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# THE MEDIATOR ROLE OF INNOVATION BETWEEN UNIVERSITY-INDUSTRY COLLABORATION AND FIRM PERFORMANCE

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## ABSTRACT

*University-industry collaboration is a matter that has been dealt with for many years in the literature, in addition to that it has a very long history. The reason why it is still attracted and researched by scholars is that the relationship between these two dynamic and powerful structures is also dynamic and their effects are strong enough not only for themselves but also for the region and even for the nation. Such that, governments support this relationship with various incentives nowadays. The aim of this study is to contribute to the related literature by investigating the mediator role of product and process innovation in the relationship between UIC and firm performance. By studying 90 firms, we found that UIC affects product and process innovation. We also found that product and process innovation influence firm performance. Furthermore, this study reveals that product and process innovation fully mediates the relationship between UIC and firm performance.*

***Keywords:*** *University-industry collaboration; Product innovation; Process innovation; Firm performance.*

## INTRODUCTION

Today's globally competitive environment forces firms to cooperate with partners, and cooperation with universities is of paramount importance for firms due to their enormous benefits (Abidin, Rani, Hamid & Zainuddin, 2014). Furthermore, the work of higher education institutes and industries in tandem is a very powerful driving force for innovation, economic growth, and competitiveness. Because this type of collaboration provides win-win situation (Ankrah & Omar, 2015) and improves the development of university and industry which are the basic building blocks of innovation and economic development.

In terms of firms, cooperating with the university has become not only important but also requisite in order to respond to changes in the environment and to reach the latest technology and knowledge quickly (Wirsich, Kock, Strumann & Schultz, 2016). In this respect, this paper examines the effect of university-industry collaboration (UIC) on firm performance which has been investigated in a limited number of empirical researches. There are studies suggesting that UIC has both a direct impact on firm performance (Abidin et al., 2014) and no direct impact (George, Zahra & Wood, 2002). Therefore, this study also examines the mediator effect of product and process innovation on the relation between UIC and firm performance to better explain this relationship. Thus, this paper will contribute to UIC literature by empirical research that provides more detail and a clear framework of the relationships among UIC, innovation and firm performance.

The paper is organized as follows. First, related literature is reviewed. Next, hypotheses are developed by explaining theoretical arguments. Then, the research method and analysis results are presented. In the last section, the results of the study are summarized briefly and the relevant inferences, limitations, and suggestions for future studies are given.

# BACKGROUND

## University-Industry Collaboration

UIC has emerged upon the introduced of Morrill Act (1862) which promote the transfer of new methods to agricultural operations on farms in the US, and in the 20th century with Bayh-Dole Act, the landscape of the concept determined again and became a model for other countries (Hasselmo & McKinnell, 2003). The Bayh-Dole Act is a policy which prompts universities and industry to collaborate with the aim of increasing technological advancements and innovations (Abidin et al., 2014). Then such collaborations gradually increased. Since when it is looked at the economics and innovation levels of developed countries, it is seen that this is due to knowledge production and the use of this information in the industry, thus gaining a competitive advantage in the global world and for this reason, today UIC is regarded as an important phenomenon not only for university and industry but also for nations (Mascarenhas, Ferreira & Marques, 2018).

UIC is an interaction system between industry and university, which aims to create mutual value and benefit by promoting the exchange of knowledge and technology. (Plewa & Quester, 2007; Ankrah & Omar, 2015). These two parties collaborating have different objectives but they trust one another and do the research tasks they determine together (Plewa et al., 2013). Motivations for industry to enter such a relation are those; response government policies, access to successful university students for internship or employment, enhance human capital, provide financial benefits from research at university, take advantage of national incentives to improve these relationships, mitigate the risks, access to the most current knowledge and improve corporate image etc., whereas motivations for university to enter such a relation are those; provide job opportunities to graduates, funding for their research, response government policies, make a gain for academics, transform theory into practice, increase in academic papers, get new ideas for curriculum, serve the community and contribute to economy, etc. (Ankrah & Omar, 2015).

UIC has 4 components: research support, cooperative research, knowledge transfer and technology transfer (Santoro & Chakrabarti, 2002). Research support is the financial contributions of the industry to the university (Chakrabarti & Santoro, 2004). Cooperative research involves research contracts, industrial affiliate programs and institutional facilities such as research centers and requires close interaction between university and industry (NSF, 1982). Knowledge transfer is the exchange of knowledge between university and industry through communication and personnel exchanges (Chakrabarti & Rice, 2003). Technology transfer involves the commercialization of products and process developed in the industry through put research conducting at the university into practice (Elmuti, Abebe & Nicolosi, 2005).

## Innovation

Innovation has been drawing intense interest since it was first introduced by Schumpeter (1934). It is everywhere nowadays, for example in the mission, vision, and goals of organizations or in the speeches of politicians (Kahn, 2018). Because of this situation, its definitions used in the current literature are quite different from each other (Dziallas & Blind, 2019). However, these definitions comprise two common features of it which are novelty and commercialization (Kande, Kirira & Michuki, 2017). In this context, innovation refers to both the process and output of developing something new which positively affects not only technological advancements but also the economy (Edwards-Schachter, 2018). It is also briefly defined as the commercialization of new ideas (Dziallas & Blind, 2019).

Product innovation refers to the development of goods or services new or improved to meet user needs. (OECD, 2005; Ramadani et al., 2019). It necessitates various activities in the manner of R&D, obtaining a patent and industrial engineering (Pan & Li, 2016). On the other hand, process innovation is about business, production and delivering process that customers do not pay directly to (Rajapathirana & Hui, 2018). Process innovation is a type of innovation that refers to the introduction of new or improved methods in production and delivery which contains activities such as usage of new software for supply chain and a new application to design product (Pan & Li, 2016). Product innovation enhances the market demand, while process innovation reduces the costs of the firm (Mantovani, 2006).

# HYPOTHESIS DEVELOPMENT

## UIC and Innovation

It is required that firms build alliances with other parties in order to increase the benefit of and reduce the cost of innovation development (Teece, 1996). If firms collaborate with some partners such as universities, their possibility of developing innovations with commercial value increases (Faems, Van Looy & Debackere, 2005). Because the university provides valuable information on issues such as market conditions and technological trends for the firm which is the partner of it (George et al., 2002). Additionally, UIC provides that basic research conducting by the university is shaped based on the firm's needs and thus raise in value (Wirsich et al., 2016). Ankrah and Omar (2015) propose that UIC allows the firm to access the new knowledge and theoretical accumulation of knowledge and thus improve innovative capabilities, develop new and improved products and processes, and increase competitiveness. With such a collaboration, the knowledge, basic research, and equipment of university and financial potential and market knowledge of the industry which are the power of them are combined and this ensured to introduce successful and beneficial new products and processes. Teece (1996) also suggests that the external linkages of firms have an impact on the direction and rate of innovation developed. Therefore:

H1a: UIC is positively related to product innovation.

H1b: UIC is positively related to process innovation.

## Innovation and Firm Performance

Innovation is a necessity for firms to be growth, be profitable and survive (Rajapathirana & Hui, 2018; Li & Ni, 2018). Because the activities for innovation allows the firm to continuously renew and develop, thus adapt to the dynamic environment and also hinders the firm vanish off the face of the earth (Danneels, 2002). Kobarg, Stumpf-Wollersheim, and Welpe (2018) stated that the increase in firm performance can be best if financial benefits are obtained through the sale of new products. Since it means not only producing new products but also increasing the quality of existing products, product innovation provides value to the firm even with small changes due to it (Pan & Li, 2016). On the other hand, process innovation enables the company to reduce the marginal production cost (Lambertini & Mantovani, 2009). Namely, both process innovation and product innovation increase the price-cost margin, and process innovation makes it possible to reduce the cost of production, whereas product innovation makes it possible to put up the price that customers willing to pay due to appealing to have new features of a product or completely new product (Fritsch & Meschede, 2001). Therefore;

H2a: Product innovation is positively related to firm performance.

H2b: Process innovation is positively related to firm performance.

## UIC, Innovation and Firm Performance

UIC is advantageous for both the university and industry. The industry can benefit from talented human resources in university and get the latest information about own tasks (Abidin et al., 2014). Additionally, UIC can facilitate taking out patents and this positively impacts the position of the firm in the market and financial situation of it positively (George et al., 2002). Hence, it can be said that, as mentioned earlier, UIC has also a positive effect on the firm performance of the company as it affects the product and process innovation. Moreover, the effects of product and process innovation on firm performance is frequently discussed in the literature (Al-Sa'di, Abdallah & Dahiyat, 2017). Many studies have claimed that firm performance and competitiveness can be superior if innovative products and processes develop ever since Porter's (1985) study. Hence, it is asserted that the relationship between UIC and firm performance can be explained by including the mediating role of product and process innovation. Therefore;

H3a: Product innovation positively mediates the relationship between UIC and firm performance.

H3b: Process innovation positively mediates the relationship between UIC and firm performance.

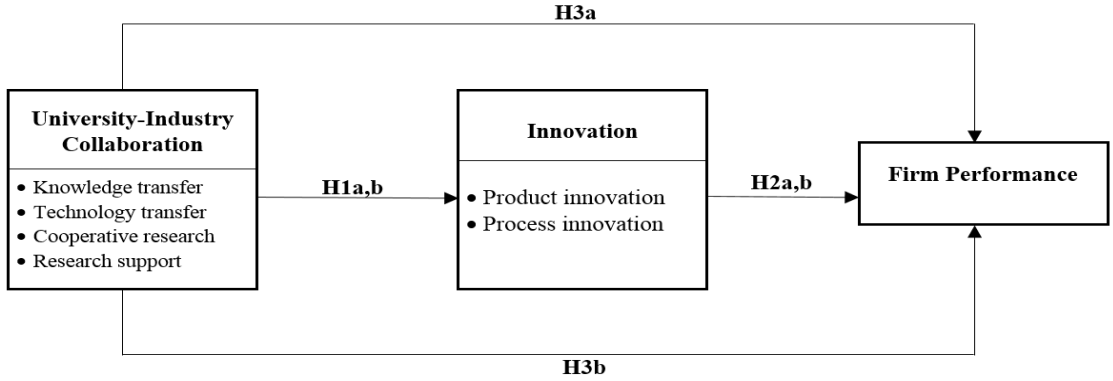


**Figure 1.** Proposed research model

# RESEARCH METHOD AND ANALYSIS

## Measures and Sampling

The scales to measure constructs were adapted from prior studies. UIC scale was adapted from Santoro, and Chakrabarti (2002). For the product and process innovation, items were adapted from Hung, Lien, Yang, Wu, and Kuo (2011). Items to measure firm performance were adapted from Ellinger, Ellinger, and Keller (2002). All the scale items were measured by a 5-point Likert scale.

The measurement items were translated into Turkish. Then they were retranslated back to English. These two translations were examined and differences were fixed. The final form of the questionnaire was tested in a pilot study on 30 respondents who work in the industry. Afterward, it was revised according to their feedback and made the understandable.

In order to implement the survey, 200 firms that have collaborated with the university were contacted and 120 of them agreed to participate in our survey study. However, a total of 184 usable questionnaires were returned from 90 firms. The participants are mid-level and senior executives in their employed firms in İstanbul and Kocaeli in Turkey.

Most of the respondents (83.7%) are male. 90.2% of them have received university or postgraduate degree. 17.9% of the participants are the owner of the business and 18.5% are general managers. The firms are different sectors such as manufacturing (25.3%), automotive (19%), etc. 65.2% of the firms have 100 or fewer employees and 48.4% of them have existed in the sector for 20 years or longer.

## Measure Validity and Reliability

After data collection, confirmatory factor analysis (CFA) was conducted using AMOS. All variables were tested in a CFA model. One of UIC's dimensions, research support was excluded because no item loaded on it and also problematic items were eliminated in a step- by- step procedure. Final CFA results shown in Table 1. These results indicated that each item loaded significantly on their respective factor and there is an adequate model fit (x2/df= 2.06, CFI = .91, IFI=.91, TLI=.90, RMSEA=0,07, PNFI= .75). Table 1 also shows the Cronbach's alpha coefficients for all variables which are above the threshold level (.70) suggested by Nunnally (1978).

**Table 1.** Factor Loadings and Cronbach's α Values

| Variables | Items | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| **Knowledge transfer** | KT1 | .63 | | | | | |
| | KT2 | .55 | | | | | |
| | KT3 | .75 | | | | | |
| | KT5 | .87 | | | | | |
| | KT6 | .86 | | | | | |
| | KT7 | .89 | | | | | |
| | KT8 | .82 | | | | | |
| **Technology transfer** | TT1 | | .88 | | | | |
| | TT2 | | .92 | | | | |
| | TT3 | | .92 | | | | |
| | TT4 | | .87 | | | | |
| | TT5 | | .88 | | | | |
| **Cooperative research** | CR1 | | | .87 | | | |
| | CR2 | | | .95 | | | |
| | CR3 | | | .86 | | | |
| | CR4 | | | .84 | | | |
| **Firm Performance** | FP16 | | | | .64 | | |
| | FP13 | | | | .79 | | |
| | FP12 | | | | .76 | | |
| | FP7 | | | | .73 | | |
| | FP6 | | | | .70 | | |
| | FP5 | | | | .64 | | |
| **Product Innovation** | ProductI1 | | | | | .78 | |
| | ProductI2 | | | | | .81 | |
| | ProductI3 | | | | | .64 | |
| | ProductI4 | | | | | .75 | |
| | ProductI5 | | | | | .67 | |
| **Process Innovation** | ProcessI1 | | | | | | .64 |
| | ProcessI2 | | | | | | .88 |
| | ProcessI3 | | | | | | .70 |
| **Cronbach's α** | | .91 | .95 | .94 | .87 | .85 | .78 |

UIC was defined as a second-order variable in this study. It consists of the variables knowledge transfer, technology transfer and cooperative research and their factor loadings between UIC are .97, .92 and .95 respectively. Table 2 presents the descriptive statistics, correlation coefficients, and reliabilities of our variables. Average variance extracted (AVE) and composite reliabilities (CR) for all variables exceed the threshold levels which are respectively .50, and .70 (Fornell & Larcker 1981). Moreover, the square root of AVE for each variable is well beyond the correlations for each construct as Fornell and Larcker (1981) recommended. According to these results, it is concluded that the measures are reliable and have validity.

**Table 2.** Correlation Coefficients, Descriptive Statistics, Validity and Reliability Scores

| Variables | Means | Std. Dev. | AVE | CR | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|---|---|
| **1. UIC** | 2.18 | .98 | .90 | .96 | (.95) | | | |
| **2. Product innovation** | 3.84 | .73 | .54 | .85 | .17** | (.73) | | |
| **3. Process innovation** | 3.62 | .74 | .56 | .79 | .26** | .66** | (.75) | |
| **4. Firm performance** | 3.56 | .66 | .51 | .86 | .21** | .51** | .49** | (.71) |

Diagonals show the square root of AVEs.

**p < .01 *p < .05

## Common Method Variance Assessment

This study prone to common method bias. To check if this problem exists, Harman's single-factor test was used (Podsakoff, MacKenzie, Lee & Podsakoff, 2003). We found that there are many factors with

eigenvalues greater than 1 and no single factor explaining most of the variance (the highest one was 37,47%). Therefore, it is concluded that common method bias is not a problem for our study.

## Hypothesis Testing

To test the hypotheses, we performed structural equation modeling (SEM) analysis. It was found that the conceptual model fits the data ($\chi$ 2 /df = 2.046, CFI: .91, IFI: .91, TLI: .90, RMSEA: .076). Table 2 shows the results of hypotheses testing. The results indicate the positive relationship between UIC and product innovation ($\beta$ = .17, p <.05) and a positive relationship between UIC and process innovation ($\beta$ = .26, p <.01), supporting H1 and H2. It is also indicated that both product innovation ($\beta$ = .32, p <.01) and process innovation ($\beta$ = .29, p <.05) positively related to firm performance, supporting H3 and H4.

**Table 3.** Path Model

| Hypotheses | Path | Path Coefficient | Result |
|---|---|---|---|
| H1a | UIC →Product innovation | .17* | Supported |
| H1b | UIC →Process innovation | .26** | Supported |
| H2a | Product innovation →Firm Performance | .32** | Supported |
| H2b | Process innovation →Firm Performance | .29* | Supported |
| | $X^{2/df}$ = 2.046, CFI: .91, IFI: .91, TLI: .90, RMSEA: .076 | | |

**p < .01 *p < .05

To test the mediating effects of product and process innovation, Baron and Kenny (1986) procedure was employed. In this regard, three regression models were tested (Table 4). In model 1, the direct relationship between UIC and firm performance was tested and it was found that UIC is positively related to firm performance ($\beta$ = .21, p < .05). In model 2, we tested the effect of UIC on product and process innovation and we found that UIC is positively associated with both product and process innovation ($\beta$ = .17, p < .05 and $\beta$ = .26, p < .01, respectively). In model 3, mediating variables product and process innovation added the model 1 and we found that UIC is positively related to product innovation ($\beta$ = .17, p < .05) and process innovation ($\beta$ = .26, p < .01). Product innovation is positively related to firm performance ($\beta$ = .31, p < .01) and process innovation is also related to firm performance ($\beta$ = .26, p < .05). However, we found that there is no relationship between UIC and firm performance ($\beta$ = .09, p > .05). Therefore, it is concluded that product and process innovation fully mediates the relationship between UIC and firm performance.

To estimate the significance of the mediation effects, bootstrap resampling procedures with 2000 samples and a 95% bias-corrected confidence interval was used and we also created the user-defined estimand to calculate the specific indirect effects. Because bias-corrected bootstrap provides accurate confidence limits and the greatest statistical power for mediation analysis (MacKinnon, Lockwood & Williams, 2004). According to results shown in Table 5, specific mediating effects of both product innovation ($\beta$ = .05, p < .05) and process innovation ($\beta$ = .06, p < .05) are significant, supporting H5 and H6.

**Table 4.** Results for Mediation Analysis

| Relationship | Model 1 | Model 2 | Model 3 |
|---|---|---|---|
| UIC → Firm performance | .21* | | .09 |
| UIC → Product innovation | | .17* | .17* |
| UIC → Process innovation | | .26** | .26** |
| Product innovation → Firm performance | | | .32** |
| Process innovation → Firm performance | | | .26* |
| Model fit indices | $\chi^{2/df}$ = 2.028, CFI: .95, IFI: .95, TLI: .94, RMSEA: .075 | $\chi^{2/df}$ = 2.121, CFI: .93, IFI: .93, TLI: .92, RMSEA: .078 | $\chi^{2/df}$ = 1.951, CFI: .92, IFI: .92, TLI: .91, RMSEA: .072 |

Path coefficients are standardized.
**p < .01, *p < .05.

**Table 5. Bootstrap Analysis and Specific Mediation Effects**

| Paths | Estimate | BC95%CI |
|---|---|---|
| *Direct effect* | | |
| UIC→Firm performance | .07 | -.069/.206 |
| *Indirect effect* | | |
| UIC→Firm performance | .11* | .022/.225 |
| *Specific indirect effects* | | |
| UIC → Product innovation→Firm performance | .05* | .001/.169 |
| UIC → Process innovation→Firm performance | .06* | .001/.180 |

*p < .05.

# DISCUSSION AND CONCLUSION

This paper investigates the effect of UIC on product and process innovation and the effect of product and process innovation on firm performance. It also examines the mediating role of product and process innovation in the relationship between UIC and firm performance. Thus, this study provides substantial contributions to related literature.

Results reveal that UIC positively affects both product and process innovation. This finding is consistent with previous researches (Maietta, 2015; Kande et al., 2017; Vega-Jurado, Kask & Manjarrés-Henriquez, 2017). This result implies that firms should collaborate with universities to develop both product and process innovation. Since firms need many things such as information, trends, and expertise to introduce successful innovations. In this respect, cooperating with universities provide firms with have up-to-date information about the market and recent trends about technology (George et al., 2002) and also get the most profound knowledge thanks to the experts of the related field who are academicians (Wirsich et al., 2016). Thus, in cooperation between these two partners, which have different strengths to develop innovation, it is inevitable to introduce more new products and processes.

It is also revealed that both product and process innovation positively influence firm performance. This result is consistent with past researches (Gunday, Ulusoy, Kilic & Alpkan, 2011; Rajapathirana & Hui, 2018; Ramadani et al., 2019). Innovation is a key factor to survive in the global market (Porter, 1985). Furthermore, product innovation making it possible to high priced sales, and process innovation reducing costs enable the financial development of firms (Fritsch & Meschede, 2001). Innovation provides not only financial benefits. Firms developing innovation become up-to-date and keep up with the times. Thus, these firms can maintain their position in the market and even become a better position by adapting to the current changing market structure. Namely, product and process innovation makes it possible for the firm to perform better.

Finally, it is demonstrated that product and process innovation fully mediates the relationship between UIC and firm performance. This implies that a successful UIC improves firm performance via product and process innovation developing in university-firm collaborative efforts. For this reason, firms collaborating with the universities should focus on developing product and process innovation with this collaboration.

There are few methodological limitations in this study. First, the generalisability of results is a limitation. Because this study was conducted in Kocaeli, and Istanbul in Turkey. Hence, different results can be obtained in studies conducting in other regions. Second, data were collected in a cross-sectional study design. Therefore, the conditions under which the data is collected may vary, and consequently, the results may vary.

This study makes several suggestions for future studies. This research was conducted in Kocaeli and Istanbul in Turkey. Next studies may examine these relationships in another district, country, and culture. Especially, research comparing UIC and its effects in two-country, one of them is a developed country and the other one is a developing country, can provide valuable results. Additionally, we examined UIC-innovation-performance linkages in terms of firms. Next studies may examine the effect of UIC on both the firm's innovative outputs and the university's innovative outputs in a study and compare the results. Furthermore, future studies may also examine our model by incorporating the cooperation time period as a moderator variable.

# REFERENCES

Abidin, I., Rani, A. A., Hamid, M. R. A. and Zainuddin, Y. (2014), University-Industry Collaboration, Firm Performance, and Stakeholder Theory, International Journal of Contemporary Business Management, 1(1), pp. 41-51.

Al-Sa'di, A. F., Abdallah, A. B. and Dahiyat, S. E. (2017), The mediating role of product and process innovations on the relationship between knowledge management and operational performance in manufacturing companies in Jordan, Business Process Management Journal, 23(2), pp. 349-376.

Ankrah, S. and Omar, A. T. (2015), Universities–industry collaboration: A systematic review, Scandinavian Journal of Management, 31(3), pp. 387-408.

Baron, R. M. and Kenny, D. A. (1986), The Moderator-Mediator Variable Distinctionin Social Psychological Research: Conceptual, Strategic, and Statistical Considerations, Journal of Personality and Social Psychology, 51 (6), pp. 1173-1182.

Chakrabarti, A. K. and Santoro, M. D. (2004), Building social capital and learning environment in university–industry relationships, International Journal of Learning and Intellectual Capital, 1(1), pp. 19-36.

Chakrabarti, A. and Rice, M. (2003), Changing roles of universities in developing entrepreneurial regions: The case of Finland and the US. Industrial Performance Center, MIT IPC Working Paper IPC-03-003, September.

Damanpour, F. (1991), Organizational innovation: A meta-analysis of effects of determinants and moderators, Academy of management journal, 34(3), pp. 555-590.

Danneels, E. (2002), The dynamics of product innovation and firm competences, Strategic management journal, 23(12), pp. 1095-1121.

Dziallas, M. and Blind, K. (2019), Innovation indicators throughout the innovation process: an extensive literature analysis, Technovation, 80-81, pp. 3-29.

Edwards-Schachter, M. (2018), The nature and variety of innovation, International Journal of Innovation Studies, 2, pp. 65-79.

Ellinger, A. E., Ellinger, A. D. and Keller, S. B. (2002), Logistics Managers' Learning Environments and Firm Performance, Journal of Business Logistics, 23(1), pp. 19-37.

Elmuti, D., Abebe, M. and Nicolosi, M. (2005), An overview of strategic alliances between universities and corporations, Journal of workplace Learning, 17(1/2), pp. 115-129.

Faems, D., Van Looy, B. and Debackere, K. (2005), Interorganizational collaboration and innovation: Toward a portfolio approach, Journal of product innovation management, 22(3), pp. 238-250.

Fornell, C. and Larcker, D. F. (1981), Evaluating Structural Equation Models with Unobservable Variables and Measurement Error, Journal of Marketing Research, 18(1), pp. 39–51.

Fritsch, M. and Meschede, M. (2001), Product innovation, process innovation, and size, Review of Industrial organization, 19(3), pp. 335-350.

George, G., Zahra, S. A. and Wood Jr, D. R. (2002), The effects of business–university alliances on innovative output and financial performance: a study of publicly traded biotechnology companies, Journal of business Venturing, 17(6), pp. 577-609.

Gunday, G., Ulusoy, G., Kilic, K. and Alpkan, L. (2011), Effects of innovation types on firm performance, International Journal of production economics, 133(2), pp. 662-676.

Hasselmo, N. and McKinnell, H. (2003), Working together, creating knowledge: The university-industry research collaborative initiative, Business-Higher Education Forum, Washington, DC.

Hung, R. Y. Y., Lien, B. Y. H., Yang, B., Wu, C. M. and Kuo, Y. M. (2011), Impact of TQM and organizational learning on innovation performance in the high-tech industry, International business review, 20(2), pp. 213-225.

Kahn, K. B. (2018), Understanding innovation, Business Horizons, 61, pp. 453-460.

Kande, A. W., Kirira, P. G. and Michuki, G. N. (2017), University Industry Collaboration and Innovativeness of Firms: Evidence from Kenya Innovation Survey, International Journal for Innovation Education and Research, 5(3), pp. 1-10.

Kobarg, S., Stumpf-Wollersheim, J. and Welpe, I. M. (2018), University-industry collaborations and product innovation performance: the moderating effects of absorptive capacity and innovation competencies, The Journal of Technology Transfer, 43(6), pp. 1696-1724.

Lambertini, L. and Mantovani, A. (2009), Process and product innovation by a multiproduct monopolist: a dynamic approach, International Journal of Industrial Organization, 27(4), pp. 508-518.

Li, Z. and Ni, J. (2018), Dynamic product innovation and production decisions under quality authorization, Computers & Industrial Engineering, 116, pp. 13-21.

MacKinnon, D. P., Lockwood, C. M. and Williams, J. (2004), Confidence limits for the indirect effect: Distribution of the product and resampling methods, Multivariate behavioral research, 39(1), pp. 99-128.

Maietta, O. W. (2015), Determinants of university–firm R&D collaboration and its impact on innovation: A perspective from a low-tech industry, Research Policy, 44(7), pp. 1341-1359.

Mantovani, A. (2006), Complementarity between product and process innovation in a monopoly setting, Economics of Innovation and New Technology, 15(03), pp. 219-234.

Mascarenhas, C., Ferreira, J. J. and Marques, C. (2018), University–industry cooperation: A systematic literature review and research agenda, Science and Public Policy, 45(5), pp. 708-718.

National Science Foundation, (1982), University–Industry Research Relationships: Myths, Realities, and Potentials, Fourteenth Annual Report, US Government Printing Office, Washington, DC.

Nunnally, J. C. (1978), Psychometric Theory (2nd ed.) (McGraw-Hill Series in Psychology), New York, McGraw-Hill.

Pan, X. and Li, S. (2016), Dynamic optimal control of process–product innovation with learning by doing, European Journal of Operational Research, 248(1), pp. 136-145.

Plewa, C. and Quester, P. (2007), Key drivers of university-industry relationships: the role of organisational compatibility and personal experience, Journal of Services Marketing, 21(5), pp. 370-382.

Plewa, C., Korff, N., Johnson, C., Macpherson, G., Baaken, T. and Rampersad, G. C. (2013), The evolution of university–industry linkages—A framework, Journal of Engineering and Technology Management, 30(1), pp. 21-44.

Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y. and Podsakoff, N. P. (2003), Common method biases in behavioral research: a critical review of the literature and recommended remedies. Journal of Applied Psychology, 88(5), pp. 879-903.

Porter, M. (1985), Competitive Advantage: Creating and Sustaining Superior Performance, New York: The Free Press.

Rajapathirana, R. J. and Hui, Y. (2018), Relationship between innovation capability, innovation type, and firm performance, Journal of Innovation & Knowledge, 3(1), pp. 44-55.

Ramadani, V., Hisrich, R. D., Abazi-Alili, H., Dana, L. P., Panthi, L. and Abazi-Bexheti, L. (2019), Product innovation and firm performance in transition economies: A multi-stage estimation approach, Technological Forecasting and Social Change, 140, pp. 271-280.

Santoro, M. D. and Chakrabarti, A. K. (2002), Firm size and technology centrality in industry–university interactions, Research policy, 31(7), pp. 1163-1180.

Teece, D. J. (1996), Firm organization, industrial structure, and technological innovation, Journal of economic behavior & organization, 31(2), pp. 193-224.

Vega-Jurado, J., Kask, S. and Manjarrés-Henriquez, L. (2017), University industry links and product innovation: cooperate or contract?, Journal of technology management & innovation, 12(3), pp. 1-8.

Wirsich, A., Kock, A., Strumann, C. and Schultz, C. (2016), Effects of university–industry collaboration on technological newness of firms, Journal of Product Innovation Management, 33(6), pp. 708-725.