winsorisation, with outliers identified using Grubbs' test.
# A constant of 1 was added to address log of zero. While common practice, this approach would introduce some bias.

Estimates for specific industry sectors

The study deep dived using the "all controls" specification into the three industry sectors with the most observations: the 'Industrials' sector[9], the 'Real Estate' sector[10], and the 'Consumer Discretionary' sector[11] (Figure 3). The regression results for each industry sector are presented in Table 2. The industry sector analyses found that both IPR types are associated with higher market capitalisation in the 'Industrials' and 'Consumer Discretionary' sectors, but not in the 'Real Estate' sector.

[9]The 'Industrials' sector encompasses firms in the 'Capital Goods', 'Commercial and Professional Services', and 'Transportation' industry groups and includes firms like Keppel Corp, Jardine Cycle & Carriage, Singapore Airlines, ST Engineering, SATS, Singapore Post, and VICOM.

[10]The 'Real Estate' sector encompasses firms in the 'Real Estate Management & Development' sector and 'REITs' industry groups and includes firms like CapitaLand Investments, City Developments, UOL Group, CapitaLand Ascendas REIT, and Suntec REIT.

[11]The 'Consumer Discretionary' sector encompasses firms in the 'Automobiles and Components', 'Consumer Durables and Apparel', 'Consumer Services, Consumer Discretionary Distribution and Retail' industry groups and includes firms like Genting Singapore, Banyan Tree, Metro Holdings, Hour Glass, and Aspial Lifestyle.

Table 2: Market value regressions – Industry sectors

Market value regressions					
	All controls				
	Industrials	**Consumer Discretionary**	**Real Estate**	**All sectors**	**All sectors** except Real Estate
IP rights - within effect					
Log Patents#	0.027	-0.076	-0.151	0.035*	0.038**
Log Trade marks#	0.031***	0.015	0.006	0.030***	0.033***
IP rights - between effect					
Log Patents#	0.280***	0.348***	-0.449	0.228***	0.246***
Log Trade marks#	0.251***	0.078*	0.014	0.233***	0.255***
Control variables					
Log Total Assets	0.750***	0.784***	0.852***	0.712***	0.684***
Sales Growth^	0.042***	0.040***	-0.017	0.040***	0.072***
Sector Sales Growth^				0.053*	0.074**
R&D-Total Assets ratio (t-1)	0.716	8.552**	0.493	0.759**	0.695**
Capital Expenditure-Total Assets ratio (t-1)^	0.237***	0.138	-0.214	0.136***	0.179***
Asset Turnover ratio (t-1)	0.109***	0.038***	-0.067	0.036***	0.042***
Catalist market dummy	Yes	Yes	Yes	Yes	Yes
Industry dummies				Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes
Constant	1.048***	0.808***	0.649***	1.254***	1.335***
Observations	1,948	860	913	6,421	5,508
Groups (firms)	167	77	89	573	484
R-squared (overall)	0.916	0.897	0.914	0.902	0.892
R-squared (between)	0.579	0.511	0.577	0.551	0.553
R-squared (within)	0.928	0.930	0.947	0.923	0.911

Standard errors - *** p<0.01, ** p<0.05, * p<0.1
^ Adjusted for outliers using winsorisation, with outliers identified using Grubbs' test.
# A constant of 1 was added to address log of zero. While common practice, this approach would introduce some bias.

‘Real Estate’ sector

The ‘Real Estate’ sector, accounting for about 15% of observations, was the second largest industry sector in our sample (Figure 3).

Some studies have observed that, in the long run, the stock market performance of REITs was more aligned with underlying real estate performance than with the general stock market (Hoesli and Oikarinen, 2012; GIC and DWS, 2023). While the brands of Singapore real estate firms (e.g., Mapletree and CapitaLand Investment) were among the most valuable Singapore brands (Brand Finance, 2024b), tangible assets (i.e., the properties held) rather than intangible assets (i.e., brands, etc.) likely draw investor attention when valuing real estate firms.

Findings from the Global Intangible Finance Tracker (Brand Finance, 2024) support this view. Among the 29 industry sectors analysed, the 'Real Estate' sector had the lowest intangible asset share of total firm value at 7%. This compares with 91% for the 'Internet and Software' sector, 73% for the 'Technology and IT' sector, and 49% for the 'Engineering and Construction' sector. This suggests that intangible assets, including IPRs, were less important in determining a real estate firm's market value compared to firms in other sectors.

Our study results aligned with this view. The IPR variables, for both within and between effects, were statistically insignificant in explaining the market capitalisation of SGX-listed firms in the real estate sector.

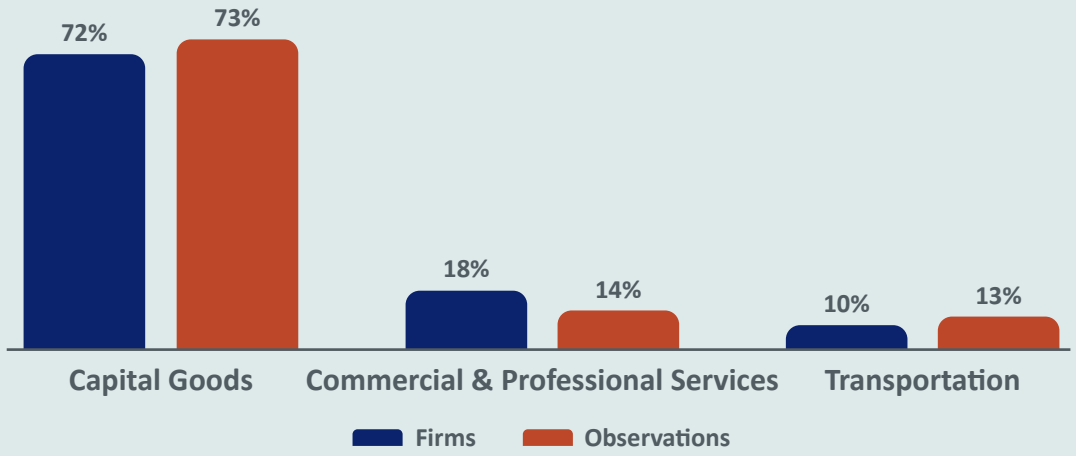
Given these results, we conducted a regression based on all observations except those from firms in the 'Real Estate' sector ('All sectors except Real Estate' in Table 2). The IPR variables for this cohort were statistically significant and their magnitudes were larger than the IPR variables from the full cohort ('All sectors' in Table 2). We will use the 'All sectors except Real Estate' results as a benchmark in analysing the remaining two industry sectors.

‘Industrials’ sector

The ‘Industrials’ sector, comprising approximately 30% of total observations, was the largest industry sector within our sample (Figure 3). The results for the IPR variables in this sector largely aligned with the overall results, with the between-effects showing significance for both IPRs and the within-effect demonstrating significance for trade marks.

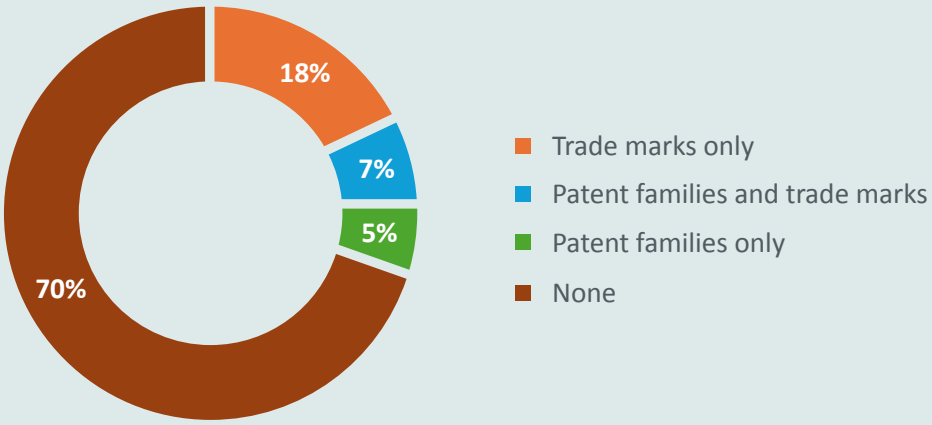
The 'Industrials' sector encompasses diverse industry groups, including 'Capital Goods', 'Commercial and Professional Services', and 'Transportation'. Firms within this sector range from engineering firms, which might rely more heavily on technical inventions (as captured in patents), to professional services firms, which might depend more on process innovations (potentially signalled by trade marks). However, it is noteworthy that most of the 'Industrials' sector cohort in our sample belonged to the 'Capital Goods' industry group, accounting for 72% of firms and 73% of observations in the sector (Figure 7).

Figure 7: Industry groups under the 'Industrials' sector



Perhaps due to the predominance of observations from the 'Capital Goods' industry group, the 'Industrials' sector demonstrated a comparatively higher use of patents. Approximately 12% of observations in this sector involved the publication of at least one new patent family, compared to 9% across all sectors. Conversely, the sector showed a lower utilisation of trade marks, with about 25% of observations involving at least one new trade mark application, as opposed to about 30% across all sectors (Figure 4 and Figure 8). This observation aligns with findings from EPO and EUIPO (2019), which noted that among IPR-using European SMEs, those in the capital goods industry exhibited a higher propensity to use patents and a lower propensity to use trade marks compared to other sectors.

Figure 8: IPRs applied in the 'Industrials' sector



Despite the increased utilisation of patents, trade mark filings remained a key signal for investors in this sector, with both the within and between effects of trade marks statistically significant. However, when the IPR coefficients for this sector were benchmarked against the 'All sectors except Real Estate' results, it was the between-effects for patents that had a larger coefficient (i.e., had larger effect on market capitalisation compared to the benchmark). The coefficient for trade marks for both effects were smaller. As such, while the result for the 'Industrials' sector aligned to the overall result, we would posit that investors of SGX-listed firms in this sector, while valuing both IPR types, accorded greater value to firms that had more patents than their competitors.

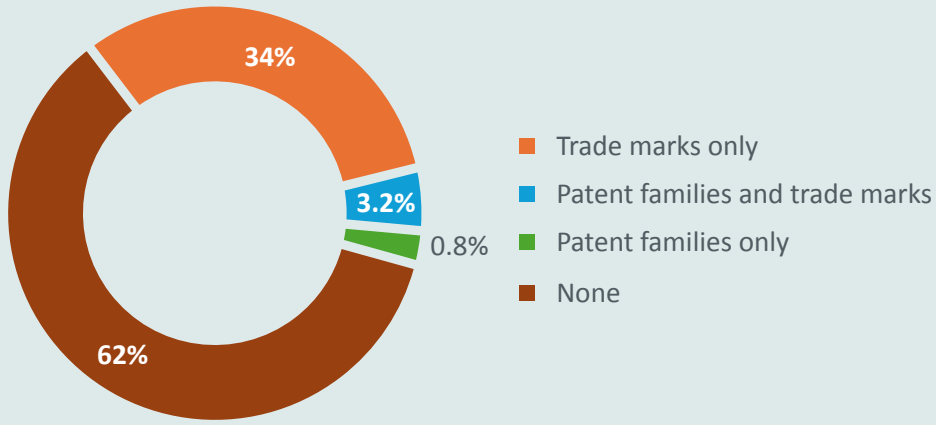
‘Consumer Discretionary’ sector

The ‘Consumer Discretionary’ sector, which formed about 13% of total observations, was the third largest industry sector in our sample (Figure 3).

For the ‘Consumer Discretionary’ sectors, IPRs were found to have a statistically significant association with market capitalisation. However, that was mainly in between-effects. The within-effect was statistically insignificant for both types of IPRs.

The 'Consumer Discretionary' sector represents firms with products and services considered non-essential but desirable by consumers (as opposed to consumer staples). This sector utilised trade marks more frequently than patents, with about 37% of observations involving at least one new trade mark application and about 4% involving the publication of at least one new patent family (Figure 9). The utilisation of trade marks was higher, and the utilisation of patents lower, than the overall cohort at 30% and 9% of observations respectively (Figure 4). The strong utilisation of trade marks in the 'Consumer Discretionary' sector was intuitive and correlated with EPO and EUIPO (2019) findings, which observed that among IPR-using European SMEs, those in consumer goods industries had a higher propensity to apply for trade mark protection compared to other sectors.

Figure 9: IPRs applied in the ‘Consumer Discretionary’ sector



However, despite the greater utilisation of trade marks, our regression analysis revealed that the between-effect for patents for this sector was larger than the ‘All sectors except Real Estate’ benchmark.

From the perspective of the retail sector, Pantano et al. (2017), having studied patent data, noted that competitiveness and complexity in the retail sector were increasing due to rapid technological changes and diffusion. They observed that retailing had been shifting towards becoming an innovation-oriented sector. The study suggested that the increasing number of patents in the retail sector pushed retailers to invest more in acquiring patented technologies to achieve advantages over competitors or to adopt novel management practices as substitutes for patents.

Patel and Pearce (2018), who examined whether IPRs (patents, copyrights and trade marks) improved the survival odds of start-ups in the US retail sector, found that all three IPR types were associated with improved survival odds, with patents showing the strongest positive effect.

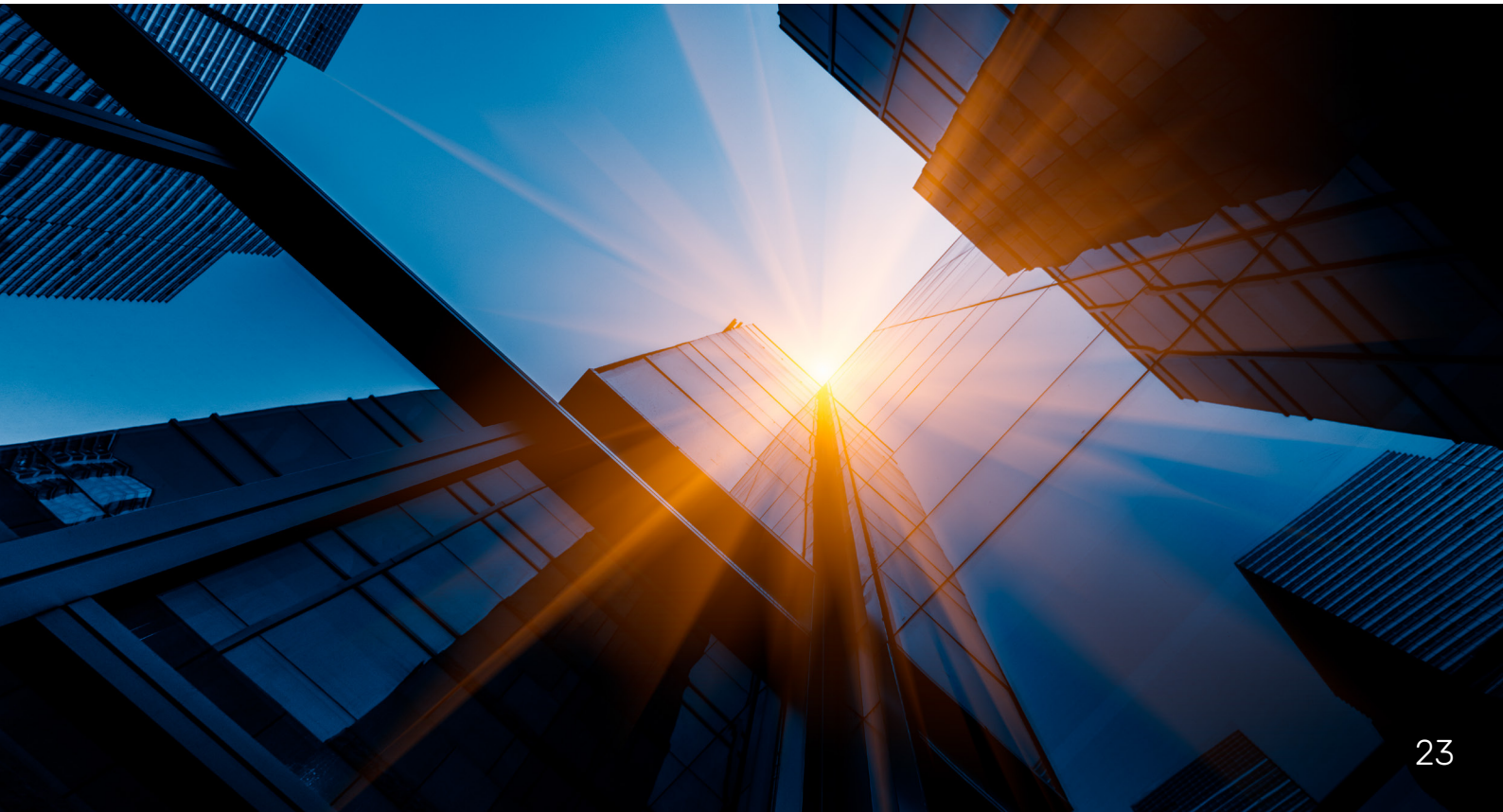
From the perspective of the consumer goods sector, Argente et al. (2020), who studied the relationship between patents and actual product innovation in the sector, found that patents were, on average, positively associated with subsequent product innovations by firms.

These studies suggest the importance and value of patents to the 'Consumer Discretionary' sector, which might explain the premium investors accorded to SGX-listed firms in the sector that had published more patent applications than their competitors.

The between-effect for trade marks was, however, smaller in magnitude than the 'All sectors except Real Estate' benchmark. We posit that firms in the 'Consumer Discretionary' sector often launch new products and services to attract consumers and capitalise on changes in consumer trends and preferences. The high propensity observed in the utilisation of trade marks by firms in this sector compared to others aligns with this view.

Korkeamäki and Takalo (2013) posited that it is information new to the market that would effect changes in market valuation. We therefore hypothesise that, given investors' expectations of firms in this sector to consistently and regularly launch new products and services, some level of new trade mark filings would be built into investor expectations. At such levels, filings would not signal unexpected sources of novel growth that are yet to be priced by the market.

Following this train of thought, we hypothesise that the smaller magnitude of the between-effect for trade marks might be due to investor expectations for increased trade mark filings in this sector. As such, a higher “threshold” or level of trade mark filings would be required to generate effects on market capitalisation in this sector as compared to other industry sectors. That said, we would highlight that the validity of this hypothesis was not tested as it was beyond the scope of this study.



CASE STUDY

Thomson Medical Group Ltd

Listed on the Mainboard of the Singapore Exchange, Thomson Medical Group Limited (SGX: A50) is one of the leading listed healthcare players in the South-East Asian region with operations in Singapore, Malaysia and Vietnam.

Established in 1979, the Group's Thomson Medical Pte Ltd is one of the largest private providers of healthcare services for women and children in Singapore. It owns and operates the iconic Thomson Medical Centre and a network of close to 40 specialist medical clinics and facilities providing outpatient women and children healthcare services, and service offerings in diagnostic imaging, health screening, gynaecological oncology, dentistry, specialist dermatology and traditional chinese medicine.

The Group's operations in Malaysia under TMC Life Sciences Berhad is a multi-disciplinary healthcare company listed on Bursa Malaysia.

It operates Thomson Hospital Kota Damansara, a tertiary hospital located in Kota Damansara, and the award-winning TMC Fertility Centre which is the industry leader in assisted reproduction in Malaysia. It also owns the proposed Thomson Iskandar Medical Hub in Johor Bahru, Malaysia.

The Group also owns a prime 9.23 ha freehold waterfront land, strategically located in Johor Bahru's City Centre, with a proposed long-term plan to build an integrated healthcare city to meet the growing healthcare needs of the people in the region.

The Group's FV Hospital operations in Vietnam provides care across more than 30 medical specialities, including oncology, cardiology, ophthalmology, orthopaedics, maternity, and gastroenterology. The first Joint Commission International-accredited hospital in South Vietnam, it has close to 200 operating beds and over 1,600 staff, which includes more than 200 Vietnamese and expatriate doctors.

FV Hospital also operates the American Chiropractic Clinic business, which consists of a network of three clinics across Vietnam, offering chiropractic services and sports medicine.

In 2013, TMG applied for 70 trade marks and 3 patents. In the same year, its market capitalisation increased by 334%. In 2018, TMG applied for 16 trade marks and 5 patents; and observed an increased market capitalisation of over 250%.

DISCUSSION

Comparison of results with Dosso and Vezzani (2020)

Our broad findings were comparable to those of Dosso and Vezzani (2020) (Annex 1). Both studies found that patents and trade marks were positively associated with market capitalisation, with between-effects stronger than within-effects. Similarly, both studies observed that the effects varied across industries, although the industry sectors examined differed.

Apart from differences mentioned in earlier sections, we note the following:

- Unlike Dosso and Vezzani (2020), our study found the within-effects to be statistically significant, albeit much smaller in magnitude than between-effects. In Dosso and Vezzani (2020), the within-effects were not statistically significant.

- Dosso and Vezzani (2020) included an IPR interaction term which was found to be statistically significant. The significance of this term suggested that investors valued the simultaneous use of both patents and trade marks. They observed that "investors seem to award a premium to those companies mastering a wider and possibly interrelated range of technical and commercial capabilities". Our study attempted to include the interaction term but omitted it due to multicollinearity. This issue is further discussed in Annex 4.

- Dosso and Vezzani (2020) included an analysis based on quality-adjusted measures of the IPR variables. Patent filings were weighted according to their IPC symbols[12], and trade mark filings were weighted according to their Nice classes. They found that their overall results held in the model using these quality-adjusted IPR variables. In our study, for comparability across IP offices, the trade mark application counts were already in class counts. As such, we did not perform an additional analysis based on the quality-adjusted measures of the IPR variables as used by Dosso and Vezzani (2020).

A comparison of the regression results between our study and Dosso and Vezzani (2020) is provided in Table 3.

[12]*The International Patent Classification (IPC) is a globally recognised system for categorising patents. IPC symbols are assigned based on the technical features described in patent applications. When a patent application encompasses multiple technical aspects, it may be assigned several IPC symbols.*

Table 3: Comparison of regression output with Dosso and Vezzani (2020)

Market value regressions					
IPOS (2025)			**Dosso and Vezzani (2020)**		
SGX-listed companies (2008-2022)	**All controls**	**No controls**	**Top global R&D companies (2005-2012)**	**All controls**	**No controls**
IP rights - within effect			**IP rights - within effect**		
Log Patents#	0.035*	0.042**	Log Patents#	0.001	−0.001
Log Trade marks#	0.030***	0.031***	Log Trade marks#	0.003	−0.003
IP rights - between effect		0.244***	**IP rights - between effect**		0.119***
Log Patents#	0.228***	0.242***	Log Patents#	0.128***	0.167***
Log Trade marks#	0.233***	0.696***	Log Trade marks#	0.169***	0.691***
Control variables			**Control variables**		
Log Total Assets	0.712***		Log Total Assets	0.661***	
Sales Growth^	0.040***		Sales Growth^	0.260***	
Sector Sales Growth^	0.759**		Sector Sales Growth^	0.026**	
R&D-Total Assets ratio (t-1)	0.053*		R&D-Total Assets ratio (t-1)	−0.064***	
			Log Labour Productivity (t-1)	0.162***	
Capital Expenditure-Total Assets ratio (t-1)^	0.136***				
Asset Turnover ratio (t-1)	0.036***				
Catalist market dummy	Yes	Yes	Financial market dummy	Yes	Yes
Industry dummies	Yes	Yes	Industry dummies	Yes	Yes
Year dummies	Yes	Yes	Year dummies	Yes	Yes
Constant	1.335***	1.479***	Constant	4.479***	3.801***
Observations	6,421	6,664	Observations	6,856	6,856
Groups (firms)	573	574	Groups (firms)	1,273	1,273
R-squared (overall)	0.902	0.896	R-squared (overall)	0.891	0.884
R-squared (between)	0.551	0.553	R-squared (between)	0.300	0.249
R-squared (within)	0.923	0.920	R-squared (within)	0.901	0.896

Standard errors: *** p<0.01, ** p<0.05, * p<0.1
^ Adjusted for outliers using winsorisation, with outliers identified using Grubbs' test.
# A constant of 1 was added to address log of zero. While common practice, this approach could introduce some bias.
Please note that in Dosso and Vezzani (2020), the IP rights interaction term between-effect was statistically significant. The interaction term was omitted from the IPOS study due to multicollinearity. For comparability, the result from Dosso and Vezzani (2020) without the interaction term is presented here.

Limitations and further research

It is important to note some limitations of the study. Firstly, while the findings suggested a positive association between IPR variables and market capitalisation, we would also like to highlight that this observed association does not entail or prove causation.

Secondly, the study sample was based on firms listed on SGX as of November 2023 and did not include firms listed as at 2008 but subsequently delisted before November 2023. As such, the study does not capture the behaviour of such firms and the results would not provide insights on how investors of delisted firms behave.

Thirdly, the corporate tree information was correct at the time of access, implying that IPR filings made by earlier divested subsidiaries would not be included. Conversely, IPR filings made by current subsidiaries before their acquisition would be included. This could positively skew our relationship of IPR and market capitalisation, where investors who invested in the listed firm because of innovative subsidiaries that had previously filed IPRs were not captured, but subsumed within the listed firm's current IPR activities. However, the authors assessed that this was unlikely a serious issue, given that such occurrences were rare.

Fourthly, we acknowledge the 'log of zero' problem and our proposed treatments (i.e., the addition of a positive constant of one, and the use of IHS for comparison). While commonly applied, these treatments have limitations and introduce bias. We therefore recommend attempting other empirical approaches that could better incorporate zero-value observations to further test the findings.

Lastly, while we formed some observations at an industry sector level, we opine that further study, perhaps utilising a larger cohort, could be valuable.

CONCLUSION

This study finds that the Intellectual Property Rights (IPRs), specifically patents and trade marks, are associated with increased market value of SGX-listed firms. This suggests that IPRs could be a relevant consideration for investors of SGX-listed firms. More specifically, the study findings suggest that investors compare IPRs between firms rather than solely look at IPRs of individual firms. Investors also have different expectations for various industry sectors.

This suggests that investors rely on IPRs as a signal of future financial performance of firms. While the publication of IPRs could have coincided with public announcements of future product lineups and hence driven up stock prices, more research remains to be done to delineate the two effects. It is also likely that savvy investors would look to IPR filings for a more upstream indication of future firm performance to reap the most benefit in a "buy low, sell high" strategy.

Contrary to traditional practices of keeping IP assets elusive from the public eye, the findings in our study indicate that the upfront disclosure of IP assets and their value could aid investors in decision-making, and reward firms that have invested wisely in IP assets. This supports previous industry consultations, where investors and financial professionals had advised for a comprehensive and consistent disclosure of IP assets to help value the companies more accurately and confidently. These factors could be especially important in industry sectors where IP assets are of greater significance to investors in their valuation of firms.

This was also the basis of collaboration between SGX and IPOS for the Foundational INtangibles Disclosure (FIND) programme, which aimed to create worked examples of how companies may use the *Intangibles Disclosure Framework (IDF)* to disclose their intangible assets, including IP. FIND was also supported by the World Intellectual Property Organization (WIPO) Singapore Office to promote transparency of intangible asset holdings to inject greater financial transactions vibrancy.

A future study could then examine the difference in firm market valuation of firms after the adoption of the IDF to disclose their intangible asset holdings. As more firms adopt the IDF and investors become au fait with the disclosure format, firm market valuation from an increase in IPR could be significantly higher than that of a firm without the IDF. The positive relationship between the firm market valuation and IPRs would also likely be stronger, since more investors would now have access to the firm's IPR holdings, much like a part of their annual report.

ANNEX 1

Overview of "Firm market valuation and intellectual property assets", Dosso and Vezzani (2020).

The study by Dosso and Vezzani (2020) examined the correlation between intellectual property rights (IPRs) – specifically patents and trade marks – and the market valuation of leading R&D investing firms globally.

Coverage:

- Over 1,250 publicly listed top R&D investing firms worldwide
- From 2005 to 2012
- Patents and trade marks filed at the USPTO
- Additional analyses on three industries: Computers & Electronics, Pharmaceuticals, and Automobiles

Methodology:

- The empirical application modelled a firm's market value based on indicators influencing market perception of the firm's actual worth and potential future performance
- Utilised a correlated panel random effects approach
- Examined both within-firm effects (changes in a firm's own IPRs over time) and between-firm effects (differences in IPR portfolios across firms)

Findings:

The study suggests that investors:

- Take IPR into account when forming expectations of firms' value
- Develop expectations by comparing IPRs between firms
- Value the concurrent use of patents and trade marks
- Form expectations differently across industries

ANNEX 2

Use of the ‘R&D-Total Assets ratio (t-1)’ in place of the ‘R&D-Capital Expenditure ratio (t-1)’.

The rationale for including 'R&D-Capital Expenditure ratio (t-1)' in Dosso and Vezzani (2020) was based on the assumption that investors would penalise firms with unproductive R&D investments within their sample of top global R&D investors. Dosso and Vezzani (2020) found the variable to be statistically significant and negatively associated with market capitalisation. However, for our study cohort, this variable did not prove to be statistically significant.

We postulate that for the firms analysed in Dosso and Vezzani (2020), being the world's leading R&D investors, investor concerns were more likely to centre on over-investment (i.e., unproductive investment) rather than under-investment in R&D. Conversely, for our cohort of SGX-listed firms, we hypothesise that the more common scenario would prevail – namely, that investors would view R&D investment as a positive indicator of a firm's innovative potential and future value creation.

Consequently, in our study, we employed the 'R&D-Total Assets ratio (t-1)' instead. This approach aligns with Griliches (1981) and other similar studies that utilised various R&D to assets ratios. The application of the 'R&D-Total Assets ratio (t-1)' in our study yielded statistically significant results, with the expected positive association in explaining market capitalisation.

Table 4 presents a comparison of the regression results between these two controls, using the "all controls" specification.

Table 4: Use of the 'R&D-Total Assets ratio (t-1)' vs the 'R&D-Capital Expenditure ratio (t-1)':

Market value regressions		
	All controls	
IP rights - within effect		
Log Patents#	0.035*	0.035*
Log Trade marks#	0.028***	0.030***
IP rights - between effect		
Log Patents#	0.224***	0.228***
Log Trade marks#	0.227***	0.233***
Control variables		
Log Total Assets	0.725***	0.712***
Sales Growth^	0.043***	0.040***
Sector Sales Growth^	0.054***	0.053*
R&D-Total Assets ratio (t-1)		0.759**
R&D-Capital Expenditure ratio (t-1)	-0.0001	
Capital Expenditure-Total Assets ratio (t-1)^	0.123***	0.136***
Asset Turnover ratio (t-1)	0.036***	0.036***
Catalist market dummy	Yes	Yes
Industry dummies	Yes	Yes
Year dummies	Yes	Yes
Constant	1.254***	1.335***
Observations	6,299	6,421
Groups (firms)	561	573
R-squared (overall)	0.903	0.902
R-squared (between)	0.556	0.551
R-squared (within)	0.923	0.923

Standard errors: *** p<0.01, ** p<0.05, * p<0.1
^ Adjusted for outliers using winsorisation, with outliers identified using Grubbs' test.
# A constant of 1 was added to address log of zero. While common practice, this approach could introduce some bias.

ANNEX 3

Discussion on the ‘log of zero’ problem

To address the 'log of zero' problem, we added a positive discretionary value of one to the IPR variables. We acknowledge that this approach introduces bias and that selecting a smaller constant is not necessarily advantageous.

To ensure rigour, we also employed the inverse hyperbolic sine (IHS) transformation for comparison (Table 5). In both transformations, the IPR coefficients remained statistically significant and positively associated with market capitalisation, with the magnitude of the between-effects exceeding that of the within-effects.

However, Bellemare and Wichman (2019) and Chen and Roth (2024) cautioned against interpreting coefficients derived from such transformations as elasticities. We have noted this limitation in our interpretation of the IPR coefficients.

Consequently, we recommend that while the core qualitative findings of this study hold, the interpretation should focus less on the quantitative estimates and more on these qualitative insights.

Table 5: Comparing Different Approaches to Log-Transform Variables with Zero Values

Market value regressions		
	All controls	
	Positive discretionary value (Log(X+1))	Inverse hyperbolic sine (IHS)
IP rights - within effect		
Log Patents	0.035*	0.028*
Log Trade marks	0.030***	0.025***
IP rights - between effect		
Log Patents	0.228***	0.191***
Log Trade marks	0.233***	0.196***
Control variables		
Log Total Assets	0.712***	0.712***
Sales Growth^	0.040***	0.040***
Sector Sales Growth^	0.053*	0.053*
R&D-Total Assets ratio (t-1)	0.759**	0.754**
Capital Expenditure-Total Assets ratio (t-1)^	0.136***	0.136***
Asset Turnover ratio (t-1)	0.036***	0.036***
Catalist market dummy	Yes	Yes
Industry dummies	Yes	Yes
Year dummies	Yes	Yes
Constant	1.335***	1.332***
Observations	6,421	6,421
Groups (firms)	573	573
R-squared (overall)	0.902	0.902
R-squared (between)	0.551	0.551
R-squared (within)	0.923	0.923

Standard errors: *** p<0.01, ** p<0.05, * p<0.1
^ Adjusted for outliers using winsorisation, with outliers identified using Grubbs' test.

ANNEX 4

Multicollinearity in the IPR interaction term

Multicollinearity was detected between the patents and the IPR interaction term.

We observed:

- High correlation between the two variables
- Standard errors of the two coefficients fluctuated from estimation to estimation
- Stability of the estimated coefficients was problematic, with both negative and positive coefficients being estimated for the same variable in alternative specifications

As such, unlike Dosso and Vezzani (2020), our study did not include an IPR interaction term.

Table 6: Correlation matrix between the IPR variables and IPR interaction term

Correlation matrix	Log Patents	Log Trade marks	Log Interaction Term
Log Patents	1		
Log Trade marks	0.323	1	
Log Interaction Term	0.803	0.425	1

Table 7: Regressions with and without the patents and interaction term variables

Market value regressions			
	All controls		
IP rights - within effect			
Log Patents#	0.035*	0.029	
Log Trade marks#	0.030***	0.029***	0.028***
Log Interaction Term		0.003	0.010
IP rights - between effect			
Log Patents#	0.228***	0.290***	
Log Trade marks#	0.233***	0.236***	0.239***
Log Interaction Term		-0.020	0.043***
Control variables			
Log Total Assets	0.712***	0.713***	0.714***
Sales Growth^	0.040***	0.040***	0.040***
Sector Sales Growth^	0.053*	0.053*	0.053*
R&D-Total Assets ratio (t-1)	0.759**	0.752**	0.803***
Capital Expenditure-Total Assets ratio (t-1)^	0.136***	0.136***	0.135***
Asset Turnover ratio (t-1)	0.036***	0.036***	0.036***
Catalist market dummy	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
Constant	1.335***	1.332***	1.333***
Observations	6,421	6,421	6,421
Groups (firms)	573	573	573
R-squared (overall)	0.902	0.902	0.901
R-squared (between)	0.551	0.551	0.551
R-squared (within)	0.923	0.923	0.923

Standard errors: *** p<0.01, ** p<0.05, * p<0.1
^ Adjusted for outliers using winsorisation, with outliers identified using Grubbs' test.
# A constant of 1 was added to address log of zero. While common practice, this approach could introduce some bias.

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