Finance Research Letters 000 (2017) 1–9

Contents lists available at ScienceDirect

Finance Research Letters

journal homepage: www.elsevier.com/locate/frl

Innovative efficiency and stock returns: Should we care about nonlinearity?

Houdou Basse Mama

ESCP Europe, Berlin, Germany

ARTICLE INFO

Article history:
Received 12 May 2017
Revised 19 June 2017
Accepted 5 July 2017
Available online xxx

JEL classification:
G12
G14
O32

Keywords:
Innovative efficiency
Patents
Research and development
Nonlinearity

ABSTRACT

Recent research suggests that a firm's innovative efficiency (IE) is a strong positive predictor of future stock returns. Using a panel of 3084 international firms over the 1999–2015 period, this study attests to the predictive power of IE for subsequent returns, but disputes the linearity of the underlying relationship. Specifically, portfolio analyses and Fama and MacBeth (1973) regressions demonstrate that IE shares a robust U-shaped relationship with future stock returns, market valuations, and operating performance. This evidence is new to the literature and bears important implications for investment and security analysis, innovative-intensive firms, policy-making, and academic research as well.

1. Introduction

There is extensive evidence of under-investment of the private sector in research and development (hereafter, R&D). This is cause for concern given the important role economic theory confers upon R&D for innovation and productivity growth. In the current context of generalized concerns about economic slowdown, identifying mechanisms and policies to promote private-sector R&D investment has vaulted to the top of the policy-making and academic agenda (e.g. EC, 2010; Brown et al., 2017).

A recent line of research argues that firms have heterogeneous intrinsic abilities in translating R&D into something they value (e.g. sales, patents, new products; see, e.g., EC, 2010; Cohen et al., 2013; Hirshleifer et al., 2013). Thus, innovative-efficient firms should generate significantly more patents than their counterparts that invest the same levels of R&D but have poor track records in patent counts. Hirshleifer et al. (2013) find that the ratio of patents or citations over R&D capital (hereafter, innovative efficiency, IE) is positively related to future stock returns, market valuations, and operating performance. Gao and Chou (2015) add that the positive association between IE and firm value is more pronounced for multinational firms that diversify into developed markets or markets with better patent protection. These contributions are valuable given the increasing importance of intellectual property in evaluating corporate divisions and targets of mergers and acquisitions (Belenzon and Patacconi, 2013; Hall et al., 2014).

However, research so far has (implicitly) imposed linearity on the relationship between patent attributes and stock returns. The present study contends that nonlinearity inheres in studies relying on patent attributes for a simple reason: The

E-mail address: hbassemama@escpeurope.eu

http://dx.doi.org/10.1016/j.frl.2017.07.001
1544-6123/

distribution of patent value is knowingly skewed (e.g. Gittelman, 2008; Hall et al., 2014) and firms may strategically seek patent protection for their inventions (Blind et al., 2006; 2009; Reitzig et al., 2007). Researchers have attempted to account for the skewed distribution of patent attributes by log transforming their patent attributes of interest. Yet, it is unclear whether such a transformation can fully account for the nonlinearity at stake.

This study revisits the relationship between IE and stock returns by explicitly allowing for nonlinearity. The sample includes 3084 international firms that held at least one patent approved by the European Patent Office (EPO) over the 1999–2015 period. The primary measure for IE used in this study is the ratio of patent counts over R&D capital. In turn, the identifying assumption is that, given market efficiency, the IE-returns relationship obtains from the association between IE and subsequent operating performance (Gu, 2005).

Portfolio tests and Fama and MacBeth (1973) regressions provide robust evidence that IE is nonlinearly related to future stock market and operating performance. For example, an investment in a value-weighted portfolio of firms that belong to the lowest (highest) quintile of IE earns on average an excess return of 4.78% (6.99%) p.a. By contrast, the average annualized excess return to the fourth quintile is 2.92%. The portfolio results are substantiated by Fama and MacBeth (1973) regressions that provide robust evidence of a U-shaped relationship between IE and future market valuations and operating performance.

These results have important implications. First, investment strategies that short firms in the lowest quintile (tertile) of IE and buy firms in the highest quintile (tertile) are unlikely to prosper. Therefore, the construction of the "Efficient minus Inefficient" (EMI) pricing factor introduced by Hirshleifer et al. (2013) appears to be disputable. Indeed, the EMI factor relies on similar assumptions as the Fama and French (1993) pricing factors "Small minus Big" (SMB) and "High minus Low" (HML). However, SMB and HML imply a linear relationship between the underlying variables (size and book-to-market, respectively) and stock returns, which is hardly tenable for IE.

Second, the nonlinearity uncovered in this study suggests that firms are not necessarily rewarded for slicing their innovations into "smallest possible patentable units". By contrast, firms are rewarded when they limit costly patent applications to their most successful inventions. Slicing schemes can result in patent trolling, thereby squelching innovation and productivity growth (Jaffe and Lerner, 2004; Reitzig et al., 2007; Cohen et al., 2016). Therefore, policymakers have strong incentives to keep patentability standards high enough to discourage firms from increasingly patenting more marginal inventions. Third, studies that overlook nonlinearity are potentially misspecified (see, e.g., Basse-Mama, 2017 for similar conclusions).

2. Data and summary statistics

The sample consists of 3084 firms listed in 21 countries, operating in fourteen sectors, and that held at least one patent approved by the EPO over the period 1999–2015.[1] Using patents granted by a single patent office bypasses differences in patent grant practices across jurisdictions (Belenzon and Patacconi, 2013; Squicciarini et al., 2013). The sample includes both dead and active firms.

Proprietary raw patent attributes are obtained from the Hamburg-based Ariad Asset Management GmbH (hereafter, Ariad).[2] Therefore, the sample reflects different restrictions imposed by Ariad (see Web Appendix). Accounting and capital market data are from Datastream; pricing factors are taken from Wharton Research Data Services (WRDS).

IE is measured as the patents granted to a firm scaled by R&D capital (hereafter, *PRDC*). I build upon Hirshleifer et al. (2013) to measure *PRDC* as the ratio of firm *i*' s patents granted (*PTCNT*) in year *t* scaled by its 3-year cumulative R&D expenses given an annual depreciation rate of 1/3 in the fiscal year ending in year $t-3$:[3]

$$PRDC_{it} = \frac{PTCNT_{it}}{R\&D_{it-3} + 0.67 * R\&D_{it-4} + 0.33 * R\&D_{it-5}} \times 100 \quad (1)$$

Because *PRDC* varies over time, across technology, and jurisdiction, the empirical analysis uses industry-year-region fractional ranks of *PRDC* (and for most variables used in Eqs. (3) and (4)). Proceeding this way ensures that, controlling for firms' regional location, the median firm in each industry and in each year gets a ranking of 0.5.

Table 1 suggests that the average firm has a market capitalization of €5.84 billion, a cash flow to assets ratio of 7.56%, an ROA of 3.62%, and 8.95% of its shares held by institutional investors. More importantly, the average firm has a PRDC of 0.23%, which implies that the average patent requires an R&D capital of approximately €430,663. However, the sample firms exhibit substantial heterogeneity.

3. Empirical analyses

The empirical analysis proceeds in three stages. The first stage consists of portfolio tests. I form quintile portfolios on each 30 June of year t, based on the fractional rank of PRDC at year-end t-1. Stocks are sorted from the lowest quintile (Q1) to the highest quintile (Q5). The 6-month time lag between the conditioning information and portfolio construction

[1] The construction of the measure for IE requires historical data prior to 1999, while portfolio returns are computed from 1 July 2000 to 30 June 2016 due to data requirements imposed when computing PRDC.

[2] URL: https://www.ariad.de.

[3] Using the crude alternative (patents/R&D in $t-2$) allows, albeit weaker, similar inferences (available upon request).

Please cite this article as: H.B. Mama, Innovative efficiency and stock returns: Should we care about nonlinearity? Finance Research Letters (2017), http://dx.doi.org/10.1016/j.frl.2017.07.001