Investments under vertical relations and agency conflicts

Dimitrios Zormpas*

February 12, 2018

Abstract

We examine the case of an investment project that, i) is characterized by uncertainty and irreversibility, ii) is undertaken in a decentralized setting and iii) its completion is conditional on the provision of an input by an outside supplier with market power.

Our findings suggest that, if compared to a case where the input is insourced, the vertical relation increases the investment cost. Nevertheless, the effect on the timing and the value of the investment is ambiguous since it depends on the information endowment of the involved parties. We discuss three levels of information sharing among the links of the supply chain and we identify the cost, the timing and the value of the option to invest for each one of them.

KEYWORDS: Investment analysis, Real options, Vertical relations, Asymmetric information, Agency conflicts.

JEL CLASSIFICATION: D82, L10.

1 Introduction

A standard framework for the analysis of investment opportunities in the literature of corporate finance is the real options approach. The real options approach examines the value and timing of investment projects building on the idea that the option to invest in a project is analogous to an American call option on a real asset. This means that, when evaluating an investment option characterized by uncertainty and irreversibility, the potential investor needs to factor in that, at the time of the investment, s/he forgoes the option to postpone the investment decision for some future time point when the uncertainty will be, naturally, partly resolved.[1]

By construction, the standard real options model does not account for agency conflicts and information asymmetries since the investment is always assumed to be managed by the project originator. However, in many modern corporations, investment decisions are delegated by the owner of the corporation (principal) to a manager (agent) who possesses a relevant skill set or piece of information.[2] Of course the principal benefits from the expertise of the agent but, at the same time, s/he might be exposed to information asymmetries. If the agent has an informational advantage over the principal, then the latter must carefully consider the underlying motives when

*Department of Civil, Architectural and Environmental Engineering, University of Padova, Via Marzolo 9, 35131, Padova, Italy. Email: dimitrios.zormpas@studenti.unipd.it. Special thanks to Michele Moretto for valuable comments and suggestions.

[1] Dixit and Pindyck (1994) and Trigeorgis (1996) provide an excellent overview of the real options approach.

[2] Delegation is a standard practice when managing large enterprises (Amaral et al., 2006). For relevant examples from industries that have to do with textiles, construction, aeronautics, telecommunications, computers, automobiles, electronics and business services, see e.g. Agrell et al. (2004), Lee et al. (2004), Schieg (2008), Tang et al. (2009), Deshpande et al. (2011), Doorey (2011), Kayis et al. (2013), Bolandifar et al. (2016), Agrell and Bogetoft (2017) and Dietrich et al. (2008).

deciding the terms of the delegation. More precisely, the principal needs to develop an appropriate mechanism in order to incentivize the agent to share private information resolving the information asymmetry. The use of such a mechanism is costly for the principal but, without it, s/he is due to face further distortions stemming from the coordination failure.[3]

As we will see in the next section, there is a growing body of papers that incorporate agency conflicts that stem from information asymmetries into the real options model. In spite of the differences in their analyses, what these papers share is the assumption that the investment cost is exogenous. As Billette de Villemeur et al. (2014) point out, this assumption is sensible when an investment is performed largely in-house as, for instance, in a research and development project. Nevertheless, this is not always true. The completion of an investment project might instead depend on the provision of a discrete input produced by an upstream firm.[4] For instance, Billette de Villemeur et al. refer to investments in the vaccine industry where facilities are specifically designed for the production of a novel vaccine. In this case, the needed customized equipment is sourced on an intermediate market from specialized input providers with market power. In the same vein, Pennings (2017) refers to large infrastructure projects as, e.g., a telecommunications network. In that case, an upstream firm (construction company) is responsible for the provision of an indispensable input (network), to a downstream firm (internet provider). In these cases, the investment cost is endogenous since it is specified by the vertical relationship between the external input supplier and the project manager who is making the investment decision on behalf of the project originator.

The key originality of this work is exactly the combination of the decentralized investment setting with the endogenous pricing of a necessary input. Using a stochastic dynamic programming model, we examine an investment project that: i) is characterized by uncertainty and irreversibility, ii) is undertaken in a decentralized setting and iii) depends on the provision of a necessary input by an external supplier with market power. Our results suggest that the effect of the presence of the upstream firm depends on the level of *transparency* in the supply chain, i.e., the extent to which information about the structure of the supply chain as well as the value of the project is readily available to the supply chain partners.[5]

In an opaque supply chain, that is, when contracting and communication are restricted only between adjacent layers of the supply chain, the endogeneity of the investment cost makes the project more expensive, favors its postponement and reduces the value of the opportunity to invest for the principal, the agent and the industry as a whole.[6]

The results differ substantially if we allow for some transparency in the supply chain.[7] We first discuss the case of traceability, that is the ability of all the firms in the supply chain to track a product's flow throughout the production process. Under traceability, the presence of an input

[3] For an overview of the literature on asymmetric information see e.g. Laffont and Martimort (2002).

[4] See also Hargadon and Sutton (2000) and Linder (2004).

[5] For a discussion on information sharing and supply chain coordination, see Lee and Whang (1998, 1999) and Kouvelis et al. (2006) respectively.

[6] Opaque supply chains are often found in consumer industries such as the garment industry (Boström et al., 2012; Doorey, 2011).

[7] Transparency is usually seen as a mechanism to promote sustainability, improve compliance with labor standards and deter unethical activities at the production site (see Egels-Zanden, 2007; Bartley, 2007 and Zyglidopoulos and Fleming, 2011 respectively). Despite the fact that many companies were initially taking a firm position against it, transparency is perceived today as a new corporate social responsibility strategy signaling that the corporation has "nothing to hide". For instance, Nike, Adidas and H&M have disclosed the names of their first-tier suppliers whereas the All American Clothing Co allows consumers to trace the flow of the final product from the cotton field and onward (see e.g. Egels-Zanden and Hansson, 2016 and the references therein). Actually Bhaduri and Ha-Brookshire (2011), Bradu et al. (2014) and Egels-Zanden and Hansson (2016) show that supply chain transparency influences positively the purchasing intentions of the consumer.

supplier still makes the investment more costly but neutralizes the informational advantage of the agent. This makes the agent worse-off but is beneficial for the project originator, the input supplier and for the industry as a whole.

Last, we discuss a transparent supply chain, that is, a supply chain comprised by firms that share the same information endowment.[8] In this case, the presence of the upstream firm guarantees optimal investment timing and a first-best aggregate value of the opportunity to invest. However, contrary to the first-best case, the value of the opportunity to invest is now shared between the project originator and the input supplier.

The remainder of the paper is organized as follows. In Section 2 we present a short overview of the related literature. In Section 3 we present in detail the model set-up demonstrating the connections with previous work. In Section 4 we analyze the case where a discrete input is a prerequisite for the completion of the project and in Section 5 we discuss our results. Section 6 concludes.

2 Overview of the related literature

This work contributes to the research area that integrates the basic theory of irreversible investment under uncertainty as in Dixit and Pindyck (1994) and the literature on asymmetric information as in Laffont and Martimort (2002).

Grenadier and Wang (2005) analyze the timing and efficiency of an investment undertaken in a decentralized setting under the presence of information asymmetries and hidden action between the project originator and the project manager. They show that the principal can induce the agent both to extend effort and to reveal private information by using a bonus-incentive contract. Despite the fact that the use of such an instrument is suboptimal in the sense that the chosen investment timing differs significantly from the timing in the setting with symmetry of information, the principal's losses are reduced since further distortions are avoided.[9] Shibata (2009) extends the analysis presented in Grenadier and Wang (2005) by replacing the bonus-incentive contract with an audit technology. Focusing on the adverse-selection-only case he shows that, by using auditing instead of a bonus-incentive, the timing inefficiency is reduced, the principal's value is larger whereas the agent's value is smaller. Nevertheless, the audit technology does not necessarily lead to an increase in the aggregate value of the opportunity to invest.

Contributing to the same body of work, Shibata (2008) focuses on the impact of uncertainty on the timing and the value of the project whereas Shibata and Nishihara (2010), Grenadier and Malenko (2011), Morellec and Schürhoff (2011), Hori and Osano (2014) and Cardoso and Pereira (2015) among others examine the effect of capital structure and financing of the investment. Cong

[8] Supply chain transparency is a broader concept than traceability since it has to do with sharing data regarding production statuses and order forecasts among the supply chain partners (see e.g. Gariverni et al., 1999, Lee and Whang, 1999 and Zhou and Benton Jr., 2007). For example, Wal-Mart's Retail Link program provides on-line summary of point-of-sales data to suppliers such as Johnson and Johnson, and Lever Brothers (Gill and Abend, 1997). Similarly, the fish-processing company Oceanpath and the supermarket chain Superquinn in Ireland, shared financial and volume data on purchasing, production, packaging, distribution and sales. The retailer was even aware of the supplier's markup whereas the supplier had access to the retailer's information on downstream demand (see Li et al., 2017).

[9] In Grenadier and Wang (2005) the management effort is assumed to be exogenous. Shibata and Nishihara (2011) approach the same problem using a two-stage optimization problem that allows investment timing and management effort endogenously decided. The numerical examples that they present suggest that the management effort is greater under asymmetric, than under symmetric, information. This in turn implies that there are trade-offs between investment efficiency and management effort under asymmetric information. In the same vein, Hori and Osano (2009) examine the replacement timing of a manager as an incentive mechanism.

(2013) and Bouvard (2014) examine the implications of endogenous learning and experimentation respectively, whereas Mæland (2010) and Koskinen and Mæland (2016) approach the agency conflict assuming that the project manager is the winner of an auction in which a number of potential delegates participate. Last, Broer and Zwart (2013) examine the optimal regulation of an investment undertaken by a monopolist who has private information on the investment cost whereas Arve and Zwart (2014) examine the case where the information asymmetry between the delegator and the delegate has to do with the starting point of the process that is used to capture the fluctuations of the stochastic parameter.

Despite the differences in the adopted framework, what all these papers have in common is the assumption that the investment cost is exogenous. However, as highlighted by Billette de Villemeur et al. (2014), the cost of an investment does not always reflect the project's economic fundamentals. Actually, as the authors show, if the completion of an investment project depends on the provision of an indispensable input from an upstream firm with market power, a vertical distortion arises. The analysis presented in Zormpas (2017) applies the endogenous pricing of the input à la Billette de Villemeur et al. (2014) to a setting that describes an investment project the completion of which depends on the successful interaction between the project originator and a foreign firm. The foreign firm in that framework is an investment partner willing to undertake a share of the sunk investment cost claiming a share of the project in return. Extending Zormpas (2017), we now study the case where the foreign firm is not an investment partner but, instead, an agent delegated by the project originator with the exercise of the investment option.

References

[1] Agrell, P. J., Bogetoft, P., 2017. Decentralization policies for supply chain investments under asymmetric information. Managerial and Decision Economics 38, 394–408.

[2] Agrell, P. J., Lindroth, R., Norrman, A., 2004. Risk, information and incentives in telecom supply chains. International Journal of Production Economics 90 (1), 1–16.

[3] Amaral, J., Billington C. A., Tsay A. A., 2006. Safeguarding the promise of production outsourcing. Interfaces 36 (3), 220–233.

[4] Arve, M., Zwart, G., 2014. Optimal Procurement and Investment in New Technologies under Uncertainty. TILEC Discussion Paper No. 2014–028.

[5] Bagnoli, M., Bergstrom, T., 2005. Log-Concave Probability and Its Applications. Economic Theory 26, 445–469.

[6] Bartley, T., 2007. Institutional emergence in an era of globalization: The rise of transnational private regulation of labor and environmental conditions. American Journal of Sociology 113(2), 297–351.

[7] Bhaduri, G., Ha-Brookshire, J. E., 2011. Do transparent business practices pay? Exploration of transparency and consumer purchase intention. Clothing & Textiles Research Journal 29(2), 135–149.

[8] Billette de Villemeur, E., Ruble R., Versaevel B., 2014. Investment timing and vertical relationships. International Journal of Industrial Organization 33, 110–123.

[9] Bolandifar, E., Kouvelis, P., Zhang, F., 2016. Delegation vs. control in supply chain procurement under competition. Production and Operations Management 25, 1528–1541.

[10] Boström, M., Börjeson, N., Gilek, M., Jönsson, A. M., & Karlsson, M., 2012. Responsible procurement and complex product chains: The case of chemical risks in textiles. Journal of Environmental Planning and Management 55(1), 95–111.

[11] Bouvard, M., 2014. Real Option Financing Under Asymmetric Information. The Review of Financial Studies 27 (1), 180–210.

[12] Bradu, C., Orquin, J. L., Thøgersen, J., 2014. The mediated influence of a traceability label on consumer's willingness to buy the labelled product. Journal of Business Ethics 124(2), 283–295.

[13] Broer, P., Zwart, G., 2013. Optimal Regulation of Lumpy Investments. Journal of Regulatory Economics 44, 177–196.

[14] Cardoso, D., Pereira, P.J., 2015. A compensation scheme for optimal investment decisions. Finance Research Letters 14, 150–159.

[15] Celik, G., 2009. Mechanism design with collusive supervision, Journal of Economic Theory 144 (1), 69–95.

[16] Cong, L. W., 2013. Costly Learning and Agency Conflicts in Investments Under Uncertainty. Available at SSRN: https://ssrn.com/abstract=2022835

[17] Deshpande, V., Schwarz, L. B., Atallah, M. J., Blanton, M., Frikken, K. B., 2011. Outsourcing manufacturing: secure price-masking mechanisms for purchasing component parts. Production and Operations Management 20, 165–180.

[18] Dietrich, B., Paleologo, G. A. Wynter, L. 2008. Revenue Management in Business Services. Production and Operations Management, 17: 475–480.

[19] Dixit, A.K., Pindyck, R.S., 1994. Investment Under Uncertainty. Princeton University Press, Princeton, NJ.

[20] Doorey, D. J., 2011. The transparent supply chain: from resistance to implementation at Nike and Levi-Strauss. Journal of Business Ethics 103(4), 587–603.

[21] Egels-Zanden, N., 2007. Suppliers' compliance with MNCs' codes of conduct: Behind the scenes at Chinese toy suppliers. Journal of Business Ethics 75(1), 45–62.

[22] Egels-Zanden, N., Hansson, N. J., 2016. Supply chain transparency as a consumer or corporate tool: The case of Nudie Jeans Co. Journal of Consumer Policy 39, 377–395.

[23] Faure-Grimaud, A., Martimort, D., 2001. On some agency costs of intermediated contracting, Economics Letters 71(1), 75–82.

[24] Gavirneni, S., Kapuscinski, R., Tayur, S., 1999. Value of information in capacitated supply chains. Management Science 45 (1), 16–24.

[25] Gill, P., Abend, J., 1997. Wal-Mart: The supply chain heavyweight champ. Supply Chain Management Review 1(1), 8–16.

[26] Grenadier, S. R., Malenko, A., 2011. Real options signaling games with applications to corporate finance. Review of Financial Studies 24: 3993–4036.

[27] Grenadier, S. R., Wang, N., 2005. Investment timing, agency, and information. Journal of Financial Economics 75, 493–533.

[28] Hargadon, A., Sutton, R. I., 2000. Building an innovation factory. Harvard Business Review (May–June), 157–166.

[29] Hayek, F. A., 1945. The use of knowledge in society. American Economic Review 35, 519–530.

[30] Hori, K., Osano, H., 2009. Optimal timing of management turnover under agency problems. Journal of Economic Dynamics and Control 34, 1962–1980.

[31] Hori, K., Osano, H., 2014. Investment timing decisions of managers under endogenous contracts. Journal of Corporate Finance 29, 607–627.

[32] Kayis, E., Erhun, F., Plambeck, E. L., 2013. Delegation vs. control of component procurement under asymmetric cost information and simple contracts. Manufacturing & Service Operations Management 15(1), 45–56.

[33] Koskinen, Y., Mæland, J., 2016. Innovation, Competition, and Investment Timing. Review of Corporate Finance Studies 5 (2), 166–199.

[34] Kouvelis, P., Chambers, C., Wang, H., 2006. Supply Chain Management Research and Production and Operations Management: Review, Trends, and Opportunities. Production and Operations Management, 15: 449–469.

[35] Laffont, J., Martimort, D., 2002. The Theory of Incentives: The Principal-Agent Model. Princeton University Press, Princeton, NJ.

[36] Laudal, T., 2010. An attempt to determine the CSR potential of the international clothing business. Journal of Business Ethics 96, 63–77.

[37] Lee H., Whang S., 1998. Information Sharing in a Supply Chain. Working Paper No. 1549, available in https://www.gsb.stanford.edu/faculty-research/working-papers/information-sharing-supply-chain

[38] Lee, H., Whang, S., 1999. Decentralized multi-echelon supply chains: Incentives and information. Management Science 45 (5), 633–640.

[39] Lee, H., Padmanabhan, V., Whang, S., 2004. Information distortion in a supply chain: The bullwhip effect. Management Science 50 (4), 546–558.

[40] Li K., Liu X.-Y., Jacobson D., 2017. Information and profit sharing between a buyer and a supplier: Theory and practice. Managerial and Decision Economics, 1–12.

[41] Linder, J. C., 2004. Transformational outsourcing. Sloan Management Review 45(2), 52–58.

[42] Mæland, J., 2010. Asymmetric Information and Irreversible Investments: an Auction Model. Multinational Finance Journal 14, 255–289.

[43] McAfee, P., McMillan, J., 1995. Organizational diseconomies of scale. Journal of Economics and Management Strategy 4, 399–426.

[44] McDonald, R., Siegel, D.R., 1986. The value of waiting to invest. Quarterly Journal of Economics 101, 707–727.

[45] Mookherjee, D., 2006. Decentralization, hierarchies and incentives: a mechanism design perspective. Journal of Economic Literature 44(2), 367-390.

[46] Mookherjee, D., Tsumagari, M., 2004. The organization of supplier networks: effects of delegation and intermediation. Econometrica 72, 1179–1219.

[47] Morellec, E., Schürhoff, N., 2011. Corporate investment and financing under asymmetric information. Journal of Financial Economics 99, 262–88.

[48] O'Brien, J.P., Folta, T.B., Johnson D.R., 2003. A real options perspective on entrepreneurial entry in the face of uncertainty. Managerial and Decision Economics 24, 515–533.

[49] Pennings E., 2017. Real options with ex-post division of the surplus. Journal of Banking & Finance 81, 200–206.

[50] Schieg, M., 2008. Strategies for avoiding asymmetric information in construction project management. Journal of Business Economics and Management 9(1), 47–51.

[51] Shibata, T., 2008 The impacts of uncertainties in the real options model under incomplete information. European Journal of Operational Research 187, 1368–1379.

[52] Shibata, T., 2009. Investment timing, asymmetric information, and audit structure: A real options framework. Journal of Economic Dynamics and Control 33, 903–921.

[53] Shibata, T., Nishihara, M., 2010. Dynamic investment and capital structure under manager-shareholder conflict. Journal of Economic Dynamics and Control 34, 158–178.

[54] Shibata, T., Nishihara, M., 2011. Interactions between investment timing and management effort under asymmetric information: Costs and benefits of privatized firms. European Journal of Operational Research 215, 688–696.

[55] Tang, C., Zimmerman, J., Nelson, M., James, I., 2009. Managing new product development and supply chain risks: the Boeing 787 case. Supply Chain Forum: An International Journal 10(1) 74–86.

[56] Trigeorgis, L., 1996. Real Options: Managerial Flexibility and Strategy in Resource Allocation. MIT Press, Cambridge, MA.

[57] Van Zandt, T., 1999. Decentralized Information Processing in the Theory of Organizations. In: Sertel M.R. (eds) Contemporary Economic Issues. International Economic Association Series. Palgrave Macmillan, London.

[58] Zhou, H., Benton Jr., W.C., 2007. Supply chain practice and information sharing. Journal of Operations Management 25,1348–1365.

[59] Zormpas, D., 2017. How vertical relationships and external funding affect investment efficiency and timing? Working Paper, Available at SSRN: https://ssrn.com/abstract=3071795.

[60] Zyglidopoulos, S., Fleming, P., 2011. Corporate accountability and the politics of visibility in 'late modernity'. Organization 18(5), 691–706.