Paper to be presented at the DRUID Academy Conference 2016 in Bordeaux, France on January 13-15, 2016

Success through Failures? Evidence from Pharmaceutical R&D Projects

Daniela Silvestri
IMT- INSTITUTE FOR ADVANCED STUDIES LUCCA
Computer, Decision, and Systems Science / Management Science
daniela.silvestri@imtlucca.it

Massimo Riccaboni
IMT - INSTITUTE FOR ADVANCED STUDIES LUCCA
Laboratory of Innovation Management and Economics
massimo.riccaboni@imtlucca.it

Bart Leten
KU Leuven
Dep. of Managerial Economics, Strategy and Innovation (MSI)
bart.leten@kuleuven.be

Rene Belderbos
KU Leuven
Dep. of Managerial Economics, Strategy and Innovation (MSI)
rene.belderbos@kuleuven.be

Abstract

State of the Art: Traditionally innovation has been conceptualized as a cumulative process (Scotchmer, 2004) where organizations build on their previous knowledge and experience. The experimental nature inherent to innovation implies high risk and uncertain outcomes. The pharmaceutical industry represents a typical example of innovation process where organizations have to face high failure rates and extensive development costs. Failures, in particular in later stages of drug development, represent a critical event to firms having large consequences for firms' return on assets. In this paper we examine when and to what extent pharmaceutical firms learn from prior failures in their subsequent drug development efforts. Theoretical Arguments: Organizational learning theory advocates that organizations modify their knowledge base by integrating in their routines and practices the knowledge acquired through direct experience, vicarious experiences and performance feedback (Baum and Dahlin, 2007; Cyert and March, 1963; Greve, 1998; Levitt and March, 1988). The literature has also acknowledged the importance of recognizing and investigating failures and their context

as a mechanism to identify potential inefficiencies and to design correct procedures (Haunschild and Sullivan, 2002). Research Gap: Notwithstanding the negative returns associated with failures, the innovation literature has stressed the important role of learning from mistakes as one of the mechanisms that can enhance firms' subsequent innovation process as well as generating spillovers to other firms operating in the industry (Teerlak and Gong, 2008; Francis and Zheng, 2010; Hoetker and Agarwal, 2007). However, it is not clear to what extent firms actually learn from failure, as firms tend to de-emphasize failures and to build and focus more on prior successes (Levinthal and March, 1993; Denrell, 2003). Using detailed and comprehensive data on pharmaceutical firms drug development efforts, we examine to what extent current drug development benefits from learning due to failed previous projects. Our study contributes to the understanding of the value of knowledge that might be generated from failures and whether and when this knowledge increases the probability of positive outcome for future projects. In addition to informing the literature on learning (from failure), our study inform the policy debate on the advantages and disadvantages of enforcing disclosure on the reasons for unsuccessful trials. Methods: To explore learning effects and the role of failure in drug development, we draw on the Pharmaceutical Industry Database (PHID) maintained at IMT Institute for Advanced Studies in Lucca (Italy). This database contains detailed information on more than 30,000 pharmaceutical R&D projects including their Anatomical Therapeutic Chemical (ATC) classification, the indication on the treated disease, the company leading the project, the development history of the project and the patents pertaining to the projects. We establish potential learning relationships by examining whether patents linked to a drug development project cite patents applied for in the context of prior drug development efforts (failed or successful), while controlling for other types of learning such as drawing on (citing) other firms' development efforts and scientific contributions. We gauge the success of drug development projects by the stage that the projects reach as well as by the forward citations to the underlying patents (Magazzini et al., 2012). We examine whether learning from failure is 1) more or less likely than learning from success; 2) more likely when the firm has a broader, related, knowledge base relevant to the drug under development; 3) more likely when the prior failed project reached a higher phase before it was terminated. Results: The large majority of projects in our dataset have failed, a large fraction is still in development while only a minor percentage has been marketed. Overall, this study suggests that nonetheless the negative returns, there is learning not only from success but also from failures as showed by citations trends and project development phases. References: Baum, J. A., & Dahlin, K. B. (2007). Aspiration performance and railroads' patterns of learning from train wrecks and crashes. Organization Science, 18(3), 368-385. Cyert, R. M., & March, J. G. (1963). A behavioral theory of the firm. Englewood Cliffs, NJ, 2. Denrell, J. (2003). Vicarious learning, undersampling of failure, and the myths of management. Organization Science, 14(3), 227-243. Francis, J., & Zheng, C. (2010). Learning vicariously from failure: The case of major league soccer and the collapse of the North American Soccer League. Group & Organization Management, 35(5), 542-571. Greeve, H. R. (1998). Performance, aspirations, and risky organizational chance. Administrative Science Quarterly, 43, 58-86. Haunschild, P. R., & Sullivan, B. N. (2002). Learning from complexity: Effects of prior accidents and incidents on airlines' learning. Administrative Science Quarterly, 47(4), 609-643. Hoetker, G., & Agarwal, R. (2007). Death hurts, but it isn't fatal: The postexit diffusion knowledge created by innovative companies. Academy of Management Journal, 50(2), 446-467. Magazzini, L., Pammolli, F., & Riccaboni, M. (2012). Learning from failures or failing to learn? Lessons from pharmaceutical R&D. European Management Review, 9(1), 45-58. Levinthal, D. A., & March, J. G. (1993). The myopia of learning. Strategic management journal, 14(S2), 95-112. Levitt, B., & March, J. G. (1988). Organizational learning. Annual review of sociology, 319-340. Scotchmer, S., (2004). Innovation and incentives. Cambridge, MA: MIT Press. Terlaak, A., & Gong, Y. (2008). Vicarious learning and inferential accuracy in adoption processes. Academy of Management Review, 33(4), 846-868.

Jelcodes:D83,O34

Success through Failures?
Evidence from Pharmaceutical R&D Projects[1]

Daniela Silvestri
Laboratory of Innovation Management and Economics (LIME),
IMT School for Advanced
Studies, Lucca, Italy
daniela.silvestri@imtlucca.it

Massimo Riccaboni
Laboratory of Innovation Management and Economics (LIME),
IMT School for Advanced
Studies, Lucca, Italy
Dep. of Managerial Economics, Strategy and Innovation (MSI),
K.U. Leuven, Belgium
massimo.riccaboni@imtlucca

Bart Leten
Dep. of Managerial Economics, Strategy and Innovation (MSI),
K.U. Leuven, Belgium
Vlerick Business School, Belgium
Bart.Leten@kuleuven.be

Rene Belderbos
Dep. of Managerial Economics, Strategy and Innovation (MSI),
K.U. Leuven, Belgium
UNU-MERIT, Maastricht University

Rene.Belderbos@kuleuven.be

[1] Preliminary and Incomplete work, please do not cite or redistribute without authors permission. Full working paper will be sent to the discussants and will be available upon request.

State of the Art

Traditionally innovation has been conceptualized as a cumulative process (Scotchmer, 2004) where organizations build on their previous knowledge and experience. The experimental nature inherent to innovation implies high risk and uncertain outcomes. The pharmaceutical industry represents a typical example of innovation process where organizations have to face high failure rates and extensive development costs. Failures, in particular in later stages of drug development, represent a critical event to firms having large consequences for firms' return on assets. In this paper we examine when and to what extent pharmaceutical firms learn from prior failures in their subsequent drug development efforts.

Theoretical Arguments

Organizational learning theory advocates that organizations modify their knowledge base by integrating in their routines and practices the knowledge acquired through direct experience, vicarious experiences and performance feedback (Baum and Dahlin, 2007; Cyert and March, 1963; Greve, 1998; Levitt and March, 1988). The literature has also acknowledged the importance of recognizing and investigating failures and their context as a mechanism to identify potential inefficiencies and to design correct procedures (Haunschild and Sullivan, 2002).

Research Gap

Notwithstanding the negative returns associated with failures, the innovation literature has stressed the important role of learning from mistakes as one of the mechanisms that can enhance firms' subsequent innovation process as well as generating spillovers to other firms operating in the industry (Teerlak and Gong, 2008; Francis and Zheng, 2010; Hoetker and Agarwal, 2007). However, it is not clear to what extent firms actually learn from failure, as firms tend to de-emphasize failures and to build and focus more on prior successes (Levinthal and March, 1993; Denrell, 2003). Using detailed and comprehensive data on pharmaceutical firms drug development efforts, we examine to what extent current drug development benefits from learning due to failed previous projects. Our study contributes to the understanding of the value of knowledge that might be generated from failures and whether and when this knowledge increases the probability of

positive outcome for future projects. In addition to informing the literature on learning (from failure), our study inform the policy debate on the advantages and disadvantages of enforcing disclosure on the reasons for unsuccessful trials.

Methods

To explore learning effects and the role of failure in drug development, we draw on the Pharmaceutical Industry Database (PHID) maintained at IMT Institute for Advanced Studies in Lucca (Italy). This database contains detailed information on more than 30,000 pharmaceutical R&D projects including their Anatomical Therapeutic Chemical (ATC) classification, the indication on the treated disease, the company leading the project, the development history of the project and the patents pertaining to the projects. We establish potential learning relationships by examining whether patents linked to a drug development project cite patents applied for in the context of prior drug development efforts (failed or successful), while controlling for other types of learning such as drawing on (citing) other firms' development efforts and scientific contributions. We gauge the success of drug development projects by the stage that the projects reach as well as by the forward citations to the underlying patents (Magazzini et al., 2012). We examine whether learning from failure is 1) more or less likely than learning from success; 2) more likely when the firm has a broader, related, knowledge base relevant to the drug under development; 3) more likely when the prior failed project reached a higher phase before it was terminated.

Results

The large majority of projects in our dataset have failed, a large fraction is still in development while only a minor percentage has been marketed. Overall, this study suggests that nonetheless the negative returns, there is learning not only from success but also from failures as showed by citations trends and project development phases.

References

Baum, J. A., & Dahlin, K. B. (2007). Aspiration performance and railroads' patterns of learning from train wrecks and crashes. *Organization Science*, *18*(3), 368-385.

Cyert, R. M., & March, J. G. (1963). A behavioral theory of the firm. *Englewood Cliffs, NJ*, *2*.

Denrell, J. (2003). Vicarious learning, undersampling of failure, and the myths of management. *Organization Science*, *14*(3), 227-243.

Francis, J., & Zheng, C. (2010). Learning vicariously from failure: The case of major league soccer and the collapse of the North American Soccer League. *Group & Organization Management*, *35*(5), 542-571.

Greeve, H. R. (1998). Performance, aspirations, and risky organizational chance. *Administrative Science Quarterly*, *43*, 58-86.

Haunschild, P. R., & Sullivan, B. N. (2002). Learning from complexity: Effects of prior accidents and incidents on airlines' learning. *Administrative Science Quarterly*, *47*(4), 609-643.

Hoetker, G., & Agarwal, R. (2007). Death hurts, but it isn't fatal: The postexit diffusion knowledge created by innovative companies. *Academy of Management Journal*, *50*(2), 446-467.

Magazzini, L., Pammolli, F., & Riccaboni, M. (2012). Learning from failures or failing to learn? Lessons from pharmaceutical R&D. *European Management Review*, *9*(1), 45-58.

Levinthal, D. A., & March, J. G. (1993). The myopia of learning. *Strategic management journal*, *14*(S2), 95-112.

Levitt, B., & March, J. G. (1988). Organizational learning. *Annual review of sociology*, 319-340.

Scotchmer, S., (2004). *Innovation and incentives*. Cambridge, MA: MIT Press.

Terlaak, A., & Gong, Y. (2008). Vicarious learning and inferential accuracy in adoption processes. *Academy of Management Review*, *33*(4), 846-868.