# Managerial ability, intellectual property rights, R&D: does firm age play a role?



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## Abstract

**Purpose** – The interplay between individual and collective creativity and its translation into innovation is a critical yet complex challenge in the ever-evolving innovation landscape. This study delves into the intricate relationship between managerial ability, intellectual property rights (IPRs) and research and development (R&D) investments contextualized within the dynamics of leverage, firm life stages and tangibility for pharmaceutical firms in the Asia-Pacific region. By exploring how micro-level factors influence macro-level innovation processes, this study aims to contribute to the broader understanding of creativity and innovation, a theme at the heart of addressing contemporary global challenges.

**Design/methodology/approach** – Econometric methodologies were used to analyse a data set comprising 2,660 firm-year observations spanning the decade from 2011 to 2020.

**Findings** – A key finding was that companies with lower managerial prowess strategically leverage R&D intensity to signal their value to the market and accrue reputational currency. The research unearths a significant positive relationship between managerial ability, IPRs and R&D investment. In environments characterized by strong managerial acumen and robust IPR safeguards, firms exhibit a heightened propensity to allocate resources to R&D endeavours. This underscores the role of intellectual leadership and legal protections in shaping R&D strategies within the pharmaceutical domain. Incorporating firm life stages as a moderating factor reveals that firm maturity fundamentally influences the interplay between managerial ability, IPRs and R&D expenditure.

**Originality/value** – These findings' implications resonate profoundly within policy-making circles and pharmaceutical firms' day-to-day operational strategies, underscoring the pivotal role of



**JEL classification** – C55, G32, N25, O32, P14

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intellectual capital and legal safeguards in shaping the future of innovation in the Asia-Pacific pharmaceutical sector.

**Keywords** Managerial ability, Intellectual property rights, R&D, Investment, Patent, Asia-Pacific, Pharmaceutical

**Paper type** Research paper



## 1. Introduction

In today's fast-changing landscape, the ongoing global pandemic has underscored the critical role of innovation in addressing pressing societal challenges, such as health-care crises. Generating novel and transformative solutions depends on individual and collective creativity and effectively translating these creative ideas into tangible innovations. However, the relationship between micro-level creativity and macro-level innovation remains complex and underexplored. Operating under a patent-driven research and development (R&D) model, the pharmaceutical and biotechnology industries are often willing to embark on risky, expensive and time-consuming projects if they promise patentable outcomes (Rutschman, 2021). However, some potentially transformative innovations remain underdeveloped, struggling to secure the necessary funding, especially in the case of emerging and uncommon diseases. In such circumstances, the role of higher managerial ability in driving R&D investments and the importance of intellectual property rights (IPRs) to protect these investments become paramount. Remarkably, the impact of managerial ability on R&D, particularly in the pharmaceutical industry, remains an underexplored area in academic research, possibly because of the inherent complexity in quantifying managerial ability, which is often unobservable.

The pharmaceutical sector's R&D projects are unlike those in other industries because of their direct impact on humans and their social well-being. Managerial ability in this context extends beyond strategic acumen; it necessitates scientific expertise to make informed decisions regarding R&D projects, especially in the context of drug discovery and development. The drug discovery process is intricate, encompassing phases such as disease targeting, drug candidate selection, preclinical animal testing (Henderson and Cockburn, 1994) and later clinical trials for safety and efficacy (Cockburn and Henderson, 2001), often involving trial-and-error methodologies (Moodysson *et al.*, 2008). Given these complexities, higher managerial ability becomes imperative in the highly regulated and scientifically rigorous pharmaceutical landscape. Nevertheless, managerial ability alone cannot drive R&D expenditure since robust IPR protection is equally essential. Global challenges demand innovative solutions; thus, bridging the gap between micro-level insights and macro-level innovation outcomes remains a pressing endeavour. This underscores the critical need for scholarly research, a gap that the existing literature has yet to address adequately.

Distinguishing itself from recent studies that relied on industry-adjusted measures of return on assets (Saragih and Ali, 2023), a broad performance metric that carries the limitation of being a somewhat noisy gauge of managerial ability, this study uses a more direct estimate of managerial ability as theorized by Demerjian *et al.* (2012a). This estimate has been empirically tested in various contexts dependent on managerial decision-making (e.g. Chen *et al.*, 2015; Bonsall *et al.*, 2017; Koester *et al.*, 2017; Yung and Nguyen, 2020; Gong *et al.*, 2021), yet has not been applied to the pharmaceutical industry, which stands out as a nexus of R&D and IPR intensity. The pharmaceutical industry's R&D projects are unlike R&D in other industries because their products influence the quality of human life. Managerial ability in this industry extends beyond strategic aptitude since scientific knowledge is necessary to make complex decision-making regarding R&D treatment projects.

This study unveils several key findings by engaging in a deeper understanding of the intricate interplay between managerial ability, IPRs and R&D investments within the pharmaceutical industry. Notably, there is a negative relationship between managerial ability and R&D investments that holds consistently for both young and mature firms. Driven by their discerning decision-making abilities, intellectual managers (managers with higher managerial abilities) tend to make wise choices irrespective of their firm's age. Their risk-conscious nature discourages reckless R&D spending, particularly considering the intricate drug discovery and clinical testing involved in pharmaceutical endeavours. The Granger causality test further supports the notion that intellectual managers may not inherently increase R&D investment. Conversely, managers with lower abilities might engage in intensive R&D to signal their worth to the market, aiming to gain reputational currency [1] through positive stakeholder perceptions.

Distinct R&D strategies emerge when comparing young and mature firms. Robust IPR protection leads to higher R&D investments in young firms, emphasizing the significance of intellectual property protection (IPP) for emerging pharmaceutical players. Mature firms, on the other hand, with their established operations and commercialized assets, do not exhibit a similar inclination towards increased R&D investments, as they are already well-versed in navigating the patent-driven landscape. These findings are corroborated by the results of the Granger causality test, which suggests a causal link between IPR and R&D investment.

The interaction between higher managerial abilities and strong IPRs positively correlates with increased R&D investments. In environments characterized by robust IPR protection, intellectual managers are incentivized to engage in greater R&D activities. This outcome aligns with the notion that under strong IPR regimes, intellectual managers strategically leverage R&D to create more commercially viable assets, thereby optimizing the patent-driven model.

This study offers guidance to governing boards, empowering them with a nuanced comprehension of the drivers behind R&D investment intensity. The findings hold important implications for firms seeking to fine-tune their R&D strategies and for policymakers aiming to foster innovation in this critical sector. Moreover, this study underscores the need for nuanced analyses that consider the distinctive dynamics of young and mature firms in the ever-evolving landscape of pharmaceutical R&D.

## 2. Literature review

The literature review underscores the multifaceted nature of managerial ability and its far-reaching implications for resource allocation, firm performance, investment decisions and innovation, which this study terms as managerial governance. In the pharmaceutical R&D landscape, strategic and scientific intellect is pivotal for innovative value creation. In addition, the review delves into agency risks, managerial entrenchment and the strategic signalling of managerial ability through R&D investments. Furthermore, it emphasizes the influence of a firm's age on its R&D strategies and the importance of securing IPRs to commercialize R&D outputs. These insights lay the groundwork for a comprehensive exploration of the relationship between managerial ability, IPRs and R&D in the pharmaceutical industry.

### *2.1 Theoretical framing*

The upper echelons theory posits that management characteristics are pivotal in shaping organizational outcomes (Hambrick and Mason, 1984), underscoring that crucial strategic decisions, encompassing investment choices and organizational strategies, tend to be influenced by the specific executives at the helm of affairs (Bertrand and Schoar, 2003). Hence, managerial oversight in every facet of a company is an essential component of managerial governance. Aligned with the resource-based view (RBV), which asserts that sustained competitive advantage relies on possessing valuable, rare, inimitable and non-substitutable resources (Barney, 1991), higher managerial ability is conceptualized as a resource with these distinctive attributes.

The behavioural theory of the firm (Cyert and March, 1963; Greve, 2003) provides essential links with the upper echelons theory and RBV. Within this context, the behavioural theory introduces the dynamic concepts of problemistic search, slack search and risk-taking, which serve as integral components influencing organizational innovations. When managers perceive the organization is performing below their "aspiration level", they initiate a problemistic search that catalyses engaging in innovative solutions. In the behavioural theory's exploration, slack search emerges as a mechanism facilitating organizations to explore unconventional and innovative ideas that may not be possible in resource-constrained environments. Risk-taking, a cornerstone of this theory, signifies decision-makers' willingness to explore risky solutions, such as innovations, under specific circumstances and showcasing their bounded rationality. This underscores the influence of resource availability on an organization's capacity for unconventional initiatives.

Within the realm of extant literature, managerial ability emerges as a critical factor influencing various aspects of corporate functioning. It exerts significant influence over resource allocation (Barney, 1991), overall firm performance (Carmeli and Tishler, 2004; Holcomb *et al.*, 2009), investment decisions (Chemmanur *et al.*, 2009), entry into new markets (Goldfarb and Xiao, 2011), the quality of company earnings (Demerjian *et al.*, 2012b) and even the creation of liquidity in the banking sector (Andreou *et al.*, 2016). The impact of managerial ability extends further to affect abnormal returns (Hayes and Schaefer, 1999), earnings quality (Demerjian *et al.*, 2012b), acquisition quality (Goodman *et al.*, 2013), goodwill impairment (Sun, 2016) and tax avoidance (Koester *et al.*, 2017).

In the pharmaceutical realm, intellectual managers, distinguished by their critical thinking, problem-solving and strategic planning prowess, play a pivotal role in R&D. Successful R&D project selection within this industry necessitates a deep understanding of the intricate drug discovery process, encompassing aspects like disease targeting and candidate selection for preclinical animal testing (Henderson and Cockburn, 1994). Moreover, navigating the drug development stages, which involve clinical trials ensuring the safety and efficacy of drugs through human testing, requires a profound knowledge of clinical science (Cockburn and Henderson, 2001). High managerial ability proves indispensable for effective innovation value creation and proper managerial governance, particularly because of the trial-and-error iterative nature of the drug discovery process.

In the context of agency theory, agency risks may lead managers to make decisions that either diminish or expropriate shareholder value (Sewpersadh, 2019). Self-interested management decisions can result in either overinvestment or underinvestment of company resources. The concept of managerial entrenchment (Shleifer and Vishny, 1989) within the agency perspective highlights scenarios where managers may engage in overinvestment to gain private benefits (Sewpersadh, 2019). Conversely, reducing R&D investments might allow firms to meet earnings targets, benefiting management or executives nearing retirement who seek to maximize performance incentives (Dechow and Sloan, 1991; Gunny, 2010). This strategy exemplifies how managers leverage their insider knowledge to manipulate perceived investor value, demonstrating that investment signals and managerial ability (Cohen and Dean, 2005) are interdependent. Within the context of agency conflicts arising from resource acquisition and deployment, managerial governance emerges as a pivotal mechanism. R&D investments are positioned as critical signals, intensively engaged by managers to showcase high levels of ability in value creation and company growth, enhancing their reputational capital [2].

Intellectual managers factor in the unique demands of their firms by considering the different stages of innovation influenced by the firm's age. Research by Chemmanur *et al.* (2019) emphasizes that younger firms tend to focus more on early-stage innovation projects, whereas older firms prioritize projects in the commercialization stage. This age-related dichotomy underscores the significance of considering a firm's life stage. A firm's age reflects its accumulated experience, knowledge and entrepreneurial flexibility, impacting its willingness and capacity to take risks, including R&D investments (Chen *et al.*, 2014). Younger firms engage in R&D to enhance market competitiveness, drive growth and bolster profitability (Coad *et al.*, 2016), ultimately building reputational capital. In contrast, mature firms, characterized by entrenched routines and structures, exhibit reduced R&D intensity (Hannan and Freeman, 1984; Lee and Sung, 2005). These well-established firms, boasting established brands and managers with market reputations, tend to be more selective with their R&D investments, not pursuing them as vigorously as younger firms striving to make a significant impression in the market.

In accordance with the intellectual capital model proposed by Edvinsson and Sullivan (1996), innovations stemming from a firm's "commercializable" resources are deemed intellectual assets. Innovators recognize the need to secure patents and copyrights for their R&D endeavours to safeguard against imitation (Mazzoleni and Nelson, 1998; Depoorter, 2004; Furukawa, 2007) and facilitate the commercialization of their R&D output (Mazzoleni and Nelson, 1998). This commercialization enables firms to recover R&D costs and realize benefits, further incentivizing additional R&D efforts (Qian, 2007). Commercializable assets empower firms to profit from using or selling their R&D products, processes and services. Consequently, older firms may focus on maximizing profits derived from the commercialization of their R&D rather than prioritizing new R&D initiatives.

### *2.2 Hypothesis development*

*2.2.1 Managerial ability.* The upper echelons theory, RBV and behavioural theory of the firm within the framework emphasize that managerial ability plays a pivotal role in strategic decision-making and resource allocation where managers initiate search activities for innovations. The extant literature examining innovation and R&D investments found that higher managerial ability leads to selecting large-scale projects with higher net present values (Chemmanur *et al.*, 2009) and more firm innovation activities (Chen *et al.*, 2015; Chemmanur *et al.*, 2019) with increases in R&D investments (Chemmanur *et al.*, 2019; Mishra, 2021). Since intellectual managers have a superior grasp of the economic and operational environment than those with low abilities, they would select value-creating R&D investments for their companies. For instance, Yung and Nguyen (2020) demonstrated that intellectual managers increase R&D investment to distinguish themselves from their rivals under the threat of competition. Thus, intellectual managers can access and use information that optimally positions them to engage in strategic R&D investments to regain market advantage.

Because of the sophisticated pharmaceutical knowledge required, intellectual managers will be more selective when investing in R&D projects than those with lower abilities because of the high costs and risks involved. Intellectual managers, regardless of whether they are in a young or old pharmaceutical company, are knowledgeable of the drug discovery process (Henderson and Cockburn, 1994) and mandated clinical trials for drug safety and efficacy (Cockburn and Henderson, 2001), thus will not recklessly increase R&D

investments. Managerial entrenchment and information asymmetry may contribute to adverse or subpar decision-making (Sewpersadh, 2019), where less capable managers need to gain reputational capital and entrench themselves within the firm by taking on more R&D projects to gain patentable innovations. Thus, managers with lower managerial abilities are more susceptible to the moral hazards of information asymmetry, where they may increase R&D investments and become further entrenched.

Intellectual managers are risk-conscious and choose efficiency-enhancing strategies that result in short-term gain, thus compromising on R&D investment intensity (Chu *et al.*, 2016). Thus, other pressures may also explain the negative relationship between managerial ability and R&D, such as managerial myopia (Stein, 1989), desire to earnings benchmarks (Dechow and Sloan, 1991; Gunny, 2010) or adverse decision-making information asymmetry conditions (Sewpersadh, 2019) that negatively impact long-term value creation through R&D investment. Therefore, a negative relationship between managerial ability and R&D in all firms is hypothesized because intellectual managers are risk-conscious, highly selective and may pursue short-term strategies. This study hypothesizes that:

*H1*. There is a negative relationship between managerial ability and R&D in all pharmaceutical firms.

*H1a*. The relationship between managerial ability and R&D of pharmaceutical firms in mature and young firms do not differ.

*2.2.2 The relationship between intellectual property rights and research and development.* The induce commercialization theory (Mazzoleni and Nelson, 1998) motivates the patent-driven model of the pharmaceutical industry, where R&D production is driven by the desire to acquire patents to recoup costs, reap benefits and avoid imitation of their innovation. Therefore, the intellectual capital model directly links to the induce commercialization theory, asserting that innovations are deemed intellectual assets and need protection through patents. R&D is either developed internally or externally through R&D collaborations or licensing agreements. The patenting of R&D is important to maintain their competitive market advantage (Ceccagnoli, 2009). This is because patents allow for the commercialization of assets without the risks of competitors replicating the innovation. Because of the significant costs involved with R&D, there would be no incentive to bear these expenses if rival companies could rapidly reproduce and profit from this innovation. For this reason, acquiring a patent remains an enticement for investment in R&D projects.

Protective regulations are essential to developing R&D, however, legally protected rights can still be exploited if not enforced (Papageorgiadis and Sharma, 2016). International companies are at risk of exploitation since their R&D is exposed to different legislation and interpretations across the countries in which they operate. For this reason, the IPR index (IPRI) was developed, examining three categories: legal and political environment (LP), physical property rights (PPR [3]) and IPR (Levy-Carciente, 2019). IPR protection stimulates innovation and growth (Gould and Gruben, 1997; Sakakibara and Branstetter, 2001; Duguet and Lelarge, 2012) and encourages R&D investment (Rutschman, 2021).

The behavioural theory emphasizes the importance of slack search, a search for innovations even in the face of resource scarcity. This concept aligns with the hypothesis that all pharmaceutical firms will have a positive relationship between IPRs and R&D. Mature firms rely on stronger IPRs to protect their existing innovations instead of engaging in more R&D, whereas younger firms still need to invest in R&D to establish themselves in the market (Coad *et al.*, 2016). This is particularly true for the pharmaceutical industry, where R&D requires significant funding with large time lags and risks. Therefore, it can be anticipated that mature pharmaceutical companies may rely on strong IPRs to protect their existing innovations to maintain their steady profits and competitive advantage, while young pharmaceutical companies yet to have made their mark with innovative drugs and treatments will pursue costly and risky R&D to produce patentable outputs for future profits and growth. Thus, different strategic dynamics between mature and young firms have concomitant effects on LP, PPR and IPR. This study hypothesizes that:

*H2*. All pharmaceutical firms have a positive relationship between IPRs and R&D.

*H2a*. The relationship between IPRs and the R&D of pharmaceutical firms in mature and young firms differ.

*2.2.3 The relationship between managerial ability and intellectual property right index with research and development.* The intellectual capital model and RBV highlight the importance of managerial ability in leveraging intellectual assets. Building on the hypotheses above, intellectual managers are proficient on IPRs, which motivates the examination of the interaction between managerial ability and IPR on R&D. The interaction effect happens when one explanatory variable (managerial abilities) interacts with another explanatory variable (IPRI) on a response variable (R&D). Under higher managerial skills and high IPRI, there may be a positive influence on R&D. Intellectual managers have experience with IPRI and, therefore, can strategically invest to gain optimal benefit under these conditions. This strategic investment suits the patent-driven model of the pharmaceutical industry, where companies are more willing to accept time-consuming, costly and risky R&D under strong IPRI environments. This study hypothesizes that:

*H3*. A positive relationship exists between the managerial ability-IPRI interaction variable and R&D in all pharmaceutical firms.

*H3a*. The relationship between managerial ability-IPRI interaction variable and R&D of pharmaceutical firms in mature and young firms differ.

## 3. Data and methodology

### *3.1 Data*

This study focused on the publicly traded pharmaceutical companies of the Asia-Pacific developed countries that include six countries: Australia, Hongkong, Japan, the Republic of Korea, Singapore and New Zealand. The firm financial data for this study was collected from the Standard and Poor Capital IQ database from 2011 to 2020. Table 1 presents the sample selection process of this study. Firms were excluded if they had no R&D investment, lacked financial variables or had undergone any merger and acquisition. The final sample has 2,660 firm observations. The country-specific data on gross domestic product (GDP),

| Stages in the sample selection process | No. of firms |
|---|---|
| Public listed pharmaceutical companies in Asia-Pacific developed countries | 453 |
| *Less*: firms less than 10 years in operation | 33 |
| *Less*: companies missing data for the period 2011 to 2020 | 154 |
| Final sample | 266 |
| Firm-year observations | 2,660 [5] |

**Source:** Table by authors

**Table 1.** Sample selection process

| Variable | Definition | Author |
|---|---|---|
| *Dependent variables* | | |
| R&D (LogRD) | Natural logarithm of R&D expenditure | Huang and Hou (2019), Meng *et al.* (2020) |
| RDIntensity | Ratio of R&D expenses to total revenue | Gui-long *et al.* (2017), Alam *et al.* (2020), AlHares *et al.* (2020) |
| *Independent variables* | | |
| Managerial ability score (MAbility) | The managerial ability score derived from the DEA analysis | Demerjian *et al.* (2012a) |
| Managerial ability rank (MARank) | The decile rank of MAbility by year | |
| Intellectual property rights index (IPRI) | IPRI proposed by the Property Rights Alliance | Malva and Santarelli (2015)), Levy-Carciente (2019) |
| *Control variables* | | |
| Age | Natural logarithm of the surveyed year minus the establishment year | Ngo *et al.* (2021) |
| Tangibility | Ratio of net property, plant and equipment to total asset | Bui *et al.* (2018), Puwanenthiren *et al.* (2019), Alam *et al.* (2020) |
| TobinQ | Ratio of firm's market value to the replacement cost of its assets | Banker *et al.* (2011), Wang *et al.* (2013) |
| Advertising intensity (AdvIntensity) | Ratio of advertising expenses to total assets | Gong *et al.* (2021), Ngo *et al.* (2021) |
| Leverage | Ratio of total debt to asset | Alam *et al.* (2019), Meng *et al.* (2020), Ngo *et al.* (2021) |
| Return on asset (ROA) | Ratio of net income to total assets | Yung and Nguyen (2020) |
| GDP | A measure of economic development | Parisi *et al.* (2006), Dalwai *et al.* (2021) |
| Inflation | Consumer price index using the Laspeyres formula | Dalwai *et al.* (2021), Liu *et al.* (2021) |

**Source:** Table by authors

**Table 2.**
Variables definition

inflation and World Governance Indicators are collected from the World Bank database. The IPRI scores are collected from Property Rights Alliance reports.

### *3.2 Regression model*

To investigate the influence of managerial ability (MARank) and IPRI on R&D investment (LogRD), the following model was estimated using panel regression fixed effects (refer Table 2 for variables definition):

Equation (1): managerial ability:

$$\begin{aligned} \text{LogRD}_{i,t} = {} & \alpha + \beta_1 \text{Managerial Ability}_{i,t} + \beta_2 \text{TobinQ}_{i,t} + \beta_3 \text{Tangibility}_{i,t} \\ & + \beta_4 \text{Advertising Intensity}_{i,t} + \beta_5 \text{Leverage}_{i,t} + \beta_6 \text{Return on Assets}_{i,t} \\ & + \beta_7 \text{Firm Age}_{i,t} + \beta_8 \text{Gross Domestic Product} + \beta_9 \text{Inflation} + \text{Year Effects} \\ & + \text{Country Effects} + \varepsilon \end{aligned} \quad (1)$$

Equation (2): managerial ability and IPRI

$$\text{LogRD}_{i,t} = \alpha + \beta_1 \text{Managerial Ability}_{i,t} + \beta_2 \text{IPRI}_{i,t} + \beta_3 \text{TobinQ}_{i,t} + \beta_4 \text{Tangibility}_{i,t} + \beta_5 \text{Advertising Intensity}_{i,t} + \beta_6 \text{Leverage}_{i,t} + \beta_7 \text{Return on Assets}_{i,t} + \beta_8 \text{Firm Age}_{i,t} + \beta_9 \text{Gross Domestic Product} + \beta_{10} \text{Inflation} + \text{Year Effects} + \text{Country Effects} + \varepsilon \quad (2)$$

Equation (3): managerial ability, IPRI and the interaction term

$$\text{LogRD}_{i,t} = \alpha + \beta_1 \text{Managerial Ability}_{i,t} + \beta_2 \text{IPRI}_{i,t} + \beta_3 \text{Managerial Ability} \times \text{IPRI}_{i,t} + \beta_4 \text{TobinQ}_{i,t} + \beta_5 \text{Tangibility}_{i,t} + \beta_6 \text{Advertising Intensity}_{i,t} + \beta_7 \text{Leverage}_{i,t} + \beta_8 \text{Return on Assets}_{i,t} + \beta_9 \text{Firm Age}_{i,t} + \beta_{10} \text{Gross Domestic Product} + \beta_{11} \text{Inflation} + \text{Year Effects} + \text{Country Effects} + \varepsilon \quad (3)$$

*3.3 Variables measurement*

*3.3.1 Dependent variable.* The dependent variable is the R&D investment (LogRD), measured as the natural logarithm of R&D expenditure in the pharmaceutical company (Huang and Hou, 2019; Meng *et al.*, 2020).

*3.3.2 Independent variables.*

3.3.2.1 Managerial ability. The multifaceted nature of decision-making imposes an idiosyncratic value on top managers (Hambrick, 2007), which this study captured using the managerial ability measure developed by Demerjian *et al.* (2012a). A higher (lower) value of this measure indicates that the manager is more (less) able to produce higher (lower) corporate revenues using the firm resources. Using the data envelopment analysis (DEA), a two-step approach is used to evaluate firm efficiency. The first step involves capturing the firm's efficiency within its industry in a multiple input-output setting using equation (4):

$$\text{Max}\,\theta = \frac{\text{Sales}}{\upsilon 1 COGS + \upsilon 2 SG\&A + \upsilon 3 PPE + \upsilon 4 Oplease + \upsilon 5 R\&D + \upsilon 6 Goodwill + \upsilon 7 Otherintangibles} \quad (4)$$

Sales are considered the output, whereas the cost of goods sold (COGS), selling and administrative expenses (SG&A), net property plant and equipment (PPE), net operating lease (Oplease), net R&D, purchased goodwill and other intangibles are the inputs. DEA is a quantitative approach rooted in linear programming theory. It aims to assess the effectiveness of decision-making units, typically firms, by gauging the relationship between their inputs, such as labour and capital and outputs, such as revenue and income. The DEA measure for firm efficiency, ɵ, results in a value between 0 and 1, whereby 1 refers to highly efficient and 0 as less efficient. The DEA result of the first step is attributed to both firms and managers. Thus, using equation (5), a second step is undertaken to derive the firm efficiency score attributed to managerial ability, excluding firm-specific characteristics. The measure of firm efficiency, nevertheless, is influenced by factors that are specific to the firm as well as characteristics of management. In the subsequent stage, the firm-specific traits are eliminated from the measure of firm efficiency generated by the DEA through the elimination of the impact of factors such as firm size, market share, positive free cash flow, firm age and so on:

$$\text{FirmEfficiency}_{i,t} = \alpha + \beta_1\text{TotalAssets}_{i,t} + \beta_2\text{MarketShare}_{i,t} + \beta_3\text{FreeCashIndicator}_{i,t} + \beta_4\text{LogAge}_{i,t} + \beta_5\text{BusinessSegment}_{i,t} + \beta_6\text{ForeignCurrency}_{i,t} + \beta_7\text{Year}_i + \varepsilon \quad (5)$$

The firm-specific characteristics include firm size (TotalAssets), firm market share (MarketShare), free cash flow indicator, firm age (LogAge), number of segments (BusinessSegment) and the foreign currency indicator (ForeignCurrency). A tobit regression is used for equation (5) to derive the residual managerial ability score (MAbility). The ability rankings (MARank) are created by ranking the scores in deciles by the year to increase comparability and reduce random measurement errors. MARank is used for this study's main analysis, and MAbility scores are used for the robustness check.

Overall, this multistep approach to measuring managerial ability, combining DEA and tobit regression, along with the use of MARank, strengthens the reliability and robustness of the metric, ensuring that it accurately captures the influence of managerial ability on firm efficiency whereas considering other pertinent factors.

3.3.2.2 Intellectual property rights. The Property Rights Alliance analysed data from 125 countries to propose the IPRI (Malva and Santarelli, 2015), measured as a composite of three core components: LP, PPR and IPR (Levy-Carciente, 2019). The measure uses many sources of information related to the IPR dimensions, such as enforcement and patent and copyright protection. More importantly, it combines *de jure* and *de facto* measures of IPR strength. The index ranges from 0 to 10, with 10 being the highest strength for IPR. Table 2 illustrates the variables for this study's model.

An alternative measure for IPRs was used to test the validity and add to the robustness of these results. The intellectual property rights alternative (IPR-A) was constructed using the IPP indicator from the World Economic Forum's Executive Opinion Survey. The robustness check results can be seen under Section 4.4.

## 4. Empirical results

### *4.1 Descriptive statistics*

Table 3 presents the descriptive statistics of the variables used in this study, including a split based on firm age. Based on the prior studies (Lee, 2012; Amore *et al.*, 2011), firms above the median age group were classified as mature and those below as young. The continuous variables are winsorized at the 1st and 99th percentile to deal with potential outlier problems consistent with the prior studies (Gan and Park, 2017; Yung and Nguyen, 2020; Vo *et al.*, 2021). Panel A suggests the mean value of R&D for the listed pharmaceutical companies of the Asia-Pacific developed countries is 0.398. In comparison, the mature firms have a higher average investment in R&D of 0.650 (Panel B), whereas the young firms are below the average for all firms and mature firms (0.145). The managerial ability rank (MARank) is the decile rank (by year) of the managerial ability score, which is an average of 0.548. The mean score of MARank is higher for younger firms than for mature firms. Similarly, the IPRI is higher for young firms (Panel C).

### *4.2 Correlation analysis*

Table 4 presents the Pearson pairwise correlation between all the study variables. As shown in Table 4, MARank is negatively correlated at 5 % significance. The result supports the hypothesized negative relationship between MARank and R&D investment (*H1*). IPRI significantly and positively correlates with LogRD, supporting this study's hypothesis (*H2*). The positive relationship between firm age and R&D investment supports this study's contention that there are differences between mature and young firm's R&D investments. The Pearson correlation is also useful for identifying multicollinearity issues between the

| Variable | Panel A: All firms Obs | Mean | SD | Panel B: Mature firms Obs | Mean | SD | Panel C: Young firms Obs | Mean | SD |
|---|---|---|---|---|---|---|---|---|---|
| *Dependent variable* | | | | | | | | | |
| LogRD | 2,660 | 0.398 | 0.975 | 1,329 | 0.650 | 1.106 | 1,331 | 0.145 | 0.742 |
| *Independent variables* | | | | | | | | | |
| MARank | 2,660 | 0.548 | 0.287 | 1,329 | 0.425 | 0.257 | 1,331 | 0.671 | 0.262 |
| IPRI | 2,660 | 7.109 | 1.036 | 1,329 | 6.965 | 1.038 | 1,331 | 7.253 | 1.013 |
| *Firm-specific control variables* | | | | | | | | | |
| TobinQ | 2,660 | 3.355 | 5.120 | 1,329 | 2.000 | 2.380 | 1,331 | 4.708 | 6.563 |
| Tangibility | 2,660 | 0.215 | 0.169 | 1,329 | 0.266 | 0.154 | 1,331 | 0.163 | 0.168 |
| AdvIntensity | 2,660 | 1.567 | 5.970 | 1,329 | 0.780 | 3.743 | 1,331 | 2.352 | 7.486 |
| Leverage | 2,660 | 0.162 | 0.216 | 1,329 | 0.171 | 0.182 | 1,331 | 0.153 | 0.245 |
| ROA | 2,660 | −0.146 | 0.686 | 1,329 | −0.024 | 0.508 | 1,331 | −0.267 | 0.808 |
| Age | 2,660 | 1.438 | 0.358 | 1,329 | 1.739 | 0.233 | 1,331 | 1.138 | 0.149 |
| *Country-specific control variables* | | | | | | | | | |
| GDP | 2,660 | 2.651 | 1.489 | 1,329 | 2.575 | 1.496 | 1,331 | 2.727 | 1.479 |
| Inflation | 2,660 | 1.569 | 1.211 | 1,329 | 1.395 | 1.164 | 1,331 | 1.742 | 1.233 |

**Notes:** This table presents the descriptive statistics of the dependent, independent and control variables used in this study. Refer Table 2 for variable definitions; SD = Standard deviation
**Source:** Table by authors

**Table 3.**
Descriptive statistics

| Variables | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) LogRD | 1.000 | | | | | | | | | | |
| (2) MARank | −0.631* | 1.000 | | | | | | | | | |
| (3) IPRI | 0.251* | 0.091* | 1.000 | | | | | | | | |
| (4) TobinQ | −0.082* | 0.228* | 0.127* | 1.000 | | | | | | | |
| (5) Age | 0.417* | −0.538* | −0.061* | −0.239* | 1.000 | | | | | | |
| (6) Tangibility | −0.081* | −0.269* | −0.366* | −0.182* | 0.256* | 1.000 | | | | | |
| (7) AdvIntensity | −0.040* | 0.178* | 0.148* | 0.067* | −0.153* | −0.199* | 1.000 | | | | |
| (8) Leverage | −0.125* | 0.015 | −0.143* | −0.016 | −0.014 | 0.286* | −0.032 | 1.000 | | | |
| (9) ROA | 0.127* | −0.330* | −0.172* | −0.162* | 0.219* | 0.178* | −0.171* | −0.477* | 1.000 | | |
| (10) GDP | −0.315* | 0.108* | −0.337* | −0.127* | −0.167* | 0.140* | −0.029 | 0.089* | 0.015 | 1.000 | |
| (11) Inflation | −0.287* | 0.127* | −0.039* | −0.087* | −0.224* | 0.046* | 0.068* | 0.105* | −0.091* | 0.384* | 1.000 |

**Notes:** This table shows Pearson's pairwise correlation coefficient between the dependent, independent and control variables used in this study. Statistical Significance of *$p < 0.05$. Refer to Table 2 for variable definitions
**Source:** Table by authors

**Table 4.**
Pearson pairwise correlations

explanatory variables. A correlation coefficient greater than 0.80 indicates a likelihood of multicollinearity issues (Hair *et al.*, 2006; Tabachnick *et al.*, 2007; Sewpersadh, 2019). In Table 4, none of the explanatory variables had a coefficient of 0.80 or above, indicating no multicollinearity issues between the variables.

### *4.3 Regression analysis*

Table 5 presents the fixed effect regression analysis results for managerial ability effect on the R&D of pharmaceutical firms. Panel A has an *R*-squared of 0.213, which suggests that

**Table 5.**
Regression analysis of managerial ability effect on R&D [equation (1)]

| Variables | Panel A: All firms LogRD | Panel B: Mature firms LogRD | Panel C: Young firms LogRD |
|---|---|---|---|
| MARank | −0.822*** (0.000) | −0.735*** (0.000) | −0.707*** (0.000) |
| TobinQ | −0.00174 (0.373) | 0.00516 (0.402) | −0.000985 (0.647) |
| Tangibility | 0.322*** (0.001) | 0.403** (0.008) | 0.195 (0.128) |
| AdvIntensity | 0.0000434 (0.978) | −0.00273 (0.428) | 0.000357 (0.843) |
| Leverage | −0.291*** (0.000) | −0.123 (0.311) | −0.343*** (0.000) |
| ROA | −0.0542** (0.002) | −0.0246 (0.453) | −0.0609** (0.006) |
| Age | 0.421* (0.023) | | |
| Constant | 0.139 (0.589) | 0.745*** (0.000) | 0.508*** (0.000) |
| Year effect | Yes | Yes | Yes |
| Country effect | Yes | Yes | Yes |
| N | 2,660 | 1,329 | 1,331 |
| $R$-sq | 0.213 | 0.181 | 0.226 |
| adj. $R$-sq | 0.120 | 0.062 | 0.122 |
| $F$-statistics | 40.13*** | 17.09*** | 22.81*** |

**Notes:** This table reports the fixed-effects regression results of the effect of MARank on LogRD from 2014 to 2018. The p-values are in parentheses. The statistical significance is denoted as $^{*}p < 0.05$; $^{**}p < 0.01$ and $^{***}p < 0.001$
**Source:** Table by authors

the explanatory variables can explain 21.3 % of the variability in R&D. The MARank is significantly and negatively associated with LogRD, which supports *H1*. However, *H1a* is not supported since no difference exists between the mature and young firms of the Asia-Pacific developed countries. Therefore, there is a lower investment in R&D projects because of high managerial ability in both mature and young firms, which supports (*H1*).

Table 6 presents the fixed effects regression results of managerial ability and IPRI on firm R&D in Columns 1, 3 and 5 for all mature and young firms, respectively. The results support Table 5 and *H1*. In contrast, IPRI has no significant relationships in Models 1, 3 and 5, thus no support for *H2*.

The fixed effects regression in Models 2, 4 and 6 includes the managerial ability-IPRI interaction variable. The managerial ability, IPRI and interaction variables are insignificant for all and young firms. However, for mature firms (Column 4), there is a negative association between IPRI and R&D which does not support *H2*. However, *H2a* is supported since this relationship does differ between mature and young firms. *H1* is supported by the negative association between managerial ability and R&D. The interaction variable (MARank × IPRI) positively influences R&D at 5 % significance for mature firms, thus supporting *H3* that countries with strong IPRs induce intellectual managers to spend more on R&D. The differences in findings between mature and young firms supports that there is a difference IPRI and the interaction variable (*H2a* and *H3a*).

A negative relationship is noted between leverage and R&D investment (Columns 1, 2, 5 and 6). This supports the view that R&D projects have uncertainty and are thus difficult to finance with debt. This result is consistent with earlier findings such as Alam *et al.* (2019), Lin *et al.* (2017) and Hottenrott and Peters (2012). Tangibility is significantly and positively associated with R&D for all firms and mature firms. This suggests that firms that invest more in property, plant and equipment also tend to invest in R&D, which is inconsistent with the findings of the study by Boubakri *et al.* (2021). This supports the resource-based theory where tangible assets are required in pharmaceutical firms, such as laboratories,

**Table 6.** Regression analysis of managerial ability and IPRI on R&D [equations (2) and (3)]

| Variables | All firms (1) LogRD | (2) LogRD | Mature firms (3) LogRD | (4) LogRD | Young firms (5) LogRD | (6) LogRD |
|---|---|---|---|---|---|---|
| MARank | −0.823*** (0.000) | −0.476 (0.196) | −0.729*** (0.000) | −1.852*** (0.001) | −0.710*** (0.000) | 0.340 (0.553) |
| IPRI | −0.0218 (0.286) | 0.00457 (0.893) | −0.0184 (0.514) | −0.0917* (0.040) | −0.0322 (0.281) | 0.0645 (0.282) |
| MARank × IPRI | | −0.0488 (0.333) | | 0.162* (0.034) | | −0.148 (0.063) |
| TobinQ | −0.00183 (0.349) | −0.00179 (0.361) | 0.00511 (0.407) | 0.00432 (0.483) | −0.00112 (0.603) | −0.000884 (0.681) |
| Tangibility | 0.319*** (0.001) | 0.319*** (0.001) | 0.401** (0.009) | 0.408** (0.008) | 0.191 (0.136) | 0.188 (0.142) |
| AdvIntensity | 0.0000359 (0.981) | 0.00000946 (0.995) | −0.00275 (0.425) | −0.00293 (0.394) | 0.000341 (0.850) | 0.000276 (0.878) |
| Leverage | −0.291*** (0.000) | −0.293*** (0.000) | −0.122 (0.318) | −0.124 (0.308) | −0.344*** (0.000) | −0.350*** (0.000) |
| ROA | −0.0540** (0.002) | −0.0551** (0.002) | −0.0244 (0.457) | −0.0242 (0.460) | −0.0609** (0.006) | −0.0637** (0.004) |
| Age | 0.418* (0.024) | 0.453* (0.016) | | | | |
| Constant | 0.302 (0.312) | 0.0697 (0.856) | 0.874*** (0.000) | 1.386*** (0.000) | 0.750** (0.002) | 0.0666 (0.879) |
| Year effect | Yes | Yes | Yes | Yes | Yes | Yes |
| Country effect | Yes | Yes | Yes | Yes | Yes | Yes |
| N | 2,660 | 2,660 | 1,329 | 1,329 | 1,331 | 1,331 |
| $R$-sq | 0.213 | 0.213 | 0.181 | 0.184 | 0.227 | 0.229 |
| adj. $R$-sq | 0.120 | 0.120 | 0.062 | 0.065 | 0.122 | 0.124 |
| $F$-statistics | 37.84*** | 35.79*** | 16.04*** | 15.40*** | 21.46*** | 20.45*** |

**Notes:** This table presents the 2SLS/IV results of MARank, IPRI, the interaction between MARank and IPRI and control variables on LogRD from 2011 to 2020. Year dummies are not reported for brevity. P-values are reported in parentheses. The statistical significance is denoted as $*p < 0.05$; $**p < 0.01$ and $***p < 0.001$, respectively. Refer Table 2 for variable definitions
**Source:** Table by authors

facilities and other scientific equipment, to create intangible assets that remain viable and relevant in the market.

*4.4 Validity testing and robustness checks*

*4.4.1 Different proxy for intellectual property rights alternative.* The results of this study have indicated that managerial ability and IPRI significantly influence R&D expenditure. However, an alternative argument might suggest that high R&D expenses are more likely to have intellectual managers and strong IPRI. It is also possible that though the models investigated have used many control variables, there might still be problems with omitted variables, measurement errors and simultaneity. To address these issues, this study conducted a two-stage least squares (2SLS) regression to investigate the managerial ability and IPRs' influence on R&D expenditure. Table 7 presents the 2SLS estimation results for the first and second stages. Institutional quality (IQ) is used as an instrument variable for IPRs. Institutional quality is an average score of six World Governance Indicators: the rule of law, regulatory quality, governance effectiveness, political stability, voice and accountability and control of corruption (Kaufmann *et al.*, 2009). IPRI is derived from three measures that include governance indicators. Thus, this variable is replaced with an alternative estimate, IPR-A, collected from the Global Competitiveness Index Historical Data set. The IPRs protection is based on the World Economic Forum's Executive Opinion Survey, which rates the questions on a seven-point scale. A higher value denotes better IP protection in a country.

IQ as an instrument variable is significant and positively associated with the first-stage regression, thus confirming its validity. All three panels support *H1* and *H1a*, where managerial ability is negatively associated with R&D expenditure, demonstrating the robustness of the above results. IPR's protection (IPR-A) positively influences R&D (supporting *H2*) across all the models (*H2a* not supported). The interaction variable is negative and significantly associated with R&D (*H3* not supported) for all and mature firms only (*H3a* not supported). R&D expenses increase in firms with low leverage and tangibility and during a period of low inflation.

*4.4.2 Endogeneity problem: two-stage least squares.* This study examines R&D as the effect IPR and managerial ability as the cause. However, there is a possibility that R&D is the driver of IPR and managerial ability. Therefore, as part of the robustness testing, the Granger causality test is used to investigate the causality linkages to the study's variables. The Granger causality test is used in multiple studies associated with R&D (Lee, 2012; Huang and Hou, 2019), IPR (Li and Yu, 2015) and managerial ability (Lee *et al.*, 2018; Naheed *et al.*, 2021b, 2021a). The results of the Granger causality are shown in Table 8. The results indicate IPRI and LogRD affect each other; MRank and LogRD do not affect each other; the alternative measure of IPRs, IRP-A, affects the alternative measure of R&D investment (RDIntensity) but not vice versa; and the alternative measure of MAbility and RDIntensity do not affect each other. Thus, the findings suggest IPR will cause R&D investment and depending on the measure of IPR and R&D, a high R&D can lead to better IPR. This evidence also reports that managerial ability does not cause R&D. Thus, there is no support for hiring superior managers for more R&D investment.

*4.4.3 Endogeneity problem: two-stage least squares.* To address the reverse causation in IPRs and R&D, the 2SLS test is used in Table 9. Using alternative measures (RDIntensity [4]), this study examines the influence of managerial ability and IPRs on R&D. IQ is used as the instrument variable, and the first stage results for Panels A, B and C confirm that it is positively significant. IPR-A has a substantial and negative influence on RDIntensity of all firms (Columns 2 and 3), specifically young pharmaceutical firms (Columns 8 and 9). This

**Table 7.** Two-stage least squares regression results of managerial ability (MARank) and IPRI effect on R&D (LogRD)

| | Panel A: All firms | | | Panel B: Mature Firms | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| | IPR-A | LogRD | LogRD | IPR-A | LogRD |
| Variables | First stage | Second stage | | First stage | Second stage |
| IQ | 0.0786*** (0.000) | | | 0.0864*** (0.000) | |
| MARank | | −2.155*** (0.000) | 1.006 (0.080) | | −2.819*** (0.000) |
| IPR-A | | 0.298*** (0.000) | 0.643*** (0.000) | | 0.396*** (0.000) |
| MARank × IPR-A | | | −0.604*** (0.000) | | |
| TobinQ | −0.00213 (0.096) | −0.000629 (0.807) | 0.000918 (0.724) | −0.0122*** (0.000) | 0.0418*** (0.000) |
| Tangibility | −0.143** (0.001) | −0.786*** (0.000) | −0.773*** (0.000) | −0.166** (0.006) | −0.647*** (0.000) |
| AdvIntensity | −0.00264* (0.014) | 0.00333 (0.121) | 0.00384 (0.076) | −0.00399 (0.073) | 0.00568 (0.261) |
| Leverage | 0.102** (0.005) | −0.239** (0.001) | −0.300*** (0.000) | 0.204*** (0.000) | −0.435*** (0.000) |
| ROA | 0.0491*** (0.000) | −0.104*** (0.000) | −0.132*** (0.000) | 0.0943*** (0.000) | −0.155*** (0.000) |
| Age | 0.103*** (0.000) | 0.244*** (0.000) | 0.227*** (0.000) | | |
| GDP | −0.0414*** (0.000) | −0.0636*** (0.000) | −0.0450** (0.002) | −0.0816*** (0.000) | −0.0383 (0.142) |
| Inflation | 0.0154* (0.019) | −0.109*** (0.000) | −0.108*** (0.000) | 0.0677*** (0.000) | −0.138*** (0.000) |
| Constant | −0.745*** (0.000) | 0.218 (0.280) | −1.663*** (0.000) | −0.948*** (0.000) | 0.168 (0.622) |
| Year effects | Yes | Yes | Yes | Yes | Yes |
| Country effect | Yes | Yes | Yes | Yes | Yes |
| N | 2,660 | 2,660 | 2,660 | 1,329 | 1,329 |
| *R*-sq | 0.826 | 0.578 | 0.571 | 0.862 | 0.658 |
| Adj. *R*-sq | 0.825 | 0.575 | 0.568 | 0.860 | 0.654 |
| F/Wald $Chi^2$ | 698.9*** | 3,665.30*** | 3,609.23*** | 482.0*** | 2,614.31*** |

**Notes:** This table presents the 2SLS/IV results of MARank, IPR-A, the interaction between MARank and IPR-A, and control variables on LogRD for 2011 to 2020. Year and country dummies are not reported for brevity. *P*-values are reported in parentheses. The statistical significance is denoted as $*p < 0.05$; $**p < 0.01$ and $***p < 0.001$, respectively
**Source:** Table by authors

(*continued*)

| | Panel B: Mature Firms | | Panel C: Young Firms | |
|---|---|---|---|---|
| | (6) | (7) | (8) | (9) |
| | LogRD | IPR-A | LogRD | LogRD |
| Variables | Second stage | First stage | Second stage | |
| IQ | | 0.0731*** (0.000) | | |
| MARank | 0.820 (0.308) | | −1.630*** (0.000) | 0.262 (0.809) |
| IPR-A | 0.748*** (0.000) | | 0.158*** (0.000) | 0.398** (0.010) |
| MARank × IPR-A | −0.706*** (0.000) | | | −0.361 (0.080) |
| TobinQ | 0.0427*** (0.000) | −0.00174 (0.225) | −0.00519* (0.041) | −0.00438 (0.088) |
| Tangibility | −0.635*** (0.000) | −0.0896 (0.149) | −0.651*** (0.000) | −0.651*** (0.000) |
| AdvIntensity | 0.00819 (0.113) | −0.00224 (0.070) | 0.00217 (0.318) | 0.00222 (0.309) |
| Leverage | −0.453*** (0.000) | 0.00980 (0.837) | −0.206* (0.015) | −0.237** (0.005) |
| ROA | −0.192*** (0.000) | 0.0240 (0.094) | −0.0707** (0.007) | −0.0825** (0.002) |
| Age | | | | |
| GDP | −0.00605 (0.834) | −0.0179* (0.032) | −0.0650*** (0.000) | −0.0579*** (0.000) |
| Inflation | −0.125*** (0.000) | −0.00690 (0.462) | −0.0497** (0.003) | −0.0560** (0.001) |
| Constant | −1.874** (0.003) | −0.346** (0.007) | 0.806*** (0.000) | −0.470 (0.575) |
| Year effects | Yes | Yes | Yes | Yes |
| Country effect | Yes | Yes | Yes | Yes |
| N | 1,329 | 1,331 | 1,331 | 1,331 |
| *R*-sq | 0.644 | 0.804 | 0.395 | 0.395 |
| Adj. *R*-sq | 0.639 | 0.802 | 0.387 | 0.387 |
| F/Wald $Chi^2$ | 2,512.39*** | 317.6*** | 863.51*** | 864.01*** |

**Table 7.**

| Null hypothesis | *F*-statistics/Probability | Inference of causality |
|---|---|---|
| IPRI does not Granger-cause LogRD | 24.550** | Bidirectional |
| LogRD does not Granger-cause IPRI | 16.903** | |
| MRank does not Granger-cause LogRD | 0.057 | No direction |
| LogRD does not Granger-cause MRank | 0.038 | |
| IPR-A does not Granger-cause RDIntensity | 5.699*** | One direction |
| RDIntensity does not Granger-cause IPR-A | 2.334 | |
| MAbility does not Granger-cause RDIntensity | 16.765 | No direction |
| RDIntensity does not Granger-cause MAbility | 57.600 | |

**Notes:** The statistical significance is denoted as $^{**}p < 0.01$ and $^{***}p < 0.001$, respectively. Refer Table 2 for variable definitions
**Source:** Table by authors

**Table 8.**
Granger causality

result is, however, inconsistent with those reported in Table 6. Mability is negatively associated with the RDIntensity of young firms, supporting the results reported in Table 6. The interaction variable of Mability × IPR-A positively impacts the R&D of all firms (Column 3) and young firms (Column 9), thus suggesting that capable managers operating in a strong IPR environment would undertake more R&D.

## 5. Results discussion

This study sheds light on the intricate dynamics between managerial ability, IPRs and R&D activities within pharmaceutical firms. Whereas the findings confirmed the negative relationship between managerial ability and R&D investments, these results also prompt further questions about how individual-level factors intersect with broader innovation processes. Pharmaceutical managers with superior insights may opt for few large-scale R&D projects or more low-cost R&D projects to manage risks and preserve capital. This would allow intellectual managers to use capital funds to optimize operations and processes. Decreases in R&D investments may also be from intellectual managers following a highly selective process that differentiates value-eroding investments from value-creating ones, leading to fewer R&D investments. Therefore, there is support for the contention that intellectual managers selectively invest in fewer high-performing R&D investments in mature and young pharmaceutical firms. This finding was also supported by the Granger causality test, where there was no support for hiring intellectual managers to increase the R&D investment intensity. Whereas firms with lower managerial abilities may want to signal their worth to the market by investing more intensively in R&D since these managers wish to gain reputational capital.

A key finding of this study was the importance of including the firm's life stages since there was support for *H2a*, where there were different R&D strategies in young and mature firms. This study showed that stronger IPRs may increase the R&D of young firms wanting to enter the patent-driven model (*H2a*). Without the protection of IPRs, rival companies could unhinderedly benefit from replicating R&D at the cost of the innovator, which is particularly detrimental for young firms wanting to create a market reputation and sustainability. Stronger IPRs led to young firms having higher R&D investments than mature firms. Because of their established operations and commercialized assets, mature pharmaceutical firms are already familiar with IPRs. The study results show that the strength of IPRs may not increase the R&D of established firms since they already have a

**Table 9.** Two-stage least squares regression results of managerial ability (MAbility) and IPR-A effect on R&D (RDIntensity)

| Variables | Panel A: All firms<br>(1)<br>IPR-A<br>First stage | (2)<br>RDIntensity<br>Second stage | (3)<br>RDIntensity | Panel B: Mature firms<br>(4)<br>IPR-A<br>First stage | (5)<br>RDIntensity<br>Second stage |
|---|---|---|---|---|---|
| IQ | 0.0786*** (0.000) | | | 0.0864*** (0.000) | |
| MAbility | | −0.773 (0.594) | −3.678 (0.056) | | −0.674 (0.626) |
| IPR-A | | −0.687* (0.014) | −1.406** (0.003) | | −0.200 (0.518) |
| MAbility × IPR-A | | | 0.531* (0.019) | | |
| TobinQ | −0.00213 (0.096) | 0.0198 (0.496) | 0.0171 (0.556) | −0.0122*** (0.000) | 0.260*** (0.000) |
| Tangibility | −0.143** (0.001) | 0.340 (0.736) | 0.495 (0.623) | −0.166** (0.006) | 0.346 (0.743) |
| AdvIntensity | −0.00264* (0.014) | 1.189*** (0.000) | 1.188*** (0.000) | −0.00399 (0.073) | 1.743*** (0.000) |
| Leverage | 0.102** (0.005) | −2.724*** (0.001) | −2.777*** (0.001) | 0.204*** (0.000) | 0.159 (0.866) |
| ROA | 0.0491*** (0.000) | −1.166*** (0.000) | −1.181*** (0.000) | 0.0943*** (0.000) | 0.972** (0.005) |
| Age | 0.103*** (0.000) | 0.157 (0.748) | 0.0991 (0.839) | | |
| GDP | −0.0414*** (0.000) | −0.321* (0.036) | −0.300* (0.049) | −0.0816*** (0.000) | −0.0876 (0.662) |
| Inflation | 0.0154* (0.019) | −0.0394 (0.791) | −0.0941 (0.529) | 0.0677*** (0.000) | −0.130 (0.418) |
| Constant | −0.745*** (0.000) | 5.810* (0.019) | 9.824** (0.004) | −0.948*** (0.000) | 1.219 (0.649) |
| Year effect | Yes | Yes | Yes | Yes | Yes |
| Country effect | Yes | Yes | Yes | Yes | Yes |
| N | 2,660 | 2,660 | 2,660 | 1,329 | 1,329 |
| *R*-sq | 0.826 | 0.508 | 0.507 | 0.862 | 0.633 |
| adj. *R*-sq | 0.825 | 0.504 | 0.503 | 0.860 | 0.628 |
| F/Wald Chi$^2$ | 698.9*** | 2,749.19*** | 2,749.66*** | 482.0*** | 2,295.47*** |

**Notes:** This table presents the 2SLS/IV results of MAbility, IPR-A, the interaction between MAbility and IPR-A, and control variables on RDIntensity for 2011 to 2020. Year dummies are not reported for brevity. *P*-values are reported in parentheses. The statistical significance is denoted as $*p < 0.05$, $**p < 0.01$ and $***p < 0.001$, respectively. Refer Table 2 for variable definitions
**Source:** Table by authors

*(continued)*

**Table 9.**

| Variables | Panel B: Mature firms (6) RDIntensity Second stage | Panel C: Young firms (7) IPR-A First stage | (8) RDIntensity Second stage | (9) RDIntensity Second stage |
|---|---|---|---|---|
| IQ | | 0.0731*** (0.000) | | |
| MAbility | −1.161 (0.514) | | −2.551 (0.288) | −7.397* (0.025) |
| IPR-A | −0.325 (0.492) | | −1.120* (0.015) | −2.293** (0.007) |
| MAbility × IPR-A | 0.0930 (0.655) | | | 0.860* (0.038) |
| TobinQ | 0.259*** (0.000) | −0.00174 (0.225) | −0.0232 (0.533) | −0.0262 (0.482) |
| Tangibility | 0.376 (0.721) | −0.0896 (0.149) | 0.537 (0.742) | 0.698 (0.668) |
| AdvIntensity | 1.742*** (0.000) | −0.00224 (0.070) | 1.057*** (0.000) | 1.057*** (0.000) |
| Leverage | 0.150 (0.873) | 0.00980 (0.837) | −3.738** (0.003) | −3.815** (0.002) |
| ROA | 0.968** (0.005) | 0.0240 (0.094) | −1.983*** (0.000) | −2.009*** (0.000) |
| Age | | | | |
| GDP | −0.0780 (0.693) | −0.0179* (0.032) | −0.483* (0.027) | −0.473* (0.030) |
| Inflation | −0.145 (0.369) | −0.00690 (0.462) | −0.0940 (0.699) | −0.151 (0.532) |
| Constant | 1.858 (0.580) | −0.346** (0.007) | 10.68** (0.002) | 17.32** (0.001) |
| Year effect | Yes | Yes | Yes | Yes |
| Country effect | Yes | Yes | Yes | Yes |
| N | 1,329 | 1,331 | 1,331 | 1,331 |
| *R*-sq | 0.633 | 0.804 | 0.490 | 0.489 |
| adj. *R*-sq | 0.628 | 0.802 | 0.483 | 0.482 |
| F/Wald $Chi^2$ | 2,295.43*** | 317.6*** | 1,287.8*** | 1,286.87*** |

patent-driven business model. These findings were consistent with the results of the Granger causality test, where IPR may cause R&D investment.

The results support the hypotheses (*H3* and *H3a*) where the interaction between higher managerial abilities and high IPRI positively correlates with R&D. Intellectual managers strategically invest in optimizing the patent-driven model under conditions of high IPRI. Under strong IPRI environments, the patent-driven model protects risk-conscious intellectual managers from accepting time-consuming, costly and risky R&D to create more commercializable assets.

## 6. Theoretical preposition

The incorporation of the concept of managerial reputation in this study significantly enhances the theoretical framework, shedding light on reputation as a pivotal resource shaping managerial decision-making, resource allocation and innovation strategies within organizations.

The upper echelons theory (Hambrick and Mason, 1984) posits that top executives' experiences, values and cognitive characteristics influence organizational outcomes, emphasizing the role of reputation in shaping managerial decisions over the short to long term. The RBV (Barney, 1991) underscores the active pursuit of valuable, rare, inimitable and non-substitutable resources for reputational gain over the long term. The behavioural theory (Cyert and March, 1963; Greve, 2003) suggests that managers, motivated by the desire to enhance and protect their reputation, strategically engage in problemistic search to address operational challenges or deficiencies, especially in resource-abundant environments where slack search for innovative ideas becomes prominent.

Incorporating stakeholder theory (Jensen, 2001; Sewpersadh, 2019), which advocates for considering all stakeholder interests, motivates managers to either appease stakeholders over the short term or strategically invest in innovation to signal commitment to stakeholders over the long term.

The study's innovative contribution lies in its revelation of how managerial motivations, intertwined with their reputation, impact organizational outcomes. By expanding the narrative surrounding managerial considerations, the reputation concept is distinguished into short- and long-term in line with their decision-making.

Reputational currency and reputational capital play crucial roles in understanding how reputation contributes to organizational success, with reputational currency being a dynamic component and reputational capital representing cumulative value. At times, management may invest in short-term strategies to gain reputational currency at the expense of their long-term reputational capital. Therefore, reputational capital is strategic and influences the organization's long-term sustainability and competitive advantage.

## 7. Conclusion

Using a sample of 2,660 firm-year observations of Asia-Pacific developed countries' pharmaceutical companies, the results show that low (high) levels of managerial ability increase (decrease) R&D expenditures, lending support to agency theory. Generally, innovation through R&D is essential for sustaining the strategic competitive advantage of firms. However, because the patent-driven model in the pharmaceutical industry, intellectual managers may reduce R&D intensity if it has a low probability of generating "commercializable" assets because being risk-conscious and strategic with their capital funding (*H1*).

This study found that countries with strong IPRs can induce intellectual managers to make more R&D expenditures in mature firms. The results show young firms with low debt levels have higher R&D expenditures. The study also uses Granger causality that suggests a vice-versa impact of IPR on R&D, whereas managerial ability has no implications on R&D or vice versa. This study used 2SLS and alternative dependent and independent variables measures to address endogeneity concerns. The results showed that the alternative measure for R&D has a negative impact on the managerial ability of young firms, lending support to the ordinary least square results.

This study has several implications. Firstly, the governing board needs to use intellectual managers for better R&D investment decision-making. This would support curbing agency problems and reducing the information asymmetry between managers and shareholders. For increased R&D investments, intellectual managers are required because of the sophistication of the R&D protocol process and the patentability of the R&D. Secondly, the management can focus on maintaining lower debt levels in its capital structure to encourage more R&D expenditure. Thirdly, the government needs to inculcate confidence in pharmaceutical companies by strengthening IPR protection and providing a conducive regulatory environment. They can also increase their grants or R&D incentives to ensure firms remain at low debt levels and have higher R&D investments. Finally, mature firms have better insight and can divert R&D expenditures even with low IPP.

This research adopted the managerial ability measurement advocated by Demerjian *et al.* (2012a). Whereas this measure has been extensively used in prior studies, the possibility of idiosyncratic abnormal performance cannot be completely ruled out. Thus, it is recommended that future studies consider alternative measures of managerial ability. Furthermore, it is recommended that the same model of this study be extended to other industries. This study considered the country-level institutional quality governance factor as an instrument but not the primary model. Future research can consider country and firm-level governance factors for exploring their influence on R&D investment.

## 8. Future research agenda

Stemming from this study's theoretical proposition, a proposed research agenda delves into key areas that merit exploration to enrich the theoretical framework surrounding managerial reputation. Understanding the multifaceted role of managerial reputation in shaping organizational decision-making, resource allocation and innovation strategies is a complex task.

### *8.1 Dynamic analysis of reputational currency and capital*

Future research aims to dissect the temporal dimension of managerial reputation. How does reputational currency evolve over time, and how is it dynamically linked with the enduring value of reputational capital? This discussion will explore factors contributing to the transition from short-term gains to long-term cumulative value in the realm of managerial reputation.

### *8.2 Short-term vs long-term decision-making*

Future research should conduct a critical examination of the trade-offs involved in managerial decisions focused on short-term strategies (reputational currency) versus those contributing to long-term sustainability and competitive advantage (reputational capital). Studies should delve into the impact of managerial actions on organizational outcomes over varying time horizons.

### *8.3 Managerial motivations and decision-making processes*

Unravelling the motivations that propel managerial decisions concerning reputational currency and capital. Studies should analyse the cognitive processes influencing decision-making under the sway of reputational considerations, providing insights into the drivers behind strategic choices.

*8.4 Stakeholder dynamics and reputation*
Studies should explore how diverse stakeholder groups perceive and respond to reputational currency and capital. Research is required to probe strategies aligning short-term reputation-building actions with the cultivation of long-term stakeholder relationships, offering a nuanced understanding of the interconnectedness.

*8.5 Cross-industry comparative analysis*
Studies should aim to conduct comparative analyses across different industries to identify sector-specific nuances in the interplay between managerial reputation and organizational outcomes. By exploring distinct industry characteristics, future research should seek to understand how strategic priorities related to reputational currency and capital differ.

*8.6 Integrating technological and social trends*
How do emerging technologies influence the dynamics of reputational currency and capital? This research should explore the impact of social media and digital platforms on contemporary managerial reputation in the business landscape, providing insights into the evolving landscape.

*8.7 Managerial reputation in crisis situations*
Analysing the functioning of managerial reputation during organizational crises. This research should explore effective strategies for rebuilding reputational capital following instances of reputational damage, shedding light on the role of reputation in crisis management.

*8.8 Quantitative metrics for reputational assessment*
Developing and evaluating quantitative metrics for systematically assessing reputational currency and capital. Future research should assess the reliability and validity of these metrics across diverse organizational contexts, offering a methodological perspective on reputation measurement.

*8.9 Influence of organizational culture*
Future research should investigate how organizational culture shapes the emphasis on either reputational currency or capital. Studies should analyse the role of cultural factors in guiding managerial decision-making related to reputation, providing insights into the cultural dynamics at play.

*8.10 Global perspectives on managerial reputation*
Future research explores cross-cultural variations in the perceived importance of reputational currency and capital. Investigating how global contexts shape managerial strategies for effective reputation management, studies should aim to uncover cultural influences on reputation dynamics.

**Notes**

1. Reputational currency is gained through trust, credibility and positive perceptions due to astute decision-making and value-creating actions.
2. Reputational capital is a broader and more enduring concept, representing the long-term accrual of management's ethical behaviour, corporate social responsibility and other value-creating actions over time.

3. PPR refers to the contractual protection of an organization's private property, as well as a country's ease of access to loans and the registration of property (Levy-Carciente, 2019).
4. R&D intensity is measured as the ratio of R&D expenses to total revenue.
5. Australia (490), Hong Kong (160), Japan (670), Korea (1290), New Zealand (30) and Singapore (20) observations.

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