

FINANCIAL SOURCES AND FIRMS' INNOVATION OUTPUTS: ANALYSIS OF JASDAQ MARKET

Norliza Che-Yahya*

Faculty of Business and Management, Universiti Teknologi MARA (UiTM), Puncak Alam, Graduate School of Innovation and Technology Management, Yamaguchi University,

Yoshiyuki Matsuura

Graduate School of Innovation and Technology Management, Yamaguchi University,

Le Thuy Ngoc An

Graduate School of Sciences and Technology for Innovation, Yamaguchi University,

Nurhayati Md Issa

Graduate School of Sciences and Technology for Innovation, Yamaguchi University

ABSTRACT

The consensus that innovation is an essential strategy for firms, which aim to competitively survive over the long term, motivates growing literature to understand the drivers of firms' innovation outputs. It is widely acknowledged that access to financial sources is fundamentally important for the survival of innovative firms. The lack of financial support may prevent the firms from entirely pursuing innovation activity and producing innovative outputs. However, this is rarely addressed in the finance literature. Focusing on both types of financing sources (internal and external), this study investigates their influence on firms' innovation outputs. Leveraging on the spirit in Pecking Order Theory, this study proposes that firms adopt a hierarchy between types of financing from internal or self-financing to external, starting from low risk to risky debts and followed by the issuance of shares on their efforts in financing innovation and producing the outputs. Poisson regression results, using a sample of 113 manufacturing firms listed in JASDAQ market of the Tokyo Stock Exchange, revealed that both financing sources (internal and external) are important in driving volume and value of firms' innovation outputs. However, the reliance of firms on self-generated financing conquers. This study, using patent-based data (application, publication, citation) to estimate firms' technology outputs, also finds the complementary power of debt financing as an important financial source, particularly when firms' internal financing source has exhausted. The findings of this study offer support to the assertion in the Pecking Order Theory concerning the risk inherited in the different financing sources.

Keywords: Financial Structure, Financial Sources, Innovation Outputs, JASDAQ Market.

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*Corresponding author: Faculty of Business and Management, Universiti Teknologi Mara (UiTM), Puncak Alam Campus, 42300 Selangor, Malaysia. Tel: +603-32587077; Email: norliza9911@uitm.edu.my

1. INTRODUCTION

Financial structure is a composition of the external financing source (debt and equity) which a firm adopts to capitalize operations and investments (financing innovation). Early work of Modigliani and Miller (1958) suggested an arbitration between tax advantage on debts and bankruptcy costs (trade-off theory) for firms to decide optimum mixture of debt and equity. Firms, given a certain level of tolerance on bankruptcy costs, rely more on debts to benefit from tax deduction. Firms use more equities when their shares are overvalued to sell the shares at premium. Regardless, trade-off theory prioritizes the external financing sources into a firm's financial structure. The presence of agency cost derived from information asymmetry shifted firm's preferred financing approach from external to internal sources.

Following Pecking Order Theory, managers practise hierarchy between types of financing from internal or self-financing to external starting from low risk to risky debts to shares in financing investment and projects (Myers, 1984). Free cash flows and retained earnings usually are the primary internal sources, while, loans and the issuance of shares as external sources. One important conclusion of this theory is that the external sources are required only if the amount of internally-generated funds are exhausted. In that case, firms prefer debt financing assumed to be less risky and followed by equity as their last financing option (Bharath et al., 2009).

In practice, financial sources for innovation activities are suggested to favour the spirit in Pecking Order Theory, while the process of producing innovation outputs is inherently uncertain. Kerr and Nanda (2014) posited that uncertainty in innovation is crucially different from other risky activities. Not only the probabilities associated with innovation success are difficult to estimate, but the forms of financial source for innovation outputs also vary. From managers' perspective, outputs of financing innovation are difficult to evaluate, particularly since often, the only way to understand is to invest in it. Therefore, in a market dominated by asymmetric information, bankruptcy risks and agency conflict, preferring external sources for financing innovation are costly and risky (Bartoloni, 2013). Firms with high internally-supported sources are more likely to produce more innovation outputs.

Second, the challenge of financing long term-based projects, such as innovation is compounded by one-sided investment's objective. Firms may not fulfil the short-term profit-goal of equity investors. Innovation by nature takes several years to actually realize outputs and financial returns, basically not preferred by equity investors. Next, loans from banks assist firms to finance innovation through the continuous supply of funds without disposing part of firms' ownership to outsiders (Rajan & Zingales, 2003; Spielkamp & Rammer, 2009). Therefore, due to the uncertainty, short-term returns realization and the issue on disposition of shares ownership issues, financing innovation by equity requires acute consideration.

After decades and considerable number of researches offered in understanding structure of a firm's financing sources, recently the attention has shifted to an equally important issue, that is, how a firm's financial structure can influence its competitive strategies and sustainable development (through innovation outputs) (Chibani et al, 2019; Mignon, 2009). Matsuno (2018) postulated that innovation output is not a mere discovery or inventions, but a series of corporate activities that will create effective economic effects for business activities (to increase in sales, operating profit, productivity, current assets, fixed assets, total assets, net profits). Thus, the significance of financial

sources on firms' innovation outputs should explain their sustainable development. Understanding how financial sources and its composition can explain firms' innovation outputs and sustainable development is not only crucial for firms, but also to policy implementation. It offers opinion on how to stimulate technological progress with sufficient innovation-friendly infrastructures one country should have to support firms' innovation outputs (Khan et al., 2018). This leads researchers into the area of innovation to a question as to which financial sources firms can engage in to enable them offering sustainable financial development through innovation outputs, given a specific financial structure.

In spite of the significance of innovation outputs to firms' financial performance and sustainable development, financing innovation activities are often challenging primarily because of the firms' financial constraints (Acharya & Xu, 2017). This postulation is particularly applicable to young and small firms as their lack of a record of accomplishment and physical collateral shuts the door to common financing sources, such as loans from banks and public equity. It results in the firms to impose substantial financial constraints on their investment scope, thus preventing them from fully pursuing innovation activities and producing outputs (He & Tian, 2018). From the perspective of listed firms, young and fast-growing firms in junior markets of a stock exchange are expected to stimulate innovation activities (Bos & Stam 2014; Colombelli et al. 2014). However, the constraint in the financial sources usually experienced by these firms may stop the production of innovation outputs.

Following the markets' less stringent listing requirements than established stock exchanges; listed firms in junior stock markets are seen to account for a large proportion of young and fast-growing firms in countries, such as Japan and the United Kingdom (Granier et al. 2019). Firms listed in these markets tend to have the potential to grow through successful innovation activities and often have higher need for financing to invest in research and development (R&D) (Lee et al. 2015; Cowling et al. 2020). To compensate for their lack of internal financing for R&D, many firms seek external financing (Mina et al. 2013). However, despite growth potential, young and innovative firms often face difficulties in acquiring external financing (Czarnitzki & Hottenrott 2011). It is plausible that young and innovative firms tend to have high uncertainty of their business outcomes. Owing to this high risk, external suppliers of capital, such as banks and investors, are hesitant to provide funds to young and innovative firms. As such, these firms tend to have more reliance on their internally-supported sources, consistent to the spirit in Pecking Order Theory. Thus, managers' ability in determining an appropriate mixture of a firm's financing sources (internal and/or external sources) given the constraint and how the financial sources explain firms' innovation outputs are essentially important. Therefore, the situation has become the aim of this study to provide answer to

The statistical and empirical specifications of this study take innovation outputs as dependent variable. The upside of using this specification is it allows this study to examine association between different type of financing sources and innovation outputs, simultaneously. Notifying that, this is in line to the objective of this study as it does not attempt to examine causal effect of different type of financing sources and structure as well as innovation outputs. Insomuch, the aim of this study is straightforward, that is whether there is evidence that innovation outputs are influenced by different type of financing sources and structure.

The main contribution of this study to the current body of literature stems from two aspects. First, the empirical evidence on the influence of financial sources and structure on innovation outputs have largely ignored the potential interrelation within financial sources of a firm. Past studies focused mostly on the influence of financial sources from the external financing aspect (debt versus equity). The inclusion of internal source (free cash flows) in the examination is pertinent to understand the influence of risk inherited in different types of financial sources to innovation outputs. Second, this study focuses on smaller and start-up firms perceived to have strong incentive to unceasingly engage in producing innovation outputs. In spite of the claim that large, established and multinational firms due to their strong financial supports usually dominate innovation (Ughetto, 2008); innovation in reality is dominated by smaller and start-up firms, such as firms in JASDAQ market, a junior market for public listed firms with certain sizes in Tokyo Stock Exchange (TSE). JASDAQ is a market characterized by the three concepts of (1) reliability, (2) innovativeness as well as (3) region and internationalization. JASDAQ is for growth firms with a certain size and business performance. Comparing JASDAQ market and other markets in TSE; Main market and Mothers, JASDAQ market requires smallest market capitalization to qualify private firms for listing in the TSE. Additionally, JASDAQ market allows listing of private firms without any consecutive years of conducting business (TSE, 2020), which denotes the eligibility of young and start-up firms to participate as publicly-owned entities in the TSE.

Junior stock market, such as JASDAQ accounts for large proportion of young and fast-growing firms. Considering potential complexity for young and start-up firms in acquiring and deciding appropriate financial sources and structure for financing innovation as well as the unique characteristics of firms in JASDAQ itself, a study on how financial sources and its composition can explain firms' innovation outputs that skewed its sample to this market is considered important. The use of firms in JASDAQ is also consistent to the spirit of Pecking Order Theory, given certain difficulties in the acquisition of financing sources due to the nature of firms in this junior market. The employment of firms publicly listed in the TSE as sample is also due to the global recognition of Japan as a dynamic innovation hub and a country that grows in a sound innovation environment. This can be referred to the high number of R&D activities and innovation outputs with high universal validity the country has produced.

The rest of this paper is designed as follows. Section 2 reviews relevant literature. This is followed by Section 3 which describes methodology used in this study. Section 4 discusses the empirical results, while Section 5 presents conclusions drawn from the findings.

2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

2.1. *Patent-based Data as An Innovation Indicator*

While innovation is considered the engine of economic growth, measuring innovation is not easy. Measuring innovation is subjective and difficult to offer an overall view in a continuous manner. R&D expenditure is frequently employed to proxy innovation or technological progress. However, expenditure is an input for R&D rather than an output of R&D, which is innovation. Another proxy is total factor productivity (TFP) which is influenced by factors other than innovation, and it has its own measurement problems, such as its procyclicality and difficulty in obtaining a good price index, particularly for goods with fast quality change or services (Nagaoka et al., 2010). As such,

in this study, it resorts to patent-based data as the indicators for innovation output, similarly proposed in Dang and Motohashi (2015).

Various studies have attempted to evaluate patent-based data as indicator of technological change and innovation output (Kleinknecht et al., 2002; Jaffe & Trajtenberg, 2005; Hall et al., 2005; Katila, 2000; Afuah, 2014; He & Tian, 2017; Igami & Subrahmanyam, 2019). Each patent covers a wide information in terms of fields and types of inventors for the insensitive activity all around the world. Highly elaborated information on the innovation itself, the technological area to which it belongs, the inventor, the geographical location and the assignee is presented in any single patent (Hall et al., 2005). Moreover, innovation output measured by patent data may constrain the information asymmetry in view of the fact that patents are governed and protected by law, making the market more transparent. Patent also discloses all “prior art” of firms’ innovation activities (Afuah, 2014). Patent encompasses the success of all (both observable and unobservable) innovation inputs (financial supports, talent allocation, distribution of effort to innovative projects and internal incentive schemes), especially non-monetary ones such as public acknowledgement (He & Tian, 2017), preferring patent as appropriate proxy for innovation outputs (Katila, 2000). Furthermore, patent enables one to analyse not only quantity of innovation’s outputs, but also quality and fundamental attributes, estimated by citations, generality, originality, and their relevance to firms’ core businesses. Kleinknecht et al. (2002) highlighted the use of patent data as an (intermediate) output measure of innovation. Patent records offer the most comprehensive and detailed overview of technical knowledge over long time periods. Adam Jaffe pointed out that patent is readily available, including on the Internet, contains considerable details and can be used to develop time series comparison (Jaffe & Trajtenberg, 2005).

In actual definition, patent has been the only indicator containing magnificent information on new technology and its information is screened systematically by considerable resources over a long-time frame. Nagaoka et al. (2010) posited two decisive factors in increasingly using patents as innovation indicator. First, patent database has been developed and improved time after time by National Bureau of Economic Research (NBER), European Patent Office (EPO) and Japan Institute of Intellectual Property (IPP). Since other indicators are abstract, time-consuming and not statistic-friendly by their nature of size, patent data is a superior measurement for innovation. As a common practice, firms monitor the technological change and patenting activities of other firms using patent data and information generated by patent offices. Second, firms effortlessly access patent database and conduct sophisticated statistical analysis with the help of high- quality technology and software. It has never been easier than ever to utilize patent data for evaluating technological innovation.

Recent evidence suggested that patents and their refinement are the prominent innovation predictors (Igami & Subrahmanyam, 2019). The researchers assessed the usefulness of patent database as an indicator of innovation using a direct measure of innovation in the hard disk industry. The finding on emerged patents are positively correlated with innovation in a statistically significant manner. In other words, patents are adjudged as a capable indicator for innovation and technological changes that the researchers wished to study which appears both advisable and feasible. Kerr and Nanda (2015) signified the volume of patenting and the patent citation in the recognition of a definitive approach to assessing innovation. Those patent database have been connected to the economic value and have raised the crucial insight on the effect of finance into

innovation. As a result of numerous advantages to the use of patent data, this research designates patent-based data as a prominent indicator for technology change and innovation outcome.

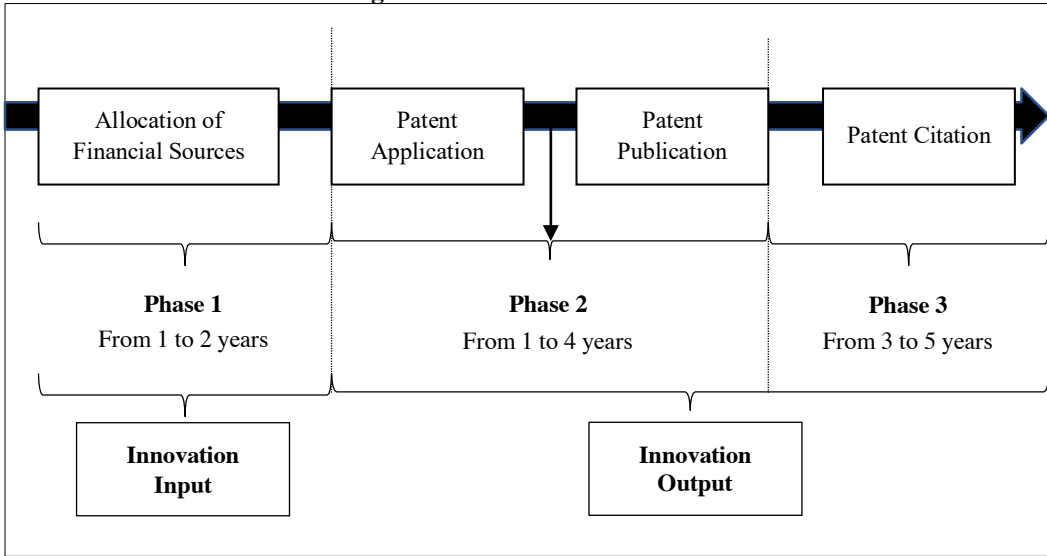
By definition of patent, one type of the intellectual properties (IP), it is the granting of a right by patent and trademark office to an inventor. This grant provides the inventor exclusive rights to the patented product, design or process for a specific period as a return to a disclosure of the invention. A patent application is a request for the grant of a patent for an invention described in the patent specifications. Meanwhile, patent publication is the public release of an applied patent by the patent and trademark office. Patent citation is defined as a patent document cited by the applicant or third party as it denotes the extent of firms' technological advancement and economical value; as high citation scores indicate novelty of innovation outputs (Hall et al., 2009). In this study, different categories of patent: application, publication and citation innovation outputs are estimated their significance as proxy to innovation output.

2.1.1. Innovation Output

In this study, innovation outputs are estimated using patent-based measure, namely: patent application, publication and citation. A patent application is a request for the grant of a patent for an invention described in the patent specifications. Meanwhile, patent publication is the public release of an applied patent by the patent and trademark office.

However, patent-based data such as patent application and publication is the type of intermediate output measure. In other words, patent application and patent publication reflect technical knowledge, but it is not necessarily measuring the commercialization of innovation. To overcome this fuzziness, in this study it examines another preferable indicator - patent citation as improved measure of technological performance. Patent citation conveys the previous patents and other extensive literature on science and technology linkage by subject, geographic location and source of investment in the prior art and differentiate from the past patent (Hall et al., 2005).

The reason for patent citation is not only an indicator of technological activity, but also commercialized innovation output being two-fold. First, a profit-seeking firm decides to refer to the extensive technology exposed in a prior art and then further conduct an innovation. The theory was that not only technical breakthroughs, but also market value is more often used as a baseline with which to compare later improvements on that basic technology. Hence, in likelihood the cited patent is a sign of economic value that the company aims for the costly innovation activities. Second, a patent citation is active over a period of time, hence if a patent is still cited time after time, it demonstrates the credibility of both superior technology and commercial worth.

Figure 1: Truncation in Patent-based Data

Truncation is another important factor that this research would investigate, mainly the difference in terms of truncation among three innovation output proxies: patent application, patent publication and patent citation in the robustness check. As suggested by Dass et al. (2016), there is a time lag and an uncertain delay in periods between when a firm applies for a patent and when the patent is granted or published (if, successful). The lag between patent application and patent publication can be from one to three years, thus suggesting the start of the truncation issue on the patent data. While the lag between the application date and publication date is possibly up to a maximum of three years (Dass et al. 2016); the application date of a patent is usually closer in time to the firms' innovation activity. In this sense, this study should expect that a patent can be applied by firms in one or two years after the allocation of financing to the firms' innovation activities (R&D activities) is made.

With regard to patent citation, defined as a patent document cited by the applicant or third party, the truncation issue is even stronger as citations of a patent which usually will take years to be accumulated or considered matured, after a patent has been granted, for one to understand the patent's impact and performance. As posited in Marku (2018), the higher the impact of a patented invention on subsequent inventions, the higher will be the number of citations a patent receives. The truncation of patent-based data, from the scope of this study, is illustrated in Figure 1.

2.2. Financial Sources, Structure and Innovation Outputs

Savnac (2006) as well as Gorodnichenko and Schitzer (2013) postulated that innovation outputs are negatively influenced by the constraint in financial sources. The studies have shown that inadequacy of the internal financing source, proxied by cash-flows and past profitability, is the main factor to the under-investment in innovation activities and it reduces the likelihood of firms producing outputs. One of the ways to understand this finding is to observe reasons of asymmetric information related to the intangible nature of human and knowledge assets used in the early phase

of innovation activities involving search and prototype development. Firms aiming to innovate usually rely on less risky source that is internal financing source. Firms shift to relatively costly financing sources (debt and equity) for later innovation phase (production and marketing of new products), only when internal sources are exhausted. As such, firms trying to complete innovation activities with outputs are likely to face financial constraint. This is particularly so, if loan application to banks are rationed out by terms and conditions. Thus, firms are less capable to produce quantity and quality of desired outputs, given the financial constraint. Hall (2002) and Savignac (2006) showed the effect of financial constraint on innovation outputs differ across industries, firm sizes, firm age, market share and technology push.

The significance of internal financial source to innovation outputs is also implied in the findings of Ughetto (2008) for 1000 Italian manufacturing firms that cash flow is the main financing source, especially for small firms. While Italian firms obtained a significant share of financing from debt, the finding showed that firms used virtually no debt to produce innovated products. Financial risk might be the reason to the finding. As posited by Kerr and Nanda (2014), uncertainty in the duration and form of innovation outputs, as it is difficult to estimate at the beginning whether and when financing innovation will pay off and what economic value it has. Hence, this has made firms not to finance innovation by riskier sources (debts) as it exposes firms to certain level of bankruptcy risk and collateral requirements. In such cases, firms opt to the safest mode of financing (internal sources) to eliminate the costs. Therefore, firms with more cash and other necessary resources in hand will produce more innovation outputs (Spielkamp & Rammer, 2009). From the context of this study, it hypothesizes that firms will have more patents application, publication and citation in cases where amount of the internally-generated funds is high, as developed in Hypothesis 1.

Hypothesis 1: Patents application, publication and citation are positively influenced by firms' internally-generated source of financing (cash flow).

Relying on internal financing source to support innovation outputs is not ultimate as firms, even though they are public, may choose debt financing when they require additional funds to innovate. As found in Spielkamp and Rammer (2009), using German public firms as sample, debt financing is main substitution to cash flows. The rationale is: firstly, loans from banks assist firms to finance innovation through the continuous supply of funds (Rajan & Zingales, 2003), without giving up parts of firms' ownership to outsiders. Next, innovation takes several years to actually realize outputs and financial returns and is less able to fulfil short term profit-goal of equity investors. Firms are prone to debts for financing innovation in attempt to reduce the investment objective misalignment. Hence, given the inferiority of equity financing as opposed to debt financing in some aspects, this study hypothesizes that patents application, publication and citation are positively influenced by the proportion of firms' debt to equity, as shown in Hypothesis 2.

Hypothesis 2: Patents application, publication and citation are positively influenced by firms' debt to equity ratio.

The development of Hypothesis 1 and Hypothesis 2 leads this study to also examine the proposition built in Pecking Order Theory that firms will adopt hierarchy between types of financing from internal or self-financing to external financing, starting from lower risk to risky debts followed by the issuance of shares on their efforts in financing innovation. This is to provide answer to the question: Is innovation influenced by risk inherited in different types of firms' financial source and

structure? As this study employs sample of firms from JASDAQ market, having rather smaller market capitalizations (or, are smaller in size) and lesser operational history and experience, it is convenient to postulate that those firms are superior to financial constraint but averse to risk. The superiority to the constraint in the internally-generated financing and aversion on risk, alongside the overall risk on innovation should lead the firms to prioritize their financing from cash flow to debts and later, equity as their last option, as developed in Hypothesis 3a and Hypothesis 3a.

Hypothesis 3a: Patents application, publication and citation are influenced by hierarchy in financial sources between internal financing and external starting from self-generated sources to external sources.

Hypothesis 3b: Patents application, publication and citation are influenced by hierarchy in external financial sources from debts to equity.

3. METHODOLOGY AND RESEARCH DESIGN

3.1. Sample Size and Procedures

The population of this study consisted of publicly traded firms listed in the JASDAQ market of TSE. This study used a final sample of 113 firms in the manufacturing industry. With the rapid technological change in recent decades, modified products (product innovation) or alterations in the ways that they are produced (process innovation) are often witnessed in the manufacturing industry. That is, the manufacturing industry is constantly undergoing phases of change, from the emergence of new technologies to Industry 4.0. This rapid-changed revolution posits that manufacturing firms are urged to continuously innovate in order to remain competitive to the market. Thus, the use of this industry as sample is rather relevant. Data used in this study spanned a period of 13 years from 2003 to 2015, consisting of yearly data on patent-based elements (application, publication and citation) and firms' specific data (innovation inputs, size, age, pay-out distribution, public listing experience, investors sentiment and sector dummy). The closing year (2015) in the sample period of this study has been chosen to enable this study to have sufficient observation (5 years) of citation received for a particular patent starting from the year of publication to its assumed maturity. This study used the data gathered from the Japanese Exchange Group (JPX)'s website, Refinitiv Nikkei and Needs-Financial Quest (FQ) databases and Derwent Innovation Index Database.

For the estimation method, this study opted for count model, which leveraged on Poisson regression. Count model is used when y takes integer values that represent the number of events that occur — examples of count data include the number of patents filed by a company, which this suits the data used in this study. Poisson regression assumption imposes constraints that are often violated which is the equality of the (conditional) mean and variance. If the mean-variance equality does not hold, the model is arguably mis-specified. To reduce the issue, this study conducted maximum likelihood estimation as its count estimated method. These quasi-maximum likelihood (QML) estimators are robust in the sense that they produce consistent estimates of the parameters of a correctly specified conditional mean, even if the distribution is incorrectly specified.

3.2. Definition and Measures

3.2.1. Dependent Variable: Innovation Output

Data on patent were collected from Derwent Innovation Database. This database enabled the retrieval of trusted patent data from more than 40 patent offices including those applied and granted in the Japan Patent Office. The following equations denote the specification of each patent data used in this study.

$$\text{Application}_i = \sum_{j=1}^n \text{Application count}_{ij} \quad (1)$$

Where;

Application = Count of patent applied in a particular year of *i*th firm

$$\text{Publication}_i = \sum_{j=1}^n \text{Publication count}_{ij} \quad (2)$$

Where;

Publication = Count of patent published in a particular year of *i*th firm

$$\text{Citation}_i = \sum_{j=1}^n \text{Citation count}_{ij} \quad (3)$$

Where;

Citation = Count of patent cited in particular year(s) of *i*th firm

To address the issue of truncation in patent data, this study integrated data on patent application of a firm from one year to four years after financial sources (cash flow, debts and equity) were reported in firms' financial reports, for statistical examination. Meanwhile, this study used data on patent publication of a firm from two years to five years after the reporting of the financial data or from one year to four years' after a patent has been applied. In addition, this study employed data on patent citation received by a firm within five years to seven years from the reporting of the financial data or three years to five years after patents of a firm in a particular year have been published. All the time lags and delays identified not only enabled this study to address the truncation issue on patent data, but also allowed this study to investigate the influence of the different type of firm's financing sources on innovation outputs using different sets of time on patent data individually in separate statistical models.

3.2.2. Independent Variable: Financial Structure and Sources

The different types of financing sources, treated as the main independent variable in this study, were assessed from the two aspects, namely internal financing source and external financing source. The external financing source, also regarded as financial structure, is the proportion of debt and equity of a firm estimated on the yearly basis.

$$\text{EXTERNALFIN}_i = \text{Debt/Equity}_{ij} \quad (4)$$

Where;

Debt_{*i*} = Yearly amount of total debts of the *i*th firm.

Equity_{*i*} = Yearly amount of total shareholders' equity of the *i*th firm.

The internal financing source is captured using firms' cash flows on the yearly basis (Savignac, 2006; Gorodnichenko & Schitzer, 2013). The amount of cash flow, besides an indicative of the direct internal potential of a firm's financing, has also been one of the most important indicators in testing the firms' external financial constraint as an adequate rate of operating cash flow that denotes favourable conditions of a firm for attracting funds from external sources (Spielkamp & Rammer, 2009).

$$\text{INTERNALFIN}_i = \text{Operating Cashflow}_{ij} / \text{Total Asset}_{ij} \quad (5)$$

Where;

Operating Cash Flow_i = Yearly amount of cash flow (fund from operating) of the ith firm

Total Asset_i = Yearly amount of net asset of the ith firm

3.2.3. Control Variables

In studying the influence of different financing sources on firms' innovation output, this study controlled for a set of other independent variables that have included firms' characteristics and market sentiment. The inclusion of these variables was mainly to ensure that the influence of financial structure and sources on firms' innovation outputs were not due to the omission of other relevant explanatory variables. The summary of all other independent variables and their theoretical arguments used by this study can be found in Table 1.

Table 1: Summary of Control Variable and Expected Signs

Control Variables	Proxy (Measurement)	Theoretical Arguments	Exp. Sign	Empirical Evidence
R&D Intensity (R&D EXP)	R&D Allocation (R&D expenditure divided by total sales)	R&D activity facilitates the assimilation, improvement and exploitation of the existing knowledge. It increases the ability of a firm to absorb new technologies emerging on the market for firm competitive advantage - Hadhri et al. (2016) Public firms engage more in R&D activities will generate more innovation outputs (measured by patents) - Acharya and Xu (2017).	+ve	+ve: Arvanitis et al. (2014); Bozeman et al. (2007); Hadhri et al. (2016)
Profit Distribution (PAYOUT)	Dividend Payout (dividends paid out to shareholders divided by net profits)	The increased in internal cash holding (used as an intermediary to R&D intensity) is accomplished by a lower dividend policy. That is, a policy of low dividend payout practiced by a firm increases the firm internal funds, innovation activity (measured by R&D intensity) and firm value, consequently. - Lee and Lee (2019)	-ve	-ve: Lee and Lee (2019)
Investor Optimism (OPTIMISM)	Market Value (share price multiplied by the number of ordinary shares)	Market overvaluation, through a direct reflection to investor optimism, is positively associated to firms' innovation. Market overvaluation generates social value by increasing innovative outputs and by encouraging firms to engage in highly inventive innovation (measured by originality, generality, and novelty of the innovative investments). Stronger effect of market overvaluation on innovative projects is found in firms with greater growth - Dong et al. (2017).	+ve	+ve: Dong et al. (2017)
Firm Size (SIZE)	Firm Size (natural log of total net assets a firm)	Firm size represents the access to innovation activity, the ability to diversify risk and the potential to benefit from scale economies. Larger firms usually invest more on innovation activity due to their ability in diversifying risks. For manufacturing firms, large firms also obtain a larger total benefit from process innovations (through lower production costs) - Hadhri et al. (2016). On the other hand, smaller firms which represents greater specialization possibilities and better communication, tend to continuously introduce new products, develop new processes, make changes in the organizational structure and explore new markets. - Avermaete et al. (2003).	+ve	+ve: Galende and de la Fuente (2003); Spielkamp and Rammer (2009); Zemplerová and Hromadková (2012); Hadhri et al. (2016); Sycz et al. (2018)

Table 1: (Continued)

Control Variables	Proxy (Measurement)	Theoretical Arguments	Exp. Sign	Empirical Evidence
Organizational Resources (OSOURCE)	Age (number of years of establishment prior to listing of a firm)	Age represents the experience and knowledge accumulated throughout a firm's history and is related to a better management of communication and of necessary creativity to innovate as well as a more effective capacity for absorption. Age is used to measure the experience and resources of firms. - Galende and de la Fuente (2003). Older firms are viewed to reap out the advantage of having necessary inputs for innovative projects and that produce more innovation outputs.	+ve	+ve: Galende and de la Fuente (2003) -ve: Zemplerová and Hromádková (2012)
Going Public (PUBLIC)	Listing Experience (number year of listing prior to the examination year)	Going public changes firms' strategies in pursuing innovation. Supporting for an agency explanation: out of career concerns, managers are averse to innovative projects, which are long term and highly risky in nature. Since public firms face more severe agency conflict than private companies, managers are more likely to divert resources away from innovation activity. In specific, going public may impose short-term pressure on managers to focus more on quarterly profits rather than on long-term earnings potential, leading to the "managerial myopia" problem - Stein (1988).	-ve	-ve: He and Tian (2017)
Industry (INDUSTRY)	(industry dummy equals one if a firm is categorized as chemical firm and zero, otherwise)	Industry dummy controls for inter-industry differences in factors, such as technological and economic opportunity. Higher levels of innovative activity are more likely to be observed in concentrated industries - Schumpeter (1942).	+ve	+ve: Spielkamp and Rammer (2009)

3.3. Estimated Equations

$$\widehat{Application}_i = \hat{\beta}_0 + \hat{\beta}_1 EXTERNALFIN_i + \hat{\beta}_2 INTERNALFIN_i + \hat{\beta}_3 R\&D EXP_i + \hat{\beta}_4 PAYOUT_i + \hat{\beta}_5 OPTIMISM_i + \hat{\beta}_6 SIZE_i + \hat{\beta}_7 OSOURCE_i + \hat{\beta}_8 PUBLIC_i + \hat{\beta}_9 INDUSTRY_i + e_i \quad (6)$$

$$\widehat{Publication}_i = \hat{\beta}_0 + \hat{\beta}_1 EXTERNALFIN_i + \hat{\beta}_2 INTERNALFIN_i + \hat{\beta}_3 R\&D EXP_i + \hat{\beta}_4 PAYOUT_i + \hat{\beta}_5 OPTIMISM_i + \hat{\beta}_6 SIZE_i + \hat{\beta}_7 OSOURCE_i + \hat{\beta}_8 PUBLIC_i + \hat{\beta}_9 INDUSTRY_i + e_i \quad (7)$$

$$\widehat{Citation}_i = \hat{\beta}_0 + \hat{\beta}_1 EXTERNALFIN_i + \hat{\beta}_2 INTERNALFIN_i + \hat{\beta}_3 R\&D EXP_i + \hat{\beta}_4 PAYOUT_i + \hat{\beta}_5 OPTIMISM_i + \hat{\beta}_6 SIZE_i + \hat{\beta}_7 OSOURCE_i + \hat{\beta}_8 PUBLIC_i + \hat{\beta}_9 INDUSTRY_i + e_i \quad (8)$$

Where,

$\widehat{Application}$	=	Count of patent applied in a particular year
$\widehat{Publication}$	=	Count of patent published in a particular year
$\widehat{Citation}$	=	Count of patent cited in particular year(s)
$\hat{\beta}_0$	=	The constant term
$\hat{\beta}$	=	Estimate coefficient or loading of the respective factor
i	=	The i th firm
EXTERNALFIN	=	Debt to Equity Ratio
INTERNALFIN	=	Cash Flow
R&D EXP	=	R&D Expenditure to Sales Ratio
PAYOUT	=	Dividend Distribution
OPTIMISM	=	Investors Optimism
SIZE	=	Firm Size
OSOURCE	=	Organizational Resources
PUBLIC	=	Going Public
INDUSTRY	=	Dummy Chemical Products Sector
e	=	Error term

4. RESULT AND DISCUSSION

4.1. Preliminary Analyses

The aim of this study is to quantify the influence of financial sources and structure on firms' innovation outputs. This study uses Poisson regression models for data analyses as patent application, publication and citation; employed to proxy innovation outputs, are observed count data, the nonnegative integers (0, 1, 2, 3) and assumed to have Poisson distribution. Table 2 presents the distribution of sample firms employed in this study (Panel A and the descriptive statistics for patent data (Panel B). The sample from each sector is rather representative of its population with a total of 80.71 percent. In general, innovation outputs of the sample firms do portray some noteworthy diversities. As reported in Panel B, firms during the observation period

(from 2003 to 2015), on average, have applied and published not more than 6 patents, yearly, although some firms have no patent applied and published in any year, while some others applied for 67 patents and published for 99 patents in a single year. The published patents are also cited, on average, five times regardless of whether the citations were accumulated within three years (4.78), four years (4.92) or five years (4.98) after publication of the patents. Some firms reported to have their patents cited as much as 88 times, while some other firms reported only zero number of citations for their patents published within the next three, four and five years. In contrast to patent application and publication which can denote number of innovation outputs, patent citation can signify the quality of innovation outputs as a patent of high quality, usually being cited more frequently, *ceteris paribus* (Lee et al., 2007). Thus, firms that reported high number of citations from their patents visibly have published relatively high economical value (Hall et al., 2009) and level of originality (Kang & Lee, 2017) on their innovation outputs.

Table 2: Sample Distribution and Descriptive Statistics (Dependent Variables)

Panel A: Distribution of firm in Manufacturing Industry						
Sector	Construction	Electrical Appliance	Transportation Equipment	Chemical Products	Metal Products	Total
Population	32	46	14	29	19	140
Sample	27	37	13	22	14	113
Percentage	84.75	80.43	92.86	75.86	73.68	80.71

Panel B: Descriptive Statistics of Patent Counts

Sector	Patent Application				Patent Publication				Patent Citation		
	1	2	3	4	1	2	3	4	3	4	5
Year Lag	1	2	3	4	1	2	3	4	3	4	5
Mean	5.36	5.08	4.92	4.81	5.99	5.64	5.33	5.11	4.78	4.92	4.98
Median	2.00	2.00	1.00	1.00	2.00	2.00	2.00	2.00	1.00	1.00	1.00
Maximum	67	67	67	61	99	73	73	73	85	88	88
Minimum	0	0	0	0	0	0	0	0	0	0	0
Std Dev.	9.17	8.89	8.82	8.64	10.39	9.47	9.07	8.87	9.50	10.00	10.31

Notes: Year lag in patent application is calculated based on the duration between the year that information on financial sources (cash flow, debt and equity) are reported in firms' financial statement and the year that patent(s) of inventive projects are applied. Year lag in patent publication is calculated based on the duration between the year that patent(s) of the inventive projects are applied and the year that the patents are published. Meanwhile, year lag in patent citation is calculated based on the duration between the year that the patent(s) are published and the duration of which citation of the patents are accumulated after publication of the patent.

The correlation coefficients are examined prior to the examination of the regression analyses. The independent variables should have a low correlation with other explanatory variables to avoid multi-collinearity problems which reduce the explanatory power of the independent variables. The matrix of independent variables presented in Table 3 suggests little collinearity.

Table 3: Descriptive Statistics and Correlations (Independent Variables)

	Sample Observations (N= 1469)										
	Mean	Std. Dev.	1	2	3	4	5	6	7	8	
<i>EXTERNALFIN</i>	1.21	1.13	1.00								
<i>INTERNALFIN</i>	1257039	2419695	-0.13	1.00							
<i>R&D EXP</i>	0.03	0.04	-0.19	-0.02	1.00						
<i>PAYOUT</i>	2.04	1.65	-0.16	0.04	-0.04	1.00					
<i>OPTIMISM</i>	8752.32	17889.19	-0.19	0.30	0.07	-0.15	1.00				

Table 3: continued

<i>SIZE</i>	1971215723603596	0.04	0.21	-0.06	0.04	0.46	1.00			
<i>OSOURCE</i>	53.95	20.16	-0.10	-0.02	-0.13	0.08	-0.04	0.11	1.00	
<i>PUBLIC</i>	12.3	5.03	-0.13	0.00	-0.05	0.06	-0.03	0.15	0.41	1.00
<i>INDUSTRY</i>	-	-	-0.00	0.09	-0.04	0.01	0.07	0.02	0.06	0.00

Notes: 1. EXTERNALFIN = Debt to Equity Ratio (%), 2. INTERNALFIN = Cash Flow (Dollar, 000), 3. R&D EXP = R&D Expenditure to Sales Ratio (%), 4. PAYOUT = Dividend Distribution (%), 5. OPTIMISM = Investors Optimism, 6. SIZE = Firm Size (Dollar,000), 7. OSOURCE = Organizational Resources (Years), 8. PUBLIC = Going Public (Years) and INDUSTRY = Dummy Chemical Products Sector.

The mean value for INTERNALFIN is higher than the mean value of EXTERNALFIN due to the different units of estimation. INTERNALFIN is measured by cash flow of the company in Dollar (JPY). Meanwhile, EXTERNALFIN is measured by debt-to-equity ratio. The huge deviation is expected and provides only minimal impact in the estimation (if any) because of the data transformation into natural logarithm when regressing the model in the later analysis stage. Huge deviation data have been minimized or standardized. As for the standard deviation, the standard deviation of INTERNALFIN is higher when comparing to EXTERNALFIN, indicating large dispersion of data for INTERNALFIN variable. There are firms having very low INTERNALFIN and firms with very high of INTERNALFIN which makes the dispersion to be greater, hence high value of standard deviation. Besides, all variables reported only raw data in Table 3 to demonstrate their actual characteristics. The data will be transformed before entering into regression analysis to minimize the estimation error.

All correlations among independent variables are low. The two highest coefficients are between OPTIMISM and SIZE (0.46) and between PUBLIC and OSOURCE (0.41), implying no significant multi-collinearity problems found among the independent variables of this study. Thus, reliable results from independent influence of all independent variables on innovation outputs can be obtained from the regression analyses.

4.2. Main Analyses and Discussion

The results on the tests of the hypotheses postulated in this study are presented in Table 4. Panel A, Panel B and Panel C of Table 4 present results on the influence of the different financing sources (INTERNALFIN and EXTERNALFIN) on innovation outputs, separating into the different proxies, namely patent application, patent publication and patent citation, subsequently. On this note, the examination on the influence of the different financing sources on innovation outputs is done with the inclusion of the controlling effect of other variables, which the reporting of and the discussion on the results are made later in Table 6 for specific emphasis.

Briefly, all hypothesized propositions built in this study are supported with significant effects. Hypothesis 1 expects that innovation outputs are positively influenced by firms' internally-generated source of financing (cash flow). As reported in Table 4 (from all panels), INTERNALFIN, abbreviates the internal source of financing which is significantly and positively associated to innovation outputs, regardless of proxies to innovation outputs and years lag. The explanatory power of firms' internal financing source (referred to z-statistics reported in the parentheses) on all proxies of innovation outputs do portray certain varieties which INTERNALFIN is found to positively influence patent application, patent publication and patent citation most strongly; when four years lag (Panel A and Panel B) and three years lag (Panel C)

counts of the proxies are used in the specifications. Regardless, the positive and significant association between firms' internal financing source and innovation outputs (at confidence levels of 99 percent) indicates that firms having more cash in hand produced more volume and quality of innovation outputs.

The results, provided in this study, support the findings revealed in Gorodnichenko and Schitzer (2013), Savignac (2006) as well as Ughetto (2008). The proposition of this study from one aspect indicates the lowest financial risk denoted by the internal financing source, alongside future uncertainty related to the outcomes and risks on innovation; is difficult to assess at the early phase of the innovation activity whether and when it will pay off. Therefore, these conditions have led firms to opt for the safest mode for financing innovation.

From another aspect, the lower ability of firms, due to the inadequate rate of operating cash flow as essential precondition to acquire additional financial sources outside the firm; has resulted in firms to have lower incentive to engage in innovation activity, hence limiting their innovation outputs. This result is practically suitable for manufacturing firms leveraging on the complex connection between everyday financial functions such as inventory management, accounts payable and accounts receivable and cash flow adequacy. The incapability of firms to comprehend the connection, alongside the external issues of the unreliable customer demand forecasts and industry-wide, will usually expose manufacturing firms to the unexpected demand on their working capital, cash flow inflexibility and internal financial constraint. Therefore, without a strong support from the external financing sources, the engagement of firms to new chain of innovation activities will be less probable.

Table 4: Poisson Regression Results (Debt to Equity and Cash Flow)

Panel A: Dependent Variable = Patent Application				
	Model 1	Model 2	Model 3	Model 4
Year Lag (From Allocation of Financial Sources)	1 Year Lag	2 Year Lag	3 Year Lag	4 Year Lag
<i>INTERNALFIN</i>	0.043(13.082) ***	0.055(15.535) ***	0.055(15.426) ***	0.066 (17.040) ***
<i>EXTERNALFIN</i>	0.111(9.157) ***	0.126(10.276) ***	0.115 (9.026) ***	0.150 (11.871) ***
Adjusted R ²	0.280	0.282	0.263	0.244
Prob (LR statistics)	0.000	0.000	0.000	0.000
Panel B: Dependent Variable = Patent Publication				
	Model 1	Model 2	Model 3	Model 4
Year Lag (From Patent Application)	1 Year Lag	2 Year Lag	3 Year Lag	4 Year Lag
<i>INTERNALFIN</i>	0.037(12.022) ***	0.045(13.904) ***	0.049(14.554) ***	0.055 (15.916) ***
<i>EXTERNALFIN</i>	0.120(10.554) ***	0.112(9.471) ***	0.121(10.066) ***	0.116 (9.529) ***
Adjusted R ²	0.262	0.273	0.270	0.255
Prob (LR statistics)	0.000	0.000	0.000	0.000
Panel C: Dependent Variable = Patent Citation				
	Model 1	Model 2	Model 3	
Year Lag (From Patent Publication)	Within 3 Years	Within 4 Years	Within 5 Years	

Table 4: continued

<i>INTERNALFIN</i>	0.045 (11.094) ***	0.048 (11.097) ***	0.064 (13.088) ***
<i>EXTERNALFIN</i>	0.047 (3.027) ***	0.057 (3.595) ***	0.121 (7.952) ***
Adjusted R ²	0.324	0.351	0.368
Prob (LR statistics)	0.000	0.000	0.000

Notes: The reported values are coefficient estimates and z-statistics (reported in parentheses).

Table 4 also reveals that *EXTERNALFIN* has an equal importance as firms financing source. Regardless of proxies to innovation outputs and years lag, debt to equity ratio are found to positively and significantly relate to innovation outputs, as expected in Hypothesis 2: Innovation outputs are positively influenced by firms' debt to equity ratio. The positive association denotes that firms are inclined to choose debts to complement the self-generated funds (cash flow) for funding innovation. The higher the amount of debt in firms' financial structure, the higher is firms' innovation outputs. The results support the proposition of this study that suggested debt as a less sensitive financing mode to information asymmetry and agency conflict. The need for firms to disclose their confidential information and business secrets to outside investors when issuing for equity have caused hesitation for firms to use equity as their main external financing source for innovation.

In addition, the potential mis-matching issue on the investment objectives between firms and equity investors, as well as the short-term investors' pressure also justifies the firms' heavy and significant reliance on debt financing as opposed to equity financing in producing innovation outputs as reported in all panels of Table 4. In addition, a stable rate of cash flow as a safe-guard cushion to guarantee an easy access to debt makes firms to have less difficulty to fund their innovation via debts rather than using equity. Regardless, it is worth stating that despite similar confidence levels (referred to the asterisks) on the influence of *EXTERNALFIN* to firms' innovation outputs, their explanatory power is not as high as those *INTERNALFIN* (referred to the z-statistics values presented in parentheses). Hereby, *INTERNALFIN* portrays a consistent superiority, as opposed to *EXTERNALFIN*, as a main driver to firms' innovation outputs. One important implication that can be drawn from this finding is that, both types of financing sources are complemented, but the preference of firms is to the internal financing source, probably based on the financing risks.

The results addressed on Hypothesis 1 and Hypothesis 2 seem to straightforwardly link to the subsequent Hypothesis 3: Innovation outputs are influenced by hierarchy in financial sources between internal financing and external starting from self-generated source to debts followed by equity. The positive and significant influence of both types of financing sources show their importance in producing outputs on firms' innovation activity. Leveraging on the values of z-statistics of *INTERNALFIN* and *EXTERNALFIN* in Panel A, Panel B and Panel C of Table 4, however, indicate that firms' innovation activity, while outputs are predominantly financed by self-financing means (cash flow). Meanwhile, the positive and significant association between debt to equity ratio and innovation outputs implies the preference of firms to debt financing in supplementing cash flow. As such, it is safe to initially conclude that firms used as sample of this study adopt hierarchy in financial sources between internal financing and external financing. In this situation, the priority is given to the safest financing mode to less risky and followed by relatively risky mode of financing.

As this study employs a sample of firms from JASDAQ market which is smaller in size, they have lesser operational history and are risk averse. Hence, it is rather appropriate to accept that the firms' financing decision should mainly be based on the risk of each financial source. This finding, besides supporting Hypothesis 3, also provides support to the proposition in Pecking Order Theory related to the risk inherited in different types of financial sources. Specifically, firms prefer internally-generated financing that is less risky, prior to debt financing that will only be used at the riskiest mode, equity financing as their last financing option.

Table 5: Poisson Regression Results on The Interaction between Financial Sources 16
(Debt to Equity and Cash Flow) and R&D Intensity (R&D to Sales Ratio)

Panel A: Dependent Variable = Patent Application				
	Model 1	Model 2	Model 3	Model 4
Year Lag (From Allocation of Financial Sources)	1 Year Lag	2 Year Lag	3 Year Lag	4 Year Lag
<i>INTERNALFIN</i> * <i>R</i> & <i>DEXP</i>	0.302(19.600) ***	0.306(19.886) ***	0.311(19.834) ***	0.324 (20.356) ***
<i>EXTERNALFIN</i> * <i>R</i> & <i>DEXP</i>	1.260(6.491) ***	1.340(6.983) ***	0.202 (6.039) ***	0.154 (5.081) ***
Adjusted R ²	0.272	0.268	0.249	0.244
Prob (LR statistics)	0.000	0.000	0.000	0.000
Panel B: Dependent Variable = Patent Publication				
	Model 1	Model 2	Model 3	Model 4
Year Lag (From Patent Application)	1 Year Lag	2 Year Lag	3 Year Lag	4 Year Lag
<i>INTERNALFIN</i> * <i>R</i> & <i>DEXP</i>	0.265(16.688) ***	0.283(18.070) ***	0.292(18.786) ***	0.296 (19.031) ***
<i>EXTERNALFIN</i> * <i>R</i> & <i>DEXP</i>	1.506(8.019) ***	1.419(7.484) ***	0.246(6.411) ***	1.355 (7.065) ***
Adjusted R ²	0.255	0.264	0.260	0.240
Prob (LR statistics)	0.000	0.000	0.000	0.000
Panel C: Dependent Variable = Patent Citation				
	Model 1	Model 2	Model 3	
Year Lag (From Patent Publication)	Within 3 Years	Within 4 Years	Within 5 Years	
<i>INTERNALFIN</i> * <i>R</i> & <i>DEXP</i>	0.292 (15.345) ***	0.276 (13.637) ***	0.269 (12.993) ***	
<i>EXTERNALFIN</i> * <i>R</i> & <i>DEXP</i>	1.551 (7.230) ***	1.532 (6.861) ***	1.648 (7.336) ***	
Adjusted R ²	0.308	0.335	0.342	
Prob (LR statistics)	0.000	0.000	0.000	

Notes: The reported values are coefficient estimates and z-statistics (reported in parentheses).

The explanation on the significant and positive association between firms' financing sources and innovation outputs, thus far, is made with assumptions that innovation outputs are affected individually by the allocation of firms' financial sources to innovation activity. In most cases, however, the strong financing supports are interacted by the intensive R&D activity as the latter usually indicates the level of efforts devoted to produce innovative product and process as well as firms' response to the market's demand and improved technology. It can be posited that an effective interaction between financing sources and R&D intensity should support firms in producing more quantity and quality of their innovation outputs as both are viewed as a syndicated element to innovation performance.

Henceforth, the issue on how R&D intensity can moderate the influence of financial sources on innovation outputs should be of prime interest. R&D intensity, acknowledged as one of the most widely used measures of innovation inputs, is defined as the percentage of a firm's R&D expenditure to its sales. Panel A and Panel B of Table 5 show that the interaction between internal financing source and R&D intensity (INTERNALFIN*R&D EXP) has a more significant influence on patent application and patent publication as opposed to the individual influence of INTERNALFIN as shown earlier in Table 4.

Meanwhile, both interactions (INTERNALFIN* R&D EXP and EXTERNALFIN*R&D EXP) influence quality of innovation outputs or patent citation more significantly as revealed in Panel C of Table 5. This finding indicates that the interaction between both types of firms' financing sources (INTERNALFIN and EXTERNALFIN) and dedicated focus on R&D can help firms to better match the patented products and increase market expectation through the arrival of inventive products that have never been produced before. It is often accepted that the significant investment of financial source on R&D activity comes with significant outcomes, which in the context of this study, are the quality of the patented outputs measured by its citation counts.

Table 6: Summary of Poisson Regression Results on The Influence of Other Independent Variables on Innovation Outputs

	Patent Application	Patent Publication	Patent Citation	Expected Sign	Significance (Confidence Level. %)	Confirmed Sign of Relationship and Significance
	Actual Sign	Actual Sign	Actual Sign			
R&D EXP	+	+	+	+	99%	Yes
PAYOUT	+	+	+	-	99%	No
OPTIMISM	+	+	+	+	99%	Yes
SIZE	+	+	+	+	99%	Yes
OSOURCE	+	+	+	+	95%	Yes
PUBLIC	-	-	-	-	99%	Yes
INDUSTRY	+	+	+	+	99%	Yes

Notes: Poisson regression results on the influence of the firms' characteristics on all proxies of innovation outputs presented in this table is consistently arranged according to the year's lag reported in Table 4. As significance level and sign of relationship of each of the firms' characteristic are found to be consistent across panels and years lags, the results are summarized as one.

Seven other firms' characteristics are deduced from related literature to control for the influence of financing sources and structure on innovation outputs. The summary of the regression results on the influence of the firms' characteristics is presented in Table 6. All relationships are found to be significant with six of the characteristics, in terms of their sign of relationship, correspond with those expected by this study (Table 1). Specifically, similar to interacting it to financing sources, R&D intensity (R&D EXP) represents an internal strength to firms as more engagement of firms to R&D activities will assist them to generate more and better innovation outputs. R&D EXP is positively significant at 0.01 implying that the ability of a firm to absorb new technologies emerging on the market, which helps it to produce better innovative outputs, seemed to be confirmed.

Dividend distribution (PAYOUT), the second control variable, indicative of the level of firms' internal funds is also significant at 0.01. The positive sign of relationship between PAYOUT and innovation outputs (for all proxies) implies that firms' innovation outputs are higher when they pay their shareholders higher rate of dividend, which these results being not able to confirm the expectation of this study, while also offering a challenge to that found in Lee and Lee (2019). Higher rate of dividends probably provides a solid demonstration of the firms' ability in creating enough profits and sends a signal about firms' financial strength.

The adequate rate of profits a firm has created gives it more flexibilities to distribute the portion to shareholders, while maintaining certain level of cash flow to be used for firms' other operational purposes. Instead of lowering the rate of firms' internal funds, distribution of dividend denotes the internal financing strength of firms that an effective exploitation of the financial strength to firms' innovation activity is highly possible.

Another significant variable at 0.01 is investor's optimism (OPTIMISM), indicative of market overvaluation. The positive relationship, which indicates the response of firms to market overvaluation by engaging in more innovative activities, riskier and creative forms of innovation and later helping firms in producing higher and better innovative outputs, seem to be corroborated. Producing similar significant at 0.01, SIZE which is representative of the firms' accessibility to innovation activity, ability to diversify risk and potential to gain from scale economies, also confirms its expected positive association to all proxies of innovation outputs. The sign of relationship verifies that larger firms usually invest more on innovation activity due to their accessibility to all necessary resources at hand for innovation activity and ability in diversifying risks which results into higher volume and quality of innovation outputs.

Organizational resources (OSOURCE), with a positive relationship and significant at 0.05, represent the experience and knowledge accumulated throughout a firm's history and are related to a better communication management of communication and of necessary creativity to innovate and a more effective capacity for absorption. Age is used to measure the experience and resources of firms. The suggestion that older firms are at a better position to reap out the advantage of having necessary inputs for innovative projects and support for producing more innovation outputs, seem to be verified.

Going Public (PUBLIC), another variable significant at 0.01 is representative of the experience of firms in years as publicly-traded entities. The negative relationship seems to confirm the proposition that going public changes firms' strategies in pursuing innovation. Since public firms face more severe agency conflict than private companies, managers are more likely to divert resources away from innovation activity, in corresponds to their years as public firms. Going public may impose short-term pressure on managers to focus more on quarterly profits rather than on long-term earnings potential (innovation activity). Therefore, the longer the firms' listing experience is, the lower their motivation is to engage in innovation activity.

The last controlling variable, industry (INDUSTRY), is significant at 0.01. Using a dummy variable that equals to one for firms listed in the chemical sector; and vice versa, INDUSTRY produces a positive association to innovation outputs, denoting the importance of innovation to the sector. The superiority of innovation activity to this sector is in connection to the need in creating

and satisfying increasingly sophisticated, demanding and environmentally-conscious consumers for chemical necessities and products.

5. CONCLUSION

This study examines financial sources, structure and factors that can determine firms' innovation outputs, leveraging on Pecking Order Theory. The primary goal is not to explain how firms strategize their innovative activity, but the drivers to their final innovative results. This study includes seven firms' specific characteristics (R&D intensity, profit distribution, investor optimism, firm size, organizational resources, public listing experience and sector dummy) to control the effect of financial sources on firms' innovation outputs, proxied by patent application, patent publication and patent citation. Evidence, using a sample of 113 manufacturing firms listed in the TSE, is found in relation to how firms' innovation outputs are explained by the different types of financing sources. The propositions of this study seem to be reasonably corroborated with supports by the significant influence of other controlling factors. Nonetheless, a different strength of influence is obtained based on the different type of financial source considered.

Specifically, while both internal financing and external financing sources are important in driving volume and value of innovation outputs, the reliance of firms on self-generated financing conquers. The complementary power of debt financing offers support to the assertion in Pecking Order Theory, concerned on the risk inherited in the different financing means. Relying on financial risk as a basis, hierarchy is adopted from internal financing to external financing source that the priority is given to financial source with lower risk.

This study believes that its empirical findings are important, in view of the diversity of the patent-based data and the different aspect of financing sources used. In particular, their economic interpretation is acceptable and contributes to the confirmation of the hypotheses and the utility of the theory. It is possible to affirm that this study provides an added value in the analysis of firms' innovation outputs, given the small number of studies in the empirical literature which explain innovation simultaneously from the internal to external financing sources. This study contributes to the increasing literature on the use of patents to measure innovation performance by distinguishing the quantity and quality in patent measurement.

Patent documents are a unique data source (Katila, 2000), namely i) patent documents deal with new and useful ideas; ii) patents detail out description of the patented invention and iii) analysis of patents can give early signals of technological change as trend indicators usually appear in patent data before they are reported in trade or technical journals. Thus, patent-based measure should be an integral part of firms' innovation outputs measurement.

Furthermore, the finding of this study displays that firms depending on internal financing source have a more significant effect compared to external financing in driving volume and value of innovation outputs. Following the finding, it is safe to infer that firms should equally prioritize on generating higher cash flow as a primary means in gearing the innovation outputs. From the view of investors, the information of firms' cash flow transmit good information on the innovation output of the firms as innovation provides more ability for the young and innovative firms to grow and sustain in the stock market.

As found in Dincer and Karakus (2021), innovation outputs have positive long-term effect on the share value of the firms. Investors are prone to participate and commit their capital for long term in firms with good innovation and growth prospect. Thus, focusing on increasing and maintaining an adequate level of cash flow should allow public firms to sustain longer in the stock market. From another view, innovation outputs also help firms to increase the welfare level of the countries as firms, which engage in innovation through the R&D activities, will continuously identify their current problems and lay the groundwork for new products and services. In this way, it contributes not only to the profit of companies, but also meets the rapid changes in the consumers' preferences (Dincer & Karakus, 2021). For these reasons, the study is of special interest.

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