GOVERNMENT SUPPORTS FOR INNOVATION: WHEN IS PROMOTING ENTREPRENEURIAL ENTRY SUBOPTIMAL?

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ABSTRACT

GOVERNMENT SUPPORTS FOR INNOVATION: WHEN IS PROMOTING ENTREPRENEURIAL ENTRY SUBOPTIMAL?

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Governments evidently provide financial support for R&D expenditures of start-ups, and subsidies for commercialization costs of entrepreneurs with the aim of promoting innovation and increasing welfare. In order to investigate these implications of entrepreneurship and government supports for an oligopolistic market with homogeneous goods, I construct a model where a start-up can commercialize its innovation either by market entry or by sale to an incumbent firm. The innovation is first considered a non-drastic process innovation, and then, in an extension, it is supposed to reduce fixed production cost. The results reveal that an optimal policy scheme for government supports is not just beneficial but also required in most cases to achieve higher innovation levels yielding more welfare. Governments' bias towards favoring entrepreneurial entry over commercialization by sale is found to be counter-productive both for a non-drastic process innovation if the start-up is not innovative enough and for a fixed cost innovation if an entry-deterring incumbent acquisition is expected. In addition, for a non-drastic process innovation, increasing level of market competition diminishes the R&D expenditure and the resulting innovation level, if the start-up is, again, not an able innovator. For a fixed cost innovation, it inclines the start-up to choose riskier projects, that is, projects to arrive the product market less frequently, when market entry is possible for the start-up. Under such circumstances, facilitating incumbent acquisition instead of promoting entrepreneurial entry seems to be a preferable option for governments.

Keywords: Entrepreneurial Innovation, Product Market Entry, Acquisitions of Start-up Innovations, Oligopolistic Market Competition, Government Policies for Innovation

ÖZ

İNOVASYON İÇİN DEVLET DESTEKLERİ: YENİ FİRMALARIN PİYASAYA GİRİŞİNİ TEŞVİK ETMEK NE ZAMAN OPTİMAL DEĞİLDİR?

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Devletler, inovasyonu teşvik etmek ve sosyal refahı artırmak amacıyla, yeni girişimlerin Ar-Ge harcamalarına finansal destek sağlamakta ve girişimcilerin karşılaştığı ticarileşme maliyetlerini sübvanse etmektedir. Girişimciliğin ve devlet desteklerinin homojen mallar üreten bir oligopol piyasa üzerindeki böylesi etkilerini incelemek için, yeni bir girişimin inovasyonunu piyasaya girerek ya da inovasyonu zaten piyasada yer alan bir firmaya satarak ticarileştirebildiği bir model kurulmuştur. İnovasyon, önce, şiddetli olmayan bir proses inovasyonu olarak düşünülmüş; sonrasında, bir ek model için, sabit üretim maliyetini düşüreceği farz edilmiştir. Sonuçlar ortaya koymaktadır ki daha fazla refah getiren yüksek dereceli inovasyonlar elde etmek için optimal bir politika tasarısı sadece faydalı değil, çoğu durumda gereklidir. Devletlerin satarak ticarileştirme yerine piyasaya girişi destekleme eğiliminin hem, girişim yeteri kadar inovatif değilse, şiddetli olmayan proses inovasyonu için hem de, piyasaya yeni girişi önleyen satın al-

manın gerçekleşmesi bekleniyorsa, sabit maliyet inovasyonu için amaçlananın aksine etki gösterdiği bulunmuştur. Bununla beraber, eğer girişim, yine, ehil bir yenilikçi değilse artan piyasa rekabeti şiddetli olmayan bir proses inovasyonu için yapılan Ar-Ge harcamalarını ve elde edilen inovasyonun derecesini azaltmaktadır. Sabit maliyet inovasyonu içinse, piyasaya giriş girişim için mümkün olduğunda, girişimi, daha az sıklıkla başarıya ulaşacak riskli projeler seçmeye sevk etmektedir. Bu şartlar altında, piyasaya girişi teşvik etmek yerine zaten piyasada yer alan firmaların inovasyonları satın almasını kolaylaştırmak devletler için tercih edilir bir seçenek olarak öne çıkmaktadır.

Anahtar Kelimeler: Girişimci İnovasyonu, Ürün Piyasasına Giriş, Girişim İnovasyonlarının Satın Alınması, Oligopol Piyasa Rekabeti, İnovasyon İçin Devlet Politikaları

To My Family

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CHAPTER 1

INTRODUCTION

In a significant number of macroeconomic models, innovation is asserted to be the main driver of economic growth. In Romer (1990), growth is shown as a result of technological change that profit-maximizing agents generate so as to exploit market incentives for developing more efficient intermediate goods. So, what his paper means by technological change is basically innovation, which is made in response to the demand of incumbent firms for more efficient production processes. Similarly, Aghion and Howitt (1992) demonstrate that growth arises solely from technological progress, which is brought about by competition among R&D firms that build innovations. Here, each innovation is assumed an intermediate good which is utilized to produce final output more efficiently than before. Additionally, Grossman and Helpman (1994) accents the endogeneity of technological progress since the process whereby scientific findings are transformed into goods with practical value almost always asks for intentional and sizeable investments by profit-seeking agents. Thus, once again, technological progress stems mostly from innovations, which are created by agents to increase their income. They also define improvements in technology as the best chance in order to promote high and sustainable economic growth [1].

Among all innovative activities held by all economic agents across all industries, entrepreneurial innovation plays a crucial role for economic progress. Baumol (2010) points out the importance of entrepreneurship for economic growth and remarks that:

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[1] For further explanations about the importance of innovation for economic growth, see, among others, Grossman and Helpman (1989, 1991).

> If we seek to explain the degree of success of those economies that have managed to grow significantly in comparison to those that have remained relatively stagnant, we find it difficult to do so without taking into consideration differences in the availability of the entrepreneurial talent and in the motivational mechanism that drives them on.

Anyone can observe real-life actions taken in parallel with Baumol's assertions. There seems to be a tendency of governments worldwide to support R&D in start-ups and small firms via grants, loans and tax incentives rather than R&D in large established firms. For instance, Özçelik and Taymaz (2008) report that small firms in Turkey have benefited more than large established firms from increased level of R&D support provided by the government in recent years. And Taymaz and Üçdoğruk (2009) illustrate that this tendency to support small-firm R&D more gives result. According to their findings, once small firms in Turkey overcome the financial hurdles to conducting R&D via government supports, they spend proportionately more on R&D than large established firms do.

Turkish government's preference to support R&D in small firms, and start-ups in particular, are still observable in today's policy packages. Small and Medium Scaled Industry Development and Support Directorate (KOSGEB as Turkish acronym) provides grants and loans to SMEs in all sectors for investing in research equipment, conducting R&D, and applying their innovations to the industry. And R&D by start-ups are supported rather by The Scientific and Technological Research Council of Turkey (TÜBİTAK as Turkish acronym). Through the 1512 – Entrepreneurship Multi-Phase Programme, TÜBİTAK subsidizes early-stage research expenditures of an individual with an innovative idea via grants, whether the idea is about a technologically-advanced product or about a process innovation for more efficient production. Grants can add up to 150,000 TL. If the innovative idea is technologically validated and is assessed economically feasible during the 1512 Programme, the individual is asked to establish a company. This brand-new start-up now can apply to the 1507 - SME Research, Development & Innovation Grant Programme. This Programme financially supports the process of turning research findings of the previous stage into innovations with practical value via grants. 75 per cent of costs of finalizing the innovations are subsidized by this Programme.

A closer look at policy applications around the globe reveals that R&D expenditures of start-ups are not supported alone, governments also favor entrepreneurial entry over the utilization of these innovations by incumbent firms. As an example for such policy in developed economies, Mirrlees et al. (2011) documents that the U.K. tax system provides incentives to individuals for entrepreneurial entry over any other alternatives of income. Additionally, The Europe 2020 Strategy states that Europe lacks enough numbers of entrepreneurs and this issue needs to be addressed so as to promote strong economic growth and high levels of employment (European Commission, 2013). And the Turkish case can be seen to exemplify developing countries' view on entrepreneurship. After substantial support for innovation in start-ups provided by TÜBİTAK, KOSGEB facilitates entrepreneurial entry through Industrial Application Support Programme via subsidizing 75 per cent of commercialization costs of start-up innovations. Having no corresponding support for any kind of transaction of innovation between an incumbent firm and a start-up, it is straightforward to conclude that the policy set in Turkey to boost innovation has a bias towards entrepreneurial entry.

Yet start-ups might prefer a different path. Results from various empirical studies point out that start-ups often choose to commercialize their innovations by licensing or selling to one or more incumbent firms. Granstrand and Sjölander (1990) present evidence on how large established firms in Sweden obtain their technological capacity by acquiring the technology of small, research-oriented firms. Blonigen and Taylor (2000) show empirically that, in the U.S. electronic and electrical equipment sectors, firms with low R&D intensity choose to acquire technology from start-ups. Their findings also indicate that, in the periods when a firm's R&D intensity lowers, its propensity to acquire new technological knowledge from start-ups rises. In order to properly explain this phenomenon of commercialization through cooperation with established firms, Gans et al. (2002) remark that:

> If a market for ideas functions efficiently, the incumbents can contract for start-up innovations and so foreclose on a potentially important form of competition. Imperfections in the market for ideas, conversely, can spur a competitive strategy by start-up innovators.

Accordingly, their empirical results indicate that when innovations receive some kind of intellectual property rights protection (e.g., a patent), and/or start-ups establish a relationship with a broker to contract with an incumbent firm (e.g., a venture capitalist), and/or sunk costs associated with product market entry are high , start-ups are more likely to prefer cooperation with established firms through licensing, alliances or acquisitions for commercializing their innovations [2].

In the face of apparent contrast between the proclivity of policies for favoring entrepreneurial entry and empirical evidence on start-ups cooperating with incumbent firms, some questions arise on how to construct the optimal policy scheme so as to incentivize innovative activity and expand social welfare at the same time. In what conditions does entrepreneurial entry or cooperation with incumbent firms provide more benefits in terms of social welfare than the other one? How does market structure, competition in particular, affect the welfare implications of entrepreneurial entry and cooperation with incumbent firms, respectively? How does competition affect the innovation incentives when the innovator chooses to enter the product market or to commercialize via cooperation with incumbent firms? Does entrepreneurial entry or commercializing via cooperation with incumbent firms lead to more R&D conducted by the innovator?

In order to investigate these sorts of implications of entrepreneurship and government supports for an oligopolistic market with homogeneous goods, I construct a model, following Norbäck and Persson (2012) and Norbäck et al. (2016), where a start-up can commercialize its innovation either by product market entry or by sale to an incumbent firm. The innovation is considered a non-drastic process innovation; that is, the resulting decrease in the marginal cost of the firm which makes use of the innovation does not throw any other firm(s) out of the market. Only the start-up has the capacity to conduct R&D and, in the sense of Arrow (1962), its innovation cannot be imitated by any incumbent firm. This assumption also rules out the possibility of preemptive innovation by an incumbent firm. This model further abstracts from spillover effects, mentioned in Spence (1984), where the total R&D expenditure in the

[2] See Hall (1990) for empirical evidence from the U.S. manufacturing sector that the number of acquisitions of new technology created by start-ups has been on the rise, and Lerner and Merges (1998) for evidence that the number of technology alliances has been growing in various industries.

entire industry defines the technological capability of one firm to a large extent. And, most importantly, the process of invention here is deterministic, which means that R&D expenditure by the start-up always yields a reduction of marginal cost to the intended level.

This model takes incumbent firms symmetric, as producing with the same and constant marginal cost. There is no fixed production cost for any firm operating in the market, let it be an incumbent firm or the entrepreneurial firm. If the start-up decides to enter the product market with its innovation, it must incur a fixed entry cost, which is referred to as commercialization cost in this thesis from this point on, as defined in Norbäck and Persson (2012). Commercialization cost consists of investments that are crucial to participate in the product market competition; such as obtaining production facilities, procurement of transportation vehicles for goods, advertising, networking, etc. Since the incumbents have already made those investments, I assume out any commercialization cost for an incumbent firm. After entry, the entrepreneurial firm displays the same characteristics with an acquiring incumbent firm. In other words, constraints of production capacities and the time necessary to claim a market share are not concerns of this study. If the start-up decides to sell the innovation, the acquiring firm must pay a transaction cost, as defined in Norbäck et al. (2016), beside the amount received by the start-up. As Norbäck et al. (2016) argue, the transaction costs associated with a technology transfer might be substantial. Such a transfer brings about administrative and legal costs, for instance licensing a patent. Likewise, adapting a new technology to the current production process causes further costs for the acquiring firm. Additionally, someone can anticipate the acquiring firm to incur more costs whilst confirming the quality of the innovation, owing to the information asymmetry between the start-up and the incumbent firms. My definition of transaction cost includes all of these features, thereby it could get very large.

Government support for innovation is modeled in two steps in this study. At first, financial support for R&D expenditures via grants is provided, no matter what the commercialization strategy of the start-up is. After the innovation is obtained, the second step is either to subsidize commercialization cost for entrepreneurial entry or to subsidize transaction cost of an incumbent acquisition of the innovation. Financial support at the second step is again a grant, and constitutes the same amount for each choice of the government. So, the government's expenditure to support innovative activity is constant whether it facilitates entrepreneurial entry or incumbent acquisition of the innovation. Government is expected to decide which one to support depending on their respective contribution to social welfare, which is the sum of consumer surplus and producer surplus. Government's income is irrelevant to the model, because the model is a partial equilibrium one, dealing with the oligopolistic market and the start-up with the possibility of market entry.

The first result of the model demonstrates that, for a given innovation level (quality), sale of the innovation is favored over entrepreneurial entry in terms of social welfare unless the innovation is too small. To understand the intuition behind this result, consider an n-firm oligopolistic market. If sale of the innovation happens, we have one efficient firm and $n-1$ inefficient firms in the market. If the start-up enters the product market, we have the same efficient firm and n inefficient firms in the market. Therefore, entrepreneurial entry brings about two effects that are contrary to each other. It increases consumer surplus, obviously, because of reduced level of market power of any firm (efficient or inefficient) in the product market. However, having one more inefficient firm, which steals business from the efficient firm, diminishes total producer surplus. According to the results of the model, for an oligopolistic market with homogeneous goods, the latter dominates the former unless the efficiency gap between the firm acquiring the innovation and the non-acquiring firms is too small. Besides, as the product market gets more competitive by increasing the number of incumbent firms, entrepreneurial entry is not preferable on the societal level for a larger range of non-drastic process innovations.

My model elucidates many dimensions of interaction between the level of product market competition and entrepreneurial innovation. One of those is the effect of product market competition on the incentives for innovative activities of a start-up. The results of the model indicate that increasing the level of product market competition, by increasing the number of incumbent firms, reduces the valuations of all agents in the model for the innovation. This means that, in an imaginary bargaining process, both the start-up and the incumbent firms bid less to acquire a given level of innovation, when product market gets more competitive [3]. In other words, whether the innovation is commercialized by product market entry or by sale to an incumbent firm, the start-up receives less payoff for its innovative activity in the face of more fierce product market competition.

It is not straightforward to see which option for commercialization strategy is affected less negatively by increased level of product market competition, or, equivalently, higher number of incumbent firms. When scrutinized, the results point out that there are two thresholds of innovation level in this respect. Below one of them, increasing level of market competition reduces an incumbent firm's valuation of deterring entrepreneurial entry less than the start-up's valuation of entrepreneurial entry. For the innovation levels above this threshold, the opposite result holds. Similarly, below the other threshold, increasing level of market competition reduces an incumbent firm's valuation of preempting other incumbents from acquiring the innovation less than the start-up's valuation of entrepreneurial entry. For the innovation levels above this threshold, the opposite result holds. When the innovation level is below these thresholds, higher market competition favors commercialization by incumbent acquisition over commercialization by entrepreneurial entry, obviously. However, above these thresholds, entrepreneurial entry becomes more preferable for the start-up as product market gets more competitive. Hence, continuously increasing market competition does not have the same effect on the choice of commercialization strategy for all possible levels of innovation. And, as I will show in Chapter-3, the innovation levels obtained for each commercialization strategy are most likely to be different. Since, for varying levels of innovation, the valuations are affected differently relative to one another by increasing product market competition, one cannot conclude which commercialization strategy will be favored as market competition gets more intense. At the bottom line, the changes in the level of product market competition, or, equivalently, in the number of incumbent firms, cannot endogenously determine commercialization strategy of the start-up for all possible innovation levels on its own. The choice of commercialization

[3] The definition of innovation incentives as willingness to pay for a given level of innovation can be traced back to Arrow (1962). For more examples, see, among others, Gilbert and Newbery (1982), Bester and Petrakis (1993), Belleflamme and Vergari (2011), Norback and Persson (2012), and Norback et al. (2016).

mode depends also on the innovation levels obtained for each commercialization strategy (as I will show in Chapter-3, they are most likely to be different) beside the costs of commercialization, transaction, and R&D.

Similarly, the level of innovation, which means the quality of innovation, is also considered to shape the commercialization strategy in the previous literature. Indeed, in Norbäck and Persson (2012) and Norbäck et al. (2016), it is strongly advocated that increasing level of innovation favors commercialization by sale over commercialization by entrepreneurial entry. The results of my model show that this is not entirely true, owing to the lack of a monotonic relationship. There seems to be again two thresholds of innovation level. Below one of them, increasing innovation level gives rise to an incumbent firm's valuation of deterring entrepreneurial entry more than the start-up's valuation of entrepreneurial entry. For the innovation levels above this threshold, the opposite result holds. Similarly, below the other threshold, increasing innovation level gives rise to an incumbent firm's valuation of preempting other incumbents from acquiring the innovation more than the start-up's valuation of entrepreneurial entry. For the innovation levels above this threshold, the opposite result holds. When the innovation level is below these thresholds, improving its quality further favors commercialization by incumbent acquisition over commercialization by entrepreneurial entry, obviously. However, above these thresholds, entrepreneurial entry becomes more preferable for the start-up if the innovation level is increased further. Hence, continuously varying levels of innovation cannot endogenously determine which commercialization strategy will be chosen by the start-up, either.

As mentioned earlier in this thesis, the innovation levels obtained for respective commercialization strategies need not equal each other. According to my findings, the expectation of commercialization by sale induces the start-up to conduct more R&D than it does for product market entry, if the start-up, with an expectation of market entry, would create an innovation with an inventive step less than a threshold. In this scenario, commercialization by sale results in a higher innovation level compared to the level obtained with an expectation of entrepreneurial entry. If the start-up generates an innovation level higher than this threshold when market entry is expected, the expectation of commercialization by sale would induce the start-up to conduct less R&D than it does for product market entry. This time, commercialization by entrepreneurial entry results in a higher innovation level compared to the level obtained with an expectation of commercialization by sale. At the bottom line, these findings indicate that, if start-ups are able innovators just like the ones in developed countries whereby there is an established innovation culture, governments' favoring entrepreneurial entry over commercialization by sale brings about higher-quality start-up innovation. However, if start-ups are only able to generate an innovation level below a threshold when responding market incentives for entrepreneurial entry, just like the ones in most of the developing countries, governments' favoring commercialization by sale over entrepreneurial entry brings about higher-quality start-up innovation.

The reason of the above-mentioned findings is the difference between the values that a start-up tries to maximize via investing in R&D (or, in other words, conducting R&D) for respective alternatives of commercialization mode. When investing in R&D with an expectation of product market entry, the start-up aims to maximize its product market profit and strategically decides how much to invest in R&D. That is, the start-up tries to expand its market share by stealing business from incumbent firms [4]. Although, when investing in R&D with an expectation of sale to an incumbent firm, the start-up aims to maximize the difference between profits of the acquiring incumbent firm and a non-acquiring incumbent firm, which is approximately the sale price of the innovation. According to my findings, the former requires a larger R&D expenditure so as to reach its maximum value than the latter does, when the resulting innovation level is higher than some threshold. When the resulting innovation level obtained in response to market incentives for entrepreneurial entry is lower than this threshold, the opposite result holds; and the expectation of commercialization by sale induces the start-up to invest more in R&D than the amount strategically determined to expand the entrepreneur's market share.

Again with increasing product market competition by increasing the number of incumbent firms, R&D expenditure and the resulting innovation level are both negatively affected when this innovation level is below some threshold if it is to be commercial-

[4] For a thorough explanation of strategic consideration in R&D investment, see Brander and Spencer(1983).

ized by sale to an incumbent firm, and when this innovation level is below another threshold if entrepreneurial entry is expected. In other words, if start-ups are only able to generate low innovation levels when responding market incentives for either entrepreneurial entry or commercialization by sale, just like the ones in most of the developing countries, both the R&D expenditures and the inventive steps of the obtained innovations diminish as product market gets more competitive. On the other hand, if the obtained innovation level for each commercialization strategy is above its respective threshold, the opposite result holds. This means that, if start-ups are able innovators just like the ones in developed countries whereby there is an established innovation culture, a start-up increases its R&D expenditures and generates a higher innovation level in the face of more fierce product market competition.

With the insight provided by these findings, government support to the start-up for commercialization cost turns out to be counter-productive in some cases. This is so because it facilitates product market entry instead of sale of the innovation to an incumbent firm. Beside entrepreneurial entry being less beneficial to society for a given innovation level unless the innovation level is too small, it induces the start-up to conduct less R&D than it does for sale to an incumbent firm, if the resulting innovation level is below some threshold. In other words, making product market entry more profitable than a sale of the innovation leaves the government with a lower level of innovation and, consequently, with a quite limited increase in social welfare, when start-ups are not innovative enough. Meanwhile, financial support for R&D expenditures stimulates the start-up to create an innovation with a bigger inventive step, no matter which commercialization strategy is chosen, since it raises the expenditure level for R&D beyond the profit-maximizing level for the start-up.

In an extension, I intend to investigate the start-up's preference of risk. Therefore, I consider the innovation, following Damsgaard et al. (2017), reducing the fixed production cost of the firm which utilizes it. The model basically remains the same, just a fixed production cost is added to the profit equation of each firm. The start-up chooses an R&D project from a set of projects where a project with a lower probability of success yields more payoff if successful [5]. Therefore, the previous assumption

[5] For formulation of R&D projects in this manner, see, among others, Henkel et al. (2015) and

of deterministic invention process is not valid anymore. Another divergence from the original model is that the R&D expenditure here is constant for all R&D projects. In other words, R&D projects do not differ according to the level of R&D expenditures anymore, it is rather the level of riskiness that distinguishes them from one another.

The results first point out that the start-up conducts a riskier R&D project with a higher payoff if it succeeds than any incumbent firm would prefer without a competitive threat from the entrepreneur. The intuition behind this finding is that, since a fixed cost innovation does not alter the product market shares of incumbent firms without market entry of the start-up, any incumbent firm is willing to pay for an R&D project which maximizes the expected difference between fixed cost reduction and transaction cost. This is referred to as "preemptive incumbent acquisition". Nevertheless, if the start-up decides to enter the product market, it chooses a riskier project because of what Damsgaard et al. (2017) call "the entrepreneurship hurdle effect". And, similarly, if the start-up decides to sell the innovation to an incumbent firm, when it is also profitable for it to enter the product market, an incumbent firm is willing to pay for the same riskier project so as to deter entrepreneurial entry and preserve its market share. Clearly, this way of commercialization is called "entry-deterring incumbent acquisition". Hence, making product market entry possible boosts innovation in this case, contrary, in part, to the findings of my original model. But, subsidizing commercialization cost is again counter-productive, since it terminates the reason to a large extent why the entrepreneur chooses a riskier project. Instead, financial support for R&D expenditure is the correct tool to make the competitive threat credible.

Nonetheless, despite the preferable effects of credible market entry threat for boosting innovation, its welfare implications tend to point to the contrary. If the innovation is to be commercialized by entry-deterring incumbent acquisition, making product market entry of the start-up possible has definitely negative welfare effects. That is because the R&D project chosen, when entry-deterring incumbent acquisition is expected, is too risky compared to the level of riskiness preferred by society in the absence of entrepreneurial entry. If entrepreneurial entry is expected to occur, the welfare implications seem to be ambiguous. That is, promoting entrepreneurial entry

Damsgaard et al. (2017).

is again suboptimal in some more cases.

The effect of higher product market competition, or – in other words – increasing number of incumbent firms, on innovation is, again, significant. Higher product market competition increases the start-up's preference of risk further when market entry is possible, meaning less frequency of innovations arriving the product market. The reason for this finding is extremely apparent; as product market competition increases, the market share of the entrepreneur dissipates. As a result, the entrepreneurship hurdle effect increases, inclining the start-up to conduct a riskier R&D project. This situation brings about innovations with more breakthrough effects, but these innovations arrive the product market less frequently, since their probability of success is quite low. In actuality, such situations can be easily observed in real life, as, despite substantial financial supports from governments in some countries - especially in developing ones, the number of innovations is far from being sufficient. When combined with start-ups in such countries being generally less innovative, as mentioned earlier in this thesis, the frequency of successful innovations arriving the product market might decrease further. Therefore, in the face of high product market competition, the best policy seems to be facilitating commercialization of the innovation by cooperation with incumbent firms, without making entrepreneurial entry possible. Because, in this case, the riskiness of the project chosen by the start-up, with an expectation of selling to an incumbent firm at its preemptive valuation, would not be affected by the increase in the number of incumbent firms. That is, the frequency of successful innovations arriving the product market would not decrease, yielding more social welfare in expected terms.

The rest of the thesis is organized as follows. In Chapter-2, the previous literature on the interactions among product market competition, innovation and entrepreneurship, and on the welfare implications of these interactions is reviewed. The possible contributions of this study to the relevant strands of the literature are discussed. In Chapter-3, the original model is presented for a non-drastic process innovation. In Chapter-4, the extension model is handled for a fixed cost innovation. Chapter-5 concludes the paper with final thoughts and ideas for future research.

CHAPTER 2

LITERATURE REVIEW

For markets with symmetric firms, the general belief in the economic theory is that, without a concern of any innovation, increasing the number of firms expands social welfare, because by doing so we have our product market converged to a perfectly competitive market and perfect competition is acknowledged to be the market structure that yields the highest social welfare. However, in a pioneering study, Mankiw and Whinston (1986) introduce the notion of "business stealing effect". This effect implies that if an entrant to the market, where firms face fixed set-up costs while entering, causes incumbent firms to reduce output, the entrepreneur desires market entry more than society does. Mankiw and Whinston show that it is exactly what happens in homogeneous goods markets with symmetric firms, and free entry results in excessive number of market participants while an imaginary social planner would choose a lower number of entries to the market. When innovation is taken into account, this business stealing effect is visible even in the absence of product market entry. Lahiri and Ono (1988) and Shapiro (1989) demonstrate that a reduction in an inefficient firm's production cost leads this firm to steal business from other efficient firms. Despite the positive effect of such a cost reduction to consumer surplus, it has a detrimental effect to social welfare on aggregate. In a complementary study, Zhao (2001) defines the conditions for a marginal cost reduction of a firm having negative welfare effects in an oligopolistic homogeneous goods market [6]. According to his findings, if a firm's market share is below a threshold, or equivalently, its marginal cost is above some

[6] See Wang and Zhao (2007) as an extension of this study for an oligopolistic differentiated goods market.

threshold, a process innovation lowering the marginal cost of this firm diminishes the social welfare on the contrary to the common intuition. In a similar vein with the previous literature, the results obtained from the original model in this study indicate that sale of a non-drastic process innovation is favored against entrepreneurial entry in terms of social welfare unless the innovation is too small. This finding is basically a conjunction of business stealing effect and negative welfare effect of a cost reduction. Here, market entrant is more efficient than incumbent firms in contrast to one modeled in Mankiw and Whinston (1986). However, entrepreneurial entry instead of sale to an incumbent firm means one more inefficient firm operating in the product market; in other words, one more inefficient firm stealing business from the efficient firm. And if the gap between the marginal costs of the efficient firm and the inefficient firms is sufficient, just like Zhao (2001) puts emphasis on, this business stealing effect causes entrepreneurial entry to be suboptimal because it generates less increase in social welfare than sale to an incumbent firm does.

In some recent studies, it has been asserted that the level of market competition and the level of innovation, or, in other words, innovation quality, have an immense influence on how the innovator chooses to commercialize its innovation. Norbäck and Persson (2012) confidently state that higher product market competition is most likely to increase the profitability of commercialization of an innovation by sale relative to commercialization by entrepreneurial entry. They argue that rising market competition reduces the profits of the market entrant, which is the main component of the profit gained by the start-up from entrepreneurial entry. If, instead, an incumbent acquisition occurs, more intense market competition again lessens the profit of the incumbent acquiring the innovation by an amount almost equal to the reduction in an entrepreneur's profit, while it also lessens the profit of a non-acquiring incumbent firm. Since the profit that a start-up gains from a sale of the innovation is nearly the difference between the profits of the acquiring incumbent firm and a non-acquiring incumbent firm, commercialization by sale stands less-negatively-affected by rising market competition in their view. They conclude that continuously increasing market competition eventually makes sale of the innovation yield more income for the start-up than entrepreneurial entry does. Nevertheless, the results of my model dispute this conclusion. I find that, for varying levels of innovation, the valuations of entrepreneurial entry and incumbent acquisition are affected differently relative to one another by increasing product market competition. Given that the innovation levels obtained for each commercialization strategy are most likely to be different, one cannot conclude which commercialization strategy will be favored as market competition gets more intense.

As the effects of varying levels of innovation quality, Norbäck et al. (2016) argue that continuously increasing the innovation quality (level) diminishes the profits of non-acquiring incumbent firms so much that, when the innovation quality reaches a sufficient level, incumbent firms will race to acquire the innovation so as to preempt other incumbent firms from possessing it. According to their theoretical work, the externalities imply that only high-quality innovations will be bought by an incumbent firm. The results of my model are, again, in contrast to these assertions. I find two thresholds of innovation level in this respect. Below one of them, increasing innovation level gives rise to an incumbent firm's valuation of deterring entrepreneurial entry more than the start-up's valuation of entrepreneurial entry. For the innovation levels above this threshold, the opposite result holds. Similarly, below the other threshold, increasing innovation level gives rise to an incumbent firm's valuation of preempting other incumbents from acquiring the innovation more than the start-up's valuation of entrepreneurial entry. For the innovation levels above this threshold, the opposite result holds. When the innovation level is below these thresholds, improving its quality further favors commercialization by incumbent acquisition over commercialization by entrepreneurial entry, obviously. However, above these thresholds, entrepreneurial entry becomes more preferable for the start-up if the innovation level is increased further. That is, there is no monotonic effect of innovation level on the choice of commercialization strategy. Hence, previous claim that only high-quality innovations being sold to an incumbent firm seems to be nothing but a strong assumption in the setting of my research.

Given that a start-up has two alternatives of commercialization strategies for its innovation, the question that which strategy inducing the start-up to conduct more R&D constitutes another point of interest. Norbäck et al. (2016) model the process of R&D

and the commercialization of the resulting innovation as the level of innovation determines the commercialization strategy chosen by the start-up. Since they assert that high levels of innovation will make commercialization by sale more profitable for the start-up compared to entrepreneurial entry, in their study the start-up always generates a higher innovation level when the innovation is to be commercialized by preemptive incumbent acquisition. The results of my model, again, dispute this conclusion. First of all, my model makes use of the "backward induction" notion while finding out the level of innovation obtained in the process of R&D. Thus, it is not the level of innovation that determines the commercialization strategy chosen by the start-up; instead, it is the commercialization mode expected by the start-up that determines how much the start-up invests in R&D and how big the resulting innovation will be. According to my model, if the start-up is an able innovator so that it generates an innovation level above some threshold when responding market incentives for entrepreneurial entry, it produces a higher innovation level with an expectation of entrepreneurial entry than the level obtained when commercialization by sale is expected. On the other hand, if the start-up, with an expectation of market entry, creates an innovation with an inventive step less than the same threshold, my model shows that the start-up would generate a higher innovation level when the innovation is expected to be commercialized by preemptive incumbent acquisition, just as claimed by Norbäck et al. (2016).

In another strand of the literature, both theoretical and empirical studies show that start-ups often choose to commercialize their innovation by cooperation with incumbent firms through selling, licensing, or technology alliances. Gans and Stern (2000) demonstrate theoretically that cooperative interactions between start-ups and incumbent firms at the commercialization stage are natural, especially when post-innovation monopoly profits for the incumbent firms are larger than the aggregate duopoly market profits, in contrast to the Schumpeterian perspective – where start-ups earn their payoff via market entry, thus, as Gans and Stern call it, "unleashing the gale of creative destruction". Teece (1987) puts forward that, as technologically progressive sectors get mature, a greater proportion of necessary assets to operate in these sectors seem to be brought in by large established incumbent firms. This situation makes acquiring those assets more costly for start-ups, and, consequently, entry becomes extremely difficult. In such cases, he suggests that, cooperation with incumbent firms should be thought of mechanisms for reducing entry requirements for innovators. Similarly, Norbäck et al. (2014) argue that installed production bases of incumbent firms are seen as entry barriers by start-ups, because they increase the entry cost, or commercialization cost in other words, which any entrepreneur must pay before operating in the market. Then, strong network effects, which are defined by them as the locked-in consumers plus the expected number of new consumers, increase the likelihood of the innovation being commercialized by a sale to an incumbent firm. Additionally, the empirical results of Gans et al. (2002) show that when innovations receive some kind of intellectual property rights protection (e.g., a patent), and/or fims establish a relationship with a broker to contract with an incumbent firm (e.g., a venture capitalist), and/or sunk costs associated with product market entry are high , start-ups are more likely to cooperate with established firms through licensing, alliances or acquisitions for commercializing their innovations [7]. The contribution of this study, here, is that commercialization of innovation by cooperation with incumbent firms can occur as a result of an intentional government policy since, in the circumstances I present, such a strategy brings about more social welfare than entrepreneurial entry does.

There is also a large number of studies that investigate the relationship between the market competition and innovation level. Yi (1999) shows that, under weak conditions, the profit incentive of an incumbent firm for a marginal process innovation decreases with the level of market competition in homogeneous goods markets. He also demonstrates theoretically that the same result holds for a very large range of non-drastic process innovations of arbitrary sizes. Belleflamme and Vergari (2011) extends this study to differentiated goods markets and shows that the profit incentive of an incumbent firm for a process innovation either decreases with the number of incumbent firms in the market or has an inverted-U shape. The second option occurs when both the innovation level and the degree of product substitutability are extremely large. Again, for a marginal process innovation, Vives (2008) finds that, when goods are strategic substitutes, cost reduction expenditure of a firm decreases with the number of firms.

[7] For other empirical studies that show cooperation with incumbent firms is a preferred commercialization strategy for start-ups, see Granstrand and Sjölander (1990), Hall (1990), Lerner and Merges (1998), Blonigen and Taylor (2000), and Henkel et al. (2015).

Those mentioned studies consider R&D expenditures and incentives for just one firm, which makes use of the innovation alone in the sense of Arrow (1962). Dasgupta and Stiglitz (1980) and Spence (1984) examine the situation where all firms in the market participate in research activities, and they show that increasing number of incumbent firms lowers cost reduction expenditure per firm. The contribution of my thesis to these studies is to consider R&D taken by an outsider start-up with the options of commercializing by market entry and by sale of the innovation to an incumbent firm. Also, as another distinction from the above-mentoned studies, I take the incentive of an incumbent firm to acquire an innovation as the incentive stemming from the competitive threat, instead of the profit incentive, i.e., the difference between the profit a firm earns with the possession of the innovation and the profit it earns if a rival firm in the market makes use of the innovation.

Beside the theoretical papers on the relationship between market competition and innovation, a vast number of empirical studies exist for the same purpose. Nickell (1996), based on an analysis of 670 U.K. companies, shows that increasing the level of market competition and the resulting lower levels of rents per firm are strongly associated with a significantly stronger total productivity growth. In order to shed more light on a firm's reaction to market competition, Aghion et al. (2005) establish an inverted-U shape relationship between the level of market competition and the weighted average number of patents taken out in an industry, based on a study on a U.K. panel data. My original model assumes only an outsider start-up innovating in contrast to the set of Aghion et al. (2005), and the results imply that the relationship between market competition and the innovative activity depends on the start-up's innovative ability. If start-ups are only able to generate low innovation levels when responding market incentives for either entrepreneurial entry or commercialization by sale, both the R&D expenditures and the inventive steps of the obtained innovations diminish as product market gets more competitive. On the other hand, if the obtained innovation levels for each commercialization strategy are above their respective thresholds, the start-up increases its R&D expenditure and generates a higher innovation level in the face of more fierce product market competition. Blundell et al. (1999), based on a study again on a panel data of British manufacturing firms, find that, despite less competitive industries having less aggregate innovations, market share of a firm has a positive and robust effect on the number of innovations and patents [8]. The findings of my work stand in agreement with what Blundell et al. (1999) assert about the importance of a firm's market share on incentives to hold possession of an innovation. The results of my original model indicate that increasing the level of product market competition, by increasing the number of incumbent firms, reduces the valuations of all agents in the model for a non-drastic process innovation with a given level of inventive step. Also, my extension model shows that higher product market competition, which means smaller market shares for each market participant, increases the start-up's preference of risk further when market entry is possible, meaning less frequency of innovations arriving the product market.

In another strand of the literature, it has been shown that entrepreneurs choose more risky projects than incumbent firms would prefer. Cohen (2010) reviews the empirical literature on entrepreneurial innovation and argues that large established firms are more likely to pursue incremental process innovations while start-ups are observed to generally innovate for breakthroughs. In a similar vein, Baumol (2004) reports that, based on a study in 2003 sponsored by the U.S. Small Business Administration, start-ups are, to a large extent, responsible for breakthrough innovations while large incumbent firms conduct more routinized R&D. He also remarks that:

> The bulk of R&D spending is shown to come from a tiny number of very large firms. Yet the revolutionary breakthroughs continue to come predominantly from small entrepreneurial enterprises [...] Moreover, these firms voluntarily disseminate much of their innovative technology widely and rapidly, both as a major revenue source and in exchange for complementary technological property of other firms.

The model developed by Henkel et al. (2015) gives support with theoretical findings to previous assertions. According to their results, start-ups tend to create innovations with bigger inventive steps than the innovations made by incumbent firms. They also provide evidence, based on a qualitative study, that in the Electronic Design Automation Industry start-ups pursue more risky innovations than incumbent firms

[8] For more empirical studies about the effect of market competition on innovation, see, among others, Geroski (1990) and Bailey and Gersbach (1995).

do and they commercialize those innovations by selling them to incumbent firms. The results obtained from the extension model in my study are in agreement with the arguments of Baumol (2004) and Henkel et al. (2015).

This extension model is, in actuality, mathematically very similar to the model presented in Damsgaard et al. (2017). Their set-up consists of a monopolist incumbent firm and an outsider start-up. They are both allowed to conduct R&D for fixed cost innovations. If the incumbent firm succeeds with its R&D, it preempts the start-up's market entry. If the monopolist fails and the start-up comes up with an innovation, the product market becomes a duopoly. My model distinguishes from Damsgaard et al. (2017) by assuming an oligopolistic product market, and by providing the start-up with the alternative of selling its innovation to one of the incumbent firms to commercialize it beside the choice of entrepreneurial entry. In my model, also, only the start-up is able to conduct R&D, so the monopolist can preempt an entrepreneurial entry by an incumbent acquisition solely. In the setting of Damsgaard et al. (2017), when the product market is a homogeneous goods market with symmetric firms, the start-up always chooses less risky projects for entrepreneurial entry than society prefers. According to my results, if the innovation is to be commercialized by entry-deterring incumbent acquisition, the R&D project chosen by the start-up is too risky compared to the level of riskiness preferred by society in the absence of entrepreneurial entry. If entrepreneurial entry is expected to occur with the same project, the welfare implications seem to be ambiguous.

CHAPTER 3

THE MODEL FOR A NON-DRASTIC PROCESS INNOVATION

This model investigates the welfare implications of a non-drastic process innovation created by an outsider innovator and the commercialization strategy chosen for this innovation so as to determine the optimal policy set for boosting innovation and increasing social welfare at the same time. So, at first, I have to define appropriately the demand and supply sides of the economy.

On the supply side, there is an oligopolistic market consisting of n symmetric firms which produce homogeneous goods with the same constant marginal cost, denoted by c. Since the goods produced in the market are homogeneous, assuming a quantity competition is plausible and in accordance with the previous literature. Outside the market, a start-up with a non-drastic process innovation, which reduces the marginal cost of the firm that makes use of the innovation, is to choose whether to enter the product market or to commercialize the innovation by selling it to an incumbent firm. There is no fixed production cost for any firm operating in the market, let it be an incumbent firm or the entrepreneurial firm. In the product market, oligopolists interact in a quantity competition.

In order to conduct a welfare analysis on aggregate demand, the model must abstract from income effects. Therefore, assuming a representative consumer with a quasilinear utility function, such as the one introduced by Singh and Vives (1984), is plausible. The utility function, denoted by $U(q, M)$ where q stands for the non-numeraire good and M represents the numeraire good, is assumed to be concave. $U(q, M)$ is apparently separable, being quadratic in the homogeneous goods that the model is interested in and linear in the numeraire good:

$$U(q, M) = \sum_{i=1}^{n} \alpha_i q_i - \frac{1}{2}(\beta_i \sum_{i=1}^{n} q_i^2 + 2\gamma \sum_{j \leq i} q_i q_j) + M \tag{3.1}$$

where i and j denotes the firms producing in the market.

α_i measures the vertical (quality) differentiation of good i from other goods. As other things are kept intact, an increase in α_i increases the marginal utility that a consumer gets from an additional unit of good i (see Häckner, 2000). β_i measures the own-price effect of good i on the representative consumer's utility function. γ measures the cross-price effects on the utility. In other words, it gives the horizontal differentiation among goods. When the utility function deals with perfect substitute goods (homogeneous goods), $\alpha_1 = ... = \alpha_n$ and $\beta_1 = ... = \beta_n = \gamma$. Thus, it is safe to assume that $\alpha_1 = ... = \alpha_n = \alpha$ and $\beta_1 = ... = \beta_n = \gamma = 1$. Then, the representative consumer's utility function becomes:

$$U(q, M) = \alpha \sum_{i=1}^{n} q_i - \frac{1}{2}(\sum_{i=1}^{n} q_i^2 + 2\gamma \sum_{j \leq i} q_i q_j) + M \tag{3.2}$$

where i and j denote the firms producing in the market.

By virtue of the quasilinear structure of the representative consumer's utility function, I will do partial equilibrium analysis for the homogeneous goods market.

Since the representative consumer is assumed to make the aggregate consumption in the market, the demand system can be obtained from the maximization problem of the representative consumer's utility:

$$\underset{q_i}{max}\ \alpha \sum_{i=1}^{n} q_i - \frac{1}{2}(\sum_{i=1}^{n} q_i^2 + 2 \sum_{j \leq i} q_i q_j) + M \tag{3.3}$$

$$subject\ to \quad p \sum_{i=1}^{n} q_i \leq w \tag{3.4}$$

where w denotes the income of the representative consumer and p is the market price for the homogeneous goods.

The solution to (3.3) subject to (3.4) gives the inverse demand schedule:

$$p = \alpha - \sum_{i=1}^{n} q_i \tag{3.5}$$

In the sense of quantity competition, given the market price, each oligopolist chooses how much to produce so as to maximize its profit, denoted by Π_i.

$$\underset{q_i}{max}\ \Pi_i = pq_i - cq_i \quad for\ i = 1, ..., n \tag{3.6}$$

The solution to (3.6) yields the quantity produced by firm i:

$$q_i = \frac{\alpha - c}{n+1} \quad for\ i = 1, ..., n \tag{3.7}$$

Owing to the symmetry among firms, (3.6) gives the profit function of any firm before an innovation arrives the market, and (3.7) represents the quantity produced by any firm in this situation. Likewise, (3.5) is the market price without an innovation.

Given the market price and the quantities produced by each firm, consumer surplus, denoted by CS, obtained in this homogeneous goods market is:

$$CS = \alpha \sum_{i=1}^{n} q_i - \frac{1}{2}(\sum_{i=1}^{n} q_i^2 + 2\sum_{j \leq i} q_i q_j) - p\sum_{i=1}^{n} q_i \tag{3.8}$$

Putting (3.5) and (3.7) into (3.8), and direct calculations will yield:

$$CS = \frac{(\sum_{i=1}^{n} q_i)^2}{2} = \frac{n^2(\alpha - c)^2}{2(n+1)^2} \tag{3.9}$$

Producer surplus, denoted by PS, obtained in this homogeneous goods market is the sum of profits earned by the oligopolists:

$$PS = \sum_{i=1}^{n} \Pi_i = \sum_{i=1}^{n} pq_i - cq_i \tag{3.10}$$

Putting (3.5) and (3.7) into (3.10), and direct calculations will yield:

$$PS = \sum_{i=1}^{n} q_i^2 = n\frac{(\alpha - c)^2}{(n+1)^2} \tag{3.11}$$

Social welfare generated by a market is the sum of producer surplus and consumer surplus obtained in this market. So, the social welfare here, denoted by W, is:

$$W = CS + PS = \frac{n^2(\alpha - c)^2}{2(n+1)^2} + n\frac{(\alpha - c)^2}{(n+1)^2} \tag{3.12}$$

(3.9), (3.11) and (3.12) gives the surplus levels before an innovation arrives the market. In the following, I will add a start-up with a non-drastic process innovation to this system, and demonstrate how it will change the above-mentioned equilibrium levels prior to its addition, according to the commercialization mode chosen by start-up. However, before doing this, I must give the exact definition of what I refer to as non-drastic process innovation.

Definition-1: A non-drastic process innovation reduces the marginal cost of the firm, which makes use of the innovation, to a level that does not throw any other firm(s) out of the market. That is, the monopoly price corresponding to the reduced marginal cost is above the marginal cost of the non-acquiring firms.

After a non-drastic process innovation, the marginal cost of the firm utilizing this innovation becomes $c - k$, where k denotes the level of reduction that the innovation imposes on the marginal cost (i.e., the innovation level –quality-). If this firm happens to be a monopolist, it will maximize the following profit function to choose the quantity produced in this monopoly:

$$\max_{q_m} \; p_m q_m - c_m q_m \tag{3.13}$$

where m denotes the monopoly.

The solution to (3.13) is:

$$q_m = \frac{\alpha - c + k}{2} \tag{3.14}$$

Putting (3.14) into (3.5) will yield:

$$p_m = \frac{\alpha + c - k}{2} \tag{3.15}$$

Hence, the initial marginal cost being less than the monopoly price means that $k < \alpha - c$. But this is not enough for consistency, there is another ordering I need to make an assumption about.

Assumption-1: The level of innovation, or, in other words, the level of reduction in marginal cost, must be lower than the initial marginal cost (i.e., $k < c$).

Assumption–1 is quite rational and standard, it ensures that the marginal cost of the firm utilizing the innovation remains positive.

The main focus of this study is to investigate the welfare implications of a start-up innovation, and to find out which commercialization strategy both induces the start-up to be more innovative and stands more preferable in terms of social welfare. In order to determine how higher innovation levels yielding more welfare can be achieved, one must answer these questions: How much does the start-up invest in R&D with expectation of respective commercialization strategies? How large will the resulting innovations be, respectively? Which commercialization strategy will the start-up choose for its innovation, given the level of market competition and the quality of innovation? Which commercialization strategy should government policies favor over its alternative? How will the equilibrium levels in the market with innovation alter from their initial levels? I model a three-stage game highlighting the process from R&D to commercialization of the resulting innovation in an attempt of answering the questions above.

In stage-1, the start-up decides how much to invest in R&D and, thus, how much the innovation level will be. As mentioned earlier, the process of innovation is assumed to be deterministic; that is, R&D expenditure by the start-up always yields a reduction of marginal cost to the intended level. The R&D expenditure depends on the commercialization strategy chosen by the start-up. R_A denotes the R&D expenditure level when the innovation is to be commercialized by sale to an incumbent firm and R_E denotes the R&D expenditure level when the innovation is to be commercialized by entrepreneurial entry.

Stage-2 is basically the same with the commercialization stage of the models in Norbäck and Persson (2012) and Norbäck et al. (2016). In stage-2, the start-up decides how to commercialize its innovation, given the innovation level generated in stage-1. This stage is modeled as an entry-acquisition game. Each incumbent firm posts its bid for the innovation in a first-price perfect information auction and the start-up either accepts or rejects these bids comparing to its reservation price, which is the profit it earns in case of entrepreneurial entry. If the start-up decides to enter the market with its innovation, it must incur a fixed entry cost, which is referred to as commercialization cost in this thesis, following Norbäck and Persson (2012), denoted by G. If the start-up decides to sell the innovation, the acquiring incumbent firm must pay transaction cost, as defined in Norbäck et al. (2016), denoted by T, beside the amount received by the start-up. There is no fixed production cost for any firm operating in the market, let it be an incumbent firm or the entrepreneurial firm.

In stage-3, firms interact in an oligopolistic product market, given the innovation level generated in stage-1. If entrepreneurial entry occurs, there will be a quantity competition among $n + 1$ firms in the market. One of those is the entrepreneur, which is not subject to any capacity constraint for production or in need of time to claim a market share, thus displays the same characteristics with the n incumbent firms, except being more efficient due to the process innovation it utilizes. If incumbent acquisition of the innovation occurs, there will be a quantity competition among the same n incumbent firms. However, this time, one of those firms, the acquiring incumbent firm, is more efficient due to the process innovation it holds possession of.

In the subgame perfect equilibrium fashion, I will solve this three stage game by backward induction.

3.1 Stage-3: Product Market Competition

There are two alternatives of market structure that we will observe after the innovation is commercialized. For determining respective equilibrium characteristics, I will deal with each alternative in turn.

Let me, at first, assume that the commercialization of the innovation, where k denotes the innovation level, occurs with a sale to an incumbent firm. In that case, we have two types of firms in the market; one acquiring incumbent firm, of which the marginal cost is $c-k$, and $n-1$ non-acquiring incumbent firms, of which the marginal cost is c. The equilibrium levels of output, where q_A denotes the output of the acquiring firm and $q_{NA}(a)$ denotes the output of a non-acquiring firm, can be directly calculated through profit maximization problem of a market participant (3.6) by using the formulation for market price (3.5):

$$q_A = \frac{\alpha - c + nk}{n+1} \tag{3.16}$$

and

$$q_{NA}(a) = \frac{\alpha - c - k}{n+1} \tag{3.17}$$

To proceed, one needs to state the profit levels of all agents at the equilibrium. There are three firm types of interest this time; one start-up, one acquiring firm, and $n-1$ non-acquiring firms. The profits of the acquiring firm and the non-acquiring firms can be directly calculated through (3.6) by putting (3.16) and (3.17) into it, respectively. The profit of the entrepreneur is exactly the winning bid of the auction in stage-2 minus the R&D expenditure, R_A, it makes in stage-1. I will explicitly identify the winning bid and state its amount when discussing stage-2. For now, let me call the acquisition price as A. Recall that the acquiring firm needs to pay transaction cost, denoted by T, beside its winning bid in the acquisiton auction. The resulting profits, Π_A denoting the profit of the acquiring firm, $\Pi_E(a)$ denoting the profit of the entrepreneur, and $\Pi_{NA}(a)$ denoting the profit of a non-acquiring firm, are:

$$\Pi_A = q_A^2 - T - A = \frac{(\alpha - c + nk)^2}{(n+1)^2} - T - A \tag{3.18}$$

and

$$\Pi_{NA}(a) = q_{NA}(a)^2 = \frac{(\alpha - c - k)^2}{(n+1)^2} \tag{3.19}$$

and

$$\Pi_E(a) = A - R_A \tag{3.20}$$

The sum of the profits earned by these three types of firms gives producer surplus, denoted by PS_A, for a given innovation level k:

$$PS_A = \Pi_E(a) + \Pi_A + (n-1)\Pi_{NA}(a) = \frac{(\alpha - c + nk)^2}{(n+1)^2} + (n-1)\frac{(\alpha - c - k)^2}{(n+1)^2} - T - R_A \tag{3.21}$$

Summing up the quantities produced, as shown by (3.16) and (3.17), gives the total production level of the market:

$$q_A + (n-1)q_{NA}(a) = \frac{n(\alpha - c) + k}{n+1} \tag{3.22}$$

Putting (3.22) into (3.9) gives consumer surplus, denoted by CS_A, for a given innovation level k, when the innovation is commercialized by incumbent acquisition:

$$CS_A = \frac{(\sum_{i=1}^{n} q_i)^2}{2} = \frac{(n(\alpha - c) + k)^2}{2(n+1)^2} \tag{3.23}$$

Social welfare obtained, denoted by W_A, for a given innovation level k, after commercialization by sale is the sum of (3.21) and (3.23):

$$W_A = CS_A + PS_A = \frac{(n(\alpha - c) + k)^2}{2(n+1)^2} + \frac{(\alpha - c + nk)^2}{(n+1)^2} + (n-1)\frac{(\alpha - c - k)^2}{(n+1)^2} - T - R_A \tag{3.24}$$

If the commercialization strategy of the start-up is entrepreneurial entry, there will be again two types of firms producing in the market, one entrepreneurial firm with an innovation, of which the marginal cost is $c - k$, and n non-acquiring incumbent firms, of which the marginal cost is c. The equilibrium levels of output, where $q_E(e)$ denotes the output produced by the entrepreneur and $q_{NA}(e)$ denotes the output of a non-acquiring firm, can be directly calculated through profit maximization problem of a market participant (3.6) by using the formulation for market price (3.5):

$$q_E(e) = \frac{\alpha - c + (n+1)k}{n+2} \tag{3.25}$$

and

$$q_{NA}(e) = \frac{\alpha - c - k}{n+2} \tag{3.26}$$

The profit levels, where $\Pi_E(e)$ denotes the profit of the entrepreneur and $\Pi_{NA}(e)$ denotes the profit of a non-acquiring firm, can be directly calculated respectively through (3.6) by putting (3.25) and (3.26) into it. Recall that the entrepreneur needs to incur commercialization cost, denoted by G, in stage-2 beside the R&D expenditure, R_E, it makes in stage-1:

$$\Pi_E(e) = q_E(e)^2 - G - R_E = \frac{(\alpha - c + (n+1)k)^2}{(n+2)^2} - G - R_E \tag{3.27}$$

and

$$\Pi_{NA}(e) = q_{NA}(e)^2 = \frac{(\alpha - c - k)^2}{(n+2)^2} \tag{3.28}$$

The sum of profits obtained in the market, according to (3.27) and (3.28), yields producer surplus, denoted by PS_E, for a given innovation level k:

$$PS_E = \Pi_E(e) + n\Pi_{NA}(e) = \frac{(\alpha - c + (n+1)k)^2}{(n+2)^2} + n\frac{(\alpha - c - k)^2}{(n+2)^2} - G - R_E \tag{3.29}$$

Summing up the quantities produced, as shown by (3.25) and (3.26), gives the total production level of the market:

$$q_E(e) + nq_{NA}(e) = \frac{(n+1)(\alpha - c) + k}{n+2} \tag{3.30}$$

Putting (3.30) into (3.9) gives consumer surplus, denoted by CS_E, for a given innovation level k, when the innovation is commercialized by entrepreneurial entry:

$$CS_E = \frac{(\sum_{i=1}^{n+1} q_i)^2}{2} = \frac{((n+1)(\alpha - c) + k)^2}{2(n+2)^2} \tag{3.31}$$

Social welfare obtained, denoted by W_E, for a given innovation level k, after commercialization by market entry, is the sum of (3.29) and (3.31):

$$W_E = CS_E + PS_E = \frac{((n+1)(\alpha - c) + k)^2}{2(n+2)^2} + \frac{(\alpha - c + (n+1)k)^2}{(n+2)^2} + n\frac{(\alpha - c - k)^2}{(n+2)^2} - G - R_E \tag{3.32}$$

When comparing social welfare levels obtained by respective commercialization strategies, as shown by (3.24) and (3.32), it is easy to observe that the only thing changes is the number of firms – ignoring transaction cost, commercialization cost and R&D expenditures. This inclines me to state my first proposition in this thesis owing to a very simple calculation, as assuming $G + R_E \geq T + R_A$ so as to be able to ignore the values of transaction cost, commercialization cost and R&D expenditures.

Proposition-1: Assuming $G + R_E \geq T + R_A$, for a given level of non-drastic process innovation, sale of the innovation is favored over entrepreneurial entry in terms of social welfare unless the innovation is smaller than a threshold, $\overline{k_1}$.

Proof: Suppose that the innovation is commercialized by a sale to an incumbent firm. Then, social welfare, denoted by W_A, is:

$$W_A = \frac{(n(\alpha - c) + k)^2}{2(n+1)^2} + \frac{(\alpha - c + nk)^2}{(n+1)^2} + (n-1)\frac{(\alpha - c - k)^2}{(n+1)^2} - G - R_E \tag{3.33}$$

Taking the derivative of W_A with respect to n will give us the insight on what happens when the number of firms producing in the market increases, that is, entrepreneurial entry occurs.

$$\begin{aligned} \frac{dW_A}{dn} &= -2\frac{(\alpha - c + nk)}{n+1}\frac{(\alpha - c - k)}{(n+1)^2} + \frac{(\alpha - c - k)^2}{(n+1)^2} - 2(n-1)\frac{(\alpha - c - k)}{(n+1)}\frac{(\alpha - c - k)}{(n+1)^2} \\ &\qquad + \frac{(n(\alpha - c) + k)}{n+1}\frac{(\alpha - c - k)}{(n+1)^2} \\ &= -2\frac{(\alpha - c + nk)(\alpha - c - k)}{(n+1)^3} - (n-3)\frac{(\alpha - c - k)^2}{(n+1)^3} + \frac{(n(\alpha - c) + k)(\alpha - c - k)}{(n+1)^3} \\ &= \frac{(\alpha - c - k)}{(n+1)^3}(\alpha - c - (n+2)k) \end{aligned} \tag{3.34}$$

This value is positive $k < \overline{k_1} = \frac{\alpha - c}{n+2}$ and negative when $k > \overline{k_1} = \frac{\alpha - c}{n+2}$.

Due to the assumption of $G + R_E \geq T + R_A$, for innovation levels above $\overline{k_1} = \frac{\alpha - c}{n+2}$,

W_A is certainly bigger than W_E.

Q.E.D.

The intuition behind this finding is basically a conjunction of business stealing effect (Mankiw and Whinston, 1986) and negative welfare effect of a cost reduction (see Lahiri and Ono, 1988; Shapiro, 1989; Zhao, 2001). Entrepreneurial entry means having one more inefficient firm in the product market, since no incumbent firms benefit from the innovation when the entrepreneur makes use of it in its own production process. In other words, when the innovation is commercialized by entrepreneurial entry, one more inefficient firm steals business from the firm with the innovation. And if the gap between marginal costs of the efficient firm and the inefficient firms is sufficient, just like Zhao (2001) puts emphasis on, the business stealing effect causes entrepreneurial entry to be suboptimal as it generates less increase in social welfare than sale to an incumbent firm does.

Ignoring transaction cost, commercialization cost and R&D expenditures is a safe assumption here. Because, commercialization cost is most likely to be much higher than transaction cost, even at the times when transaction cost gets substantially large values. And the difference between R&D expenditure levels for two distinct commercialization strategies cannot cover the difference between these costs, because this model deals with non-drastic process innovations, in other words, incremental innovations. Assuming the difference between the required expenditures for two different levels of incremental innovation to be large enough to cover the cost difference of two commercialization strategies is implausible. Therefore, including them to the calculations would only strengthen the assertion of Proposition-1.

Corollary-1: As the product market gets more competitive, entrepreneurial entry is not preferable on the societal level for a larger range of non-drastic process innovations.

Proof: Since the product market is a homogeneous-goods one, increasing the level of market competition is equivalent to increasing the number of incumbent firms. The threshold of the innovation level which is obtained in Proposition-1 is $\overline{k_1} = \frac{\alpha - c}{n+2}$. Taking the derivative of this threshold with respect to n,

$$\frac{d}{dn}(\frac{\alpha - c}{n+2}) = -\frac{\alpha - c}{(n+2)^2} < 0 \tag{3.35}$$

This means that for the innovation levels larger this threshold, which gets smaller as the number of incumbent firms increases, W_A is certainly bigger than W_E.

Q.E.D.

Proposition-1 hints that government financial support should facilitate an incumbent acquisition of the innovation instead of entrepreneurial entry, for a given innovation level, unless the innovation is too small. Corollary-1 extends this suggestion and states that, for the more competitive product markets, such a policy is preferable on the societal level for a larger range of non-drastic process innovations.

3.2 Stage-2: Commercialization Stage

At this stage, the start-up decides on the commercialization strategy for the innovation. To shed light on this process, I assume that incumbent firms bid for the innovation in a first-price perfect information auction. Assuming this kind of an auction lets me focus on the market forces that shape the decision of the start-up on how to commercialize its innovation, instead of problems stemming from asymmetric information among participants of the economy [9]. In such an auction, every incumbent firm posts its bid according to its true valuation; and the start-up either accepts or rejects these bids, comparing to its own reservation price.

Definition-2: v_e is the value of entrepreneurial entry for the start-up; that is, it stands for the reservation price of the innovation for which incumbent firms bid in an auction.

$$v_e = \Pi_E(e) - G \tag{3.36}$$

or, equivalently,

$$v_e = \frac{(\alpha - c + (n+1)k)^2}{(n+2)^2} - G \tag{3.37}$$

[9] See, for such a reasoning, Norback and Persson (2009).

Definition-3: v_{ie} is the value for an incumbent firm of possessing the innovation, when the innovation would otherwise be commercialized by entrepreneurial entry; that is, it is the entry-deterring valuation.

$$v_{ie} = \Pi_A - \Pi_{NA}(e) - T \tag{3.38}$$

or, equivalently,

$$v_{ie} = \frac{(\alpha - c + nk)^2}{(n+1)^2} - \frac{(\alpha - c - k)^2}{(n+2)^2} - T \tag{3.39}$$

Definition-4: v_{ii} is the value for an incumbent firm of possessing the innovation, when another incumbent firm would otherwise acquire the innovation; that is, it is the preemptive valuation.

$$v_{ii} = \Pi_A - \Pi_{NA}(a) - T \tag{3.40}$$

or, equivalently,

$$\begin{aligned} v_{ii} &= \frac{(\alpha - c + nk)^2}{(n+1)^2} - \frac{(\alpha - c - k)^2}{(n+1)^2} - T \\ &= (\frac{2(\alpha - c) + (n-1)k}{n+1})k - T \end{aligned} \tag{3.41}$$

Whenever the preemptive valuation is higher than the reservation price of the start-up, a sale of the innovation to an incumbent firm happens at its preemptive valuation. This is called a preemptive incumbent acquisition. When the opposite result holds, entrepreneurial entry occurs if the reservation price is higher than the entry-deterring valuation. Otherwise, i.e., if the entry-deterring valuation is higher than the reservation price, a sale of the innovation to an incumbent firm happens at the start-up's reservation price. The latter commercialization mode is called an entry-deterring incumbent acquisition. When an incumbent firm acquires the innovation at the start-up's reservation price, oligopolistic competition cannot raise the acquisition price above the reservation price, because the preemptive valuation is too low.

Corollary-2: All of these valuations decrease as the product market gets more competitive.

Proof: It is a very straightforward finding that can be derived by simply taking the derivatives of these valuations with respect to n. As it is very apparent, the process innovation being non-drastic (i.e., $k < \alpha - c$) plays a crucial role in this result.

$$\frac{dv_e}{dn} = -2\frac{(\alpha - c + (n+1)k)(\alpha - c - k)}{(n+2)^3} < 0 \tag{3.42}$$

$$\frac{dv_{ie}}{dn} = -2\frac{(\alpha - c + nk)(\alpha - c - k)}{(n+1)^3} + 2\frac{(\alpha - c - k)^2}{(n+2)^3} < 0 \tag{3.43}$$

$$\begin{aligned} \frac{dv_{ii}}{dn} &= -2\frac{(\alpha - c + nk)(\alpha - c - k)}{(n+1)^3} + 2\frac{(\alpha - c - k)^2}{(n+1)^3} \\ &= -2k\frac{(\alpha - c - k)^2}{(n+1)^3} < 0 \end{aligned} \tag{3.44}$$

Q.E.D.

It is not straightforward to see which option for commercialization strategy is affected less negatively by increased level of product market competition. Norbäck and Persson (2012) assert that continuously increasing market competition inclines the start-up to commercialize the innovation by sale to an incumbent firm eventually, since the entry-deterring and the preemptive valuations always decrease less than the reservation price of the innovation does, for any given level of innovation. That is, $\frac{d(v_{ie}-v_e)}{dn} > 0$ and $\frac{d(v_{ii}-v_e)}{dn} > 0$ for all innovation levels. Hence, when product market gets competitive enough, at least one of the entry-deterring valuation and the preemptive valuation exceed(s) the reservation price, which means commercialization by incumbent acquisition. In other words, the level of market competition can endogenously determine the commercialization strategy in their view. When I test their claim in my model, the findings dispute their assertion.

Lemma-1: For varying levels of innovation, the valuations are affected differently relative to one another by increasing product market competition since there are two thresholds of innovation level, $\overline{k_2}$ and $\overline{k_3}$, in this respect. Below $\overline{k_2}$, increasing level of product market competition affects entry-deterring valuation less negatively than reservation price. For the innovation levels above this threshold, the opposite result holds. Similarly, below $\overline{k_3}$, increasing level of product market competition affects preemptive valuation less negatively than reservation price. For the innovation levels above this threshold, the opposite result holds.

Proof: See Appendix-A.

Lemma-1 indicates that continuously increasing market competition does not have the same effect on the choice of commercialization strategy for all possible levels of innovation. And, as I will show when discussing stage-1, the innovation levels obtained for each commercialization strategy are most likely to be different. Since, for varying levels of innovation, the valuations are affected differently relative to one another by increasing product market competition, one cannot conclude which commercialization strategy will be favored as market competition gets more intense.

In a similar vein, Norbäck et al. (2016) demonstate by theoretical work that continuously increasing the level of innovation inclines the start-up to commercialize the innovation by sale to an incumbent firm eventually, since, with a higher quality innovation, the entry-deterring and the preemptive valuations always rise more than the reservation price of the innovation does. That is, $\frac{d(v_{ie}-v_e)}{dk} > 0$ and $\frac{d(v_{ii}-v_e)}{dk} > 0$. The findings of my model, again, do not agree with their assertion.

Lemma-2: There is no monotonic effect of innovation on the choice of commercialization strategy, since there are two thresholds of innovation level, $\overline{k_4}$ and $\overline{k_5}$, in this respect. Below $\overline{k_4}$, increasing innovation level gives rise to entry-deterring valuation more than reservation price. For the innovation levels above this threshold, the opposite result holds. Similarly, below $\overline{k_5}$, increasing innovation level gives rise to preemptive valuation more than reservation price. For the innovation levels above this threshold, the opposite result holds.

Proof: See Appendix-A.

Lemma-1 and Lemma-2, together, imply that, neither altering the market competition level nor improving the innovation quality endogenously inclines the start-up to commercialize its innovation by sale to an incumbent firm, which is more beneficial to society for a given level of innovation unless the innovation is too small. While determining which commercialization strategy will be chosen, a start-up shall take the amounts of commercialization cost, transaction cost, and R&D cost required for respective strategy into account, beside the level of market competition and the innovation quality. One cannot ensure commercialization by sale to eventually occur with the sole influence of more intense market competition or higher innovation quality, by simply ignoring those costs. In order to achieve incumbent acquisition of an innovation to occur, since it is the socially-desired commercialization strategy for a large range of innovation level, an exogenous intervention seems to be necessary.

Proposition-2: Favoring commercialization of a given level of innovation by sale to an incumbent firm over commercialization by entrepreneurial entry with the same innovation, via subsidizing transaction cost instead of commercialization cost, is optimal as a government policy for a large range of non-drastic process innovations.

It is obvious that such a bias in policy is not just preferable for society, but necessary to reach higher social welfare levels, given the inability of the market competition level or the innovation quality to guarantee that commercialization by sale to an incumbent firm is more profitable for the start-up than its alternative at some point. As a corollary, this situation causes the entry-deterring valuation not to exist in the model from now on. Because in my model, entrepreneurial entry is facilitated or hampered by government policy interventions, instead of endogenous developments.

3.3 Stage-1: R&D Stage

At this stage, the start-up decides how much to invest in R&D and how large its innovation will be, with rational expectations of the commercialization strategy that will be chosen in Stage-2, and the payoffs that will be earned in Stage-3. In order to appropriately investigate this stage, I shall make some alterations in the model.

To begin with, let me assume a new function, $c(.)$. It is a marginal cost function, and its independent variable is the R&D expenditure, denoted by R. $c(.)$ is a strictly concave function, with $c'(.) < 0$ and $c"(.) > 0$. The innovation level, k, is now depicted as $c - c(R)$.

It is very clear that the level of R&D expenditure directly affects the profit levels gained in the product market. Thus, in an attempt to use correct notations, let $\Pi^e_E(R_E)$ and $\Pi^e_{NA}(R_E)$ denote the product market profits earned by the start-up and a non-acquiring incumbent firm when the innovation is commercialized by entrepreneurial entry, let $\Pi_A(R_A)$ and $\Pi^a_{NA}(R_A)$ denote the product market profits earned by the acquiring incumbent firm and a non-acquiring incumbent firm when the innovation is commercialized by preemptive incumbent acquisition. Recall that R_A denotes the R&D expenditure level when the innovation is to be commercialized by sale to an incumbent firm and R_E denotes the R&D expenditure level when the innovation is to be commercialized by entrepreneurial entry.

Since, in my model, entrepreneurial entry is exogenously facilitated or hampered by government policy interventions, entry-deterring valuation vanishes. This causes that there is no possibility of entry-deterring incumbent acquisition from this point on, obviously. Because, for this commercialization mode to occur, incumbent firms must be able to deter entrepreneurial entry, and their valuation of doing so (entry-deterring valuation) must be larger than reservation price and preemptive valuation. Hence, the start-up conducts R&D in stage-1 only with an expectation of either entrepreneurial entry or preemptive incumbent acquisition.

Expecting an entrepreneurial entry, the start-up chooses how much to invest in R&D by maximizing its profit after market entry:

$$\underset{R}{max}\ v_e - R = \Pi^e_E(R) - G - R \tag{3.45}$$

The equation (3.45) becomes, when explicitly writing $\Pi^e_E(R)$:

$$\underset{R}{max}\ \frac{(\alpha - c + (n+1)(c - c(R)))^2}{(n+2)^2} - G - R \tag{3.46}$$

Expecting that the innovation will be commercialized by a preemptive incumbent acquisition in stage-2, the start-up maximizes its profit upon sale of the innovation to an incumbent firm at an incumbent firm's preemptive valuation:

$$\underset{R}{max}\ v_{ii} - R = \Pi_A(R) - \Pi^a_{NA}(R) - T - R \tag{3.47}$$

When an explicitly writing $\Pi_A(R)$ and $\Pi^a_{NA}(R)$, the equation (3.47) becomes:

$$\underset{R}{max}\ \frac{2(\alpha - c) + (n-1)(c - c(R))}{(n+1)}(c - c(R)) - T - R \tag{3.48}$$

Assumption-2: Equations (3.46) and (3.48) are strictly concave in R, respectively.

Proposition-3: The expectation of commercialization by sale induces the start-up to invest in R&D more than it does for market entry, if the start-up, with an expectation of market entry, would create an innovation with an inventive step less than a threshold, $\overline{k_6}$. If the start-up generates an innovation level higher than $\overline{k_6}$ when market entry is expected, the opposite result holds.

Proof: See Appendix-A.

In the case where the start-up, with an expectation of commercialization by preemptive incumbent acquisition, invests in R&D more than the it would for entrepreneurial entry, commercialization by sale results in a higher innovation level in comparison to the level obtained with an expectation of entrepreneurial entry. When the start-up, with an expectation of commercialization by preemptive incumbent acquisition, invests in R&D less than it would for entrepreneurial entry, commercialization by market entry results in a higher innovation level in comparison to the level obtained with an expectation of preemptive incumbent acquisition.

Proposition-3 shows that the respective amounts of R&D conducted for each commercialization strategy and the ordering between them depend on the specification of the marginal cost function, $c(.)$. When responding to market incentives for entrepreneurial entry, if the start-up strategically makes a high level of R&D expenditure to expand its market share by stealing business from incumbent firms (see, Brander and Spencer, 1983), that is, if (3.46) needs a larger reduction in marginal cost than $\overline{k_6}$ implies so as to reach its maximum value, commercialization by market entry results in a higher innovation level compared to the level obtained with an expectation of preemptive incumbent acquisition. In other words, if the start-up is able to generate high innovation level in response to market incentives for entrepreneurial entry, government's policy bias towards supporting market entry instead of commercialization by sale brings about higher-quality start-up innovation. If the innovation level, or reduction in marginal cost, required by (3.46) to maximize the start-up's profit upon market entry is smaller than $\overline{k_6}$ implies, the expectation of commercialization by sale induces the start-up to invest more in R&D than the amount strategically determined to expand the entrepreneur's market share. That is, if the start-up is not innovative enough, government's favoring commercialization by sale over entrepreneurial entry brings about higher-quality start-up innovation.

Proposition-3 gives another reason to the government for facilitating commercialization by sale to an incumbent firm instead of entrepreneurial entry. Beside sale of the innovation to an incumbent firm being more beneficial to society for a given innovation level unless the innovation level is too small, it induces the start-up to conduct more R&D than it does for entrepreneurial entry, if the start-up, with an expectation of market entry, would create an innovation with an inventive step less than a threshold, $\overline{k_6}$. As a consequence, making product market entry more profitable than a sale of the innovation leaves the government with a lower level of innovation and, consequently, with a quite limited increase in social welfare, when the start-up is not an able innovator.

Corollary-3: Since the marginal cost function, $c(.)$, is strictly concave in R&D expenditure, financial support for R&D expenditures stimulates the entrepreneur to create an innovation with a bigger inventive step, no matter how the innovation will be commercialized, because it rises the expenditure level for R&D beyond the profit-maximizing level of the start-up.

Corollary-4: The amount of R&D expenditure and the resulting innovation level are both negatively affected by increasing level of market competition, or, equivalently, increasing number of incumbent firms, when this innovation level is below some threshold, $\overline{k_7}$, if preemptive incumbent acquisition is expected, and when this innovation level is below another threshold, $\overline{k_8}$, if entrepreneurial entry is expected. Above these thresholds, respectively, the opposite results hold.

Proof: See Appendix-A.

Corollary-4 states that, if the start-up is only able to generate low innovation levels in response to market incentives for either entrepreneurial entry or commercialization by sale, both the R&D expenditure level and the quality of the obtained innovation diminish in the face of more fierce market competition. Therefore, despite the fact that entrepreneurship, with or without innovation, is considered the correct tool by governments to boost economic growth and to fight unemployment at the same time, having the market converged to "perfect competition" seems to hamper an outsider start-up's innovative activity pursuing a non-drastic process innovation when the start-up is not innovative enough.

CHAPTER 4

EXTENSION: THE MODEL FOR A FIXED COST INNOVATION

This model intends to investigate the start-up's preference of risk. To this end, I consider the innovation reducing fixed production cost of the firm which utilizes it this time. The model basically remains the same, just a fixed production cost, denoted by F, is added to the profit equation of each firm. The start-up chooses a project among an infinite number of independent R&D projects. Each project (let it be project k) is characterized by a certain probability of success, denoted by p_k, and a corresponding reduction in the fixed cost $\Gamma(p_k)$, where $\Gamma'(p_k) < 0$. The start-up, here, makes a choice among projects with high probabilities of success but yield a small reduction in the fixed production cost if successful, and projects which are riskier but are associated with a higher payoff if successful. Hence, the previous assumption of deterministic invention process is not valid anymore. R&D expenditure is made ex ante; that is, it is paid whether the innovation is achieved or not. Owing to the stochastic nature of the invention process, commercialization cost or transaction cost is paid ex post, which means that these expenditures are made only when the invention process is a success. I also assume that the expected cost reduction is strictly concave in probability of success. Another divergence from the original model of this study is that the R&D expenditure, here, is constant for all R&D projects, denoted by R.

Assumption-3: The expected cost reduction, $p\Gamma(p)$, is strictly concave in probability of success, p, ensuring that a unique project maximizes the expected fixed cost reduction.

This extension model is basically a follow-up to Damsgaard et al. (2017) in which the set-up comprises a monopolist incumbent firm and an outsider start-up. They are both allowed to conduct R&D for fixed cost innovations. If the incumbent firm achieves creating an innovation, it preempts the start-up's market entry, even when the start-up also succeeds with its R&D. If the monopolist fails and the start-up comes up with an innovation, the start-up enters the product market, making it a duopoly. My model distinguishes from Damsgaard et al. (2017) by assuming an oligopolistic product market both before and after the arrival of the innovation, and by providing the start-up with the alternative of selling its innovation to one of the incumbent firms to commercialize it beside the choice of entrepreneurial entry. Moreoever, only the start-up is capable of conducting R&D in my model, so the monopolist can preempt an entrepreneurial entry by an incumbent acquisition solely.

I, again, model a three-stage game to highlight the process from R&D to commercialization of the resulting innovation.

In stage-1, the start-up chooses the riskiness of the R&D project. All of the projects that the start-up can decide to pursue require the same R&D investment, R. So it is the level of riskiness that distinguishes them from one another, since the process of invention is stochastic. The riskiness level of the R&D project chosen by the start-up depends on the expectation of how the innovation will be commercialized. p_A denotes the R&D project's probability of success when the innovation is to be commercialized by sale to an incumbent firm and p_E denotes the project's probability of success when the innovation is to be commercialized by entrepreneurial entry.

In stage-2, the outcome of the R&D project is revealed and, if successful, the start-up decides how to commercialize its innovation. Here, I shall assume that the start-up cannot enter the product market without the innovation.

Assumption-4: $\Pi_E(e) - F - G < 0$ while $\Pi_E(e) - F + \Gamma(p) - G > 0$ for R&D projects that are risky enough.

It can either enter the product market with its innovation or sell the innovation to an incumbent firm. The start-up makes this decision by using the same three valuations which are defined in Chapter –III: reservation price, entry-deterring valuation and preemptive valuation. If the start-up opts for entrepreneurial entry with its innovation, it must incur a fixed entry cost, which is referred to as commercialization cost in this study, following Norbäck and Persson (2012), denoted by G. If the start-up decides to sell the innovation, the acquiring incumbent firm must pay transaction cost, as defined in Norbäck et al. (2016), denoted by T, beside the amount received by the start-up. In addition to the model in Chapter-III, there is fixed production cost, denoted by F, for each firm operating in the market, let it be an incumbent firm or the entrepreneurial firm. Therefore, the formulations for reservation price, entry-deterring valuation and preemptive valuation become:

$$v_e = \Pi_E(e) - F + \Gamma(p) - G \tag{4.1}$$

$$v_{ie} = \Pi_A - \Pi_{NA}(e) + \Gamma(p) - T \tag{4.2}$$

$$v_{ii} = \Pi_A - \Pi_{NA}(a) + \Gamma(p) - T \tag{4.3}$$

In stage-3, firms interact in an oligopolistic product market, given that the R&D project chosen in stage-1 is successful. If entrepreneurial entry occurs, there will be a quantity competition among $n+1$ firms in the market. One of those is the entrepreneur, which is not subject to any capacity constraint for production or in need of time to claim a market share, thus displays the same characteristics with the n incumbent firms, except having a lower fixed production cost due to the innovation it utilizes. After the start-up's market entry, all of the incumbent firms lose some of their market power to the entrepreneur. But the market shares of $n + 1$ firms do not differ to one another, since a fixed cost innovation does not make the firm that possesses the innovation more efficient than the others. Hence, the production amount of each firm after entrepreneurial entry can be derived directly from (3.7):

$$q_E(e) = q_{NA}(e) = \frac{\alpha - c}{n + 2} \tag{4.4}$$

Putting (4.4) into (3.5) and (3.6), the product market profit earned by each firm can be calculated as:

$$\Pi_E(e) = \Pi_{NA}(e) = \frac{(\alpha - c)^2}{(n+2)^2} \tag{4.5}$$

If incumbent acquisition of the innovation occurs, there will be a quantity competition among the same n incumbent firms. However, this time, one of those firms, the acquiring incumbent firm, has a lower fixed production cost due to the innovation it holds possession of. Since the innovation is to reduce fixed production cost, the market shares prior to the arrival of the innovation do not alter after the innovation is acquired by an incumbent. Hence the production amount of each firm is exactly the same with the amount stated in (3.7):

$$q_A = q_{NA}(a)\frac{\alpha - c}{n+1} \tag{4.6}$$

Putting (4.6) into (5) and (6), the product market profit earned by each firm can be calculated as:

$$\Pi_A = \Pi_{NA}(a) = \frac{(\alpha - c)^2}{(n+1)^2} \tag{4.7}$$

(4.7) implies that preemptive valuation of an incumbent firm's becomes:

$$v_{ii} = \Gamma(p) - T \tag{4.8}$$

Since the payoff gained by the start-up following an entry-deterring incumbent acquisition in stage-2 is exactly the reservation price of the innovation (see Chapter-III), the start-up tries to maximize its profit by choosing success probability of the R&D project in stage-1 either as if its payoff will equal the reservation price or as if its payoff will equal the preemptive valuation of an incumbent firm. When the payoff is expected to be the reservation price, the start-up decides which project to choose in order to maximize its expected profit after market entry:

$$\underset{p}{max}\ pv_e - R = p(\Pi_E(e) - F + \Gamma(p) - G) - R \tag{4.9}$$

With an expectation of a preemptive incumbent acquisition, the start-up maximizes its profit upon sale of the innovation to an incumbent firm at an incumbent firm's preemptive valuation:

$$\max_{p} pv_{ii} - R = p(\Gamma(p) - T) - R \tag{4.10}$$

Whenever the maximum value of (4.10) is higher than the maximum value of (4.9), the start-up chooses the R&D project that maximizes (4.10) in stage-1 in order to commercialize its resulting innovation by preemptive incumbent acquisition. That is, the commercialization strategy is determined even before stage-2 in this case. When the opposite result holds, the start-up chooses the R&D project that maximizes (4.9). In this case, the commercialization mode will be determined in stage-2 by comparing reservation price and entry-deterring valuation. Entrepreneurial entry occurs with the project that maximizes (4.9) if the reservation price is higher than the entry-deterring valuation. Entry-deterring acquisition of an incumbent firm occurs with the same project, again, if the entry-deterring valuation is higher than the reservation price. In other words, p_E is also the probability of the project chosen by the start-up when commercialization by entry-deterring incumbent acquisition is expected.

In order to look into the effects of government policies on the level of innovation and the social welfare, I assume that, without any financial support from government, the start-up cannot make an entrepreneurial entry at its profit-maximizing probability level of project chosen with an expectation of market entry.

Assumption-5: $p_E(\Pi_E(e) - F + \Gamma(p_E) - G) - R < 0$, where p_E denotes the profit-maximizing probability level of project chosen with an expectation of market entry.

Assumption-5 also rules out the entry-deterring valuation since there is no competitive threat from the start-up to the incumbent firms without any financial support from government.

However, it is possible for the start-up to build innovations to sell an incumbent firm at its preemptive valuation. This is so because of the oligopolistic structure of the product market, leaving all the bargaining power to the start-up. This model allows this option to occur.

Assumption-6: $p_A(\Gamma(p_A) - T) - R > 0$, where p_A denotes the profit-maximizing probability level of project chosen with an expectation of a preemptive incumbent acquisition.

Assumptions-5 and -6 also make it inevitable to conclude that, at the probability level p_A, it is not possible for the start-up to enter the product market either, because p_E is the unique profit-maximizing level of probability given the strict concavity of the expected cost reduction in the level of probability. That is,

$$p_A(\Pi_E(e) - F + \Gamma(p_A) - G) - R < 0 \tag{4.11}$$

This means that $\Gamma(p_A) - T$ is higher than $\Pi_E(e) - F + \Gamma(p_A) - G$. In other words,

$$T < -(\Pi_E(e) - F - G) \tag{4.12}$$

In order for financial supports of government to have a meaning, I shall assume that whenever it is possible for the start-up to enter the product market at its profit-maximizing probability level of R&D project owing to a government support, the start-up prefers entrepreneurial entry or sale to an incumbent firm at its entry-deterring valuation over sale to an incumbent firm at its preemptive valuation.

Assumption-7: $p_E(\Pi_E(e) - F + \Gamma(p_E) - G) > p_A(\Gamma(p_A) - T)$.

Direct computations following Assumptions 4 – 7 make me to state the next lemma.

Lemma-3: The start-up chooses a riskier project when market entry is possible than the project chosen to sell an incumbent firm at its preemptive valuation.

Proof: The first-order condition of the maximization problem (4.9) is,

$$\Gamma(p_E) + p_E\Gamma'(p_E)) = -(\Pi_E(e) - F - G) \tag{4.13}$$

The first-order condition of the maximization problem (4.10) is,

$$\Gamma(p_A) + p_A\Gamma'(p_A) = T \tag{4.14}$$

From (4.12), $p_E < p_A$ owing to the strictly concave nature of the expected cost reduction in probability of success.

Q.E.D.

Lemma-3 confirms the findings of Damsgaard et al. (2017). They argue that the entrepreneur chooses a riskier project than a monopolist incumbent firm does, because the value of $-(\Pi_E(e) - F - G)$ is positive. They call this value "the entrepreneurship hurdle effect". My model extends their result to oligopolistic markets and shows that the start-up chooses a riskier project than an incumbent firm would prefer without a competitive threat from the start-up, when the entrepreneurship hurdle effect is higher than the transaction cost.

Corollary-5: If the commercialization cost decreases, the start-up chooses a safer project when entrepreneurial entry is possible.

Proof: This finding can easily be obtained by applying the Implicit Function Theorem to the first order condition of the maximization problem (4.10), which is (4.13):

$$\frac{d(p_E)}{dG} = \frac{1}{2\Gamma'(p_E) + p_E \Gamma"(p_E)} < 0 \tag{4.15}$$

by virtue of the strict concavity of the expected cost reduction in p.

Q.E.D.

Lemma-3 shows that making product market entry profitable for the start-up induces the start-up to conduct a riskier project and this way of action serves to the government's aim of boosting innovation. However, Corollary-5 shows that subsidizing commercialization cost seems to be counter-productive in this respect. Lemma-3 and Corollary-5, together, shape the following claim.

Proposition-4: Subsidizing commercialization cost in an attempt to increase the level of innovation by making the start-up's market entry possible diminishes the entrepreneurship hurdle effect and, consequently, brings about an innovation with a smaller inventive step. Instead, financial support for R&D expenditure is the correct tool to make the competitive threat credible.

Corollary-5 and Proposition-4 point to the same with the findings and assertions of Damsgaard et al. (2017). They indicate that those relevant findings and assertions about the R&D race between a monopolist and an outsider innovator in Damsgaard et al. (2017) can be extended to the situations whereby an outsider innovator chooses to enter an oligopolistic market or sell its innovation to an oligopolist.

The intuition behind Proposition-4 is straightforward. Altering R&D expenditure level does not affect the start-up's choice of project riskiness, because R&D expenditure is an ex ante cost.

The model indicates that allowing the start-up into the product market induces the start-up to choose a riskier project with a higher payoff if successful. Thus, this kind of a policy serves to the government's purpose of boosting innovation. Nevertheless, what are the welfare implications of such a policy?

At first, let me assume that the reservation price is higher than the entry-deterring valuation of an incumbent firm; so the commercialization strategy decided in stage-2 is entrepreneurial entry.

Lemma-4: The welfare implications of allowing the start-up's market entry with government support is ambiguous, when entrepreneurial entry is expected.

Proof: See Appendix-A.

Lemma-4 is a direct implication of the business stealing effect (Mankiw and Whinston, 1986), which means that entry is more beneficial to the entrepreneur than it is to society, especially in homogeneous goods markets with symmetric firms. Assumption-7 guarantees the profit of the entrepreneur to be much higher in expected terms than the payoff it expects to gain when the innovation is to be commercialized by preemptive incumbent acquisition. However, since the increase in social welfare is lower than the profit of the entrepreneur, the model cannot conclude which commercialization option yields more increase in social welfare. Yet, a government can be advised not to support entrepreneurial entry, because it requires a substantial expenditure by the government and, still, its welfare implications remain ambiguous.

Now, let me assume that the commercialization mode is entry-deterring incumbent acquisition. It can happen without any exogenous intervention, just because the entry-deterring valuation is higher than the reservation price. Likewise, if it is not, the government may subsidize the transaction cost, T, to motivate the incumbent firm to make such an acquisition.

Lemma-5: Allowing the start-up's market entry is absolutely suboptimal, when entry-deterring incumbent acquisition is expected.

Proof: See Appendix-A.

Lemma-5 seems to be counter-intuitive, because commercialization by entry-deterring incumbent acquisition avoids the business stealing effect, which is shown in Lemma-4 as the reason of possible suboptimality. Nonetheless, this time, the riskiness of the R&D project, instead of business stealing effect, plays a critical role to define social welfare. When the commercialization mode is an incumbent acquisition, that is, the start-up does not enter the product market, the product market remains the same with the one prior to the arrival of the innovation. And in this case, p_A is calculated to be welfare-maximizing level of project riskiness. By bringing a riskier project to the market than is preferred, i.e., recall that $p_E < p_A$, entry-deterring incumbent acquisition is suboptimal on the societal level.

Lemma-4 and Lemma-5, together, shape the following proposition.

Proposition-5: Despite the widespread belief, facilitating entrepreneurial entry because of their riskier attitude towards innovative activity is suboptimal in some cases and cannot ensure more welfare in others, when the innovation is to reduce fixed production cost in a homogeneous goods market with symmetric firms. Instead, aligning innovative activities of the outsiders with the preferences of the incumbent firms on innovation is optimal, especially when entry-deterring incumbent acquisition is expected to be the commercialization mode.

Proposition-5 states the most important distinction between the findings of my study and the assertions of Damsgaard et al. (2017). In their setting, when the product market is a homogeneous goods market with symmetric firms, the start-up always chooses a less risky project for entrepreneurial entry than society prefers. According to my results, if the innovation is to be commercialized by entry-deterring incumbent acquisition, the R&D project chosen by the start-up is too risky compared to the level of riskiness preferred by society in the absence of entrepreneurial entry.

Now, let me look into how product market competition affects the preference of risk. It is clear that product market competition, or, in other words, the number of incumbent firms, does not affect p_A, since it does not depend on market shares of the incumbent firms as the innovation is to reduce fixed production cost. Nonetheless, p_E depends on market shares and market competition has a decisive effect on it.

Proposition-6: As the product market gets more competitive, the start-up chooses a riskier project to reduce fixed production cost when entrepreneurial entry is possible.

Proof: p_E is calculated through the maximization problem (4.9). The first-order condition of this problem is given by (4.13). Putting (4.5) into (4.13), the first-order condition becomes:

$$\Gamma(p_E) + p_E\Gamma'(p_E)) = -(\frac{(\alpha - c)^2}{(n+2)^2} - F - G) \tag{4.16}$$

Simply taking the derivative of the left hand side of (4.16) with respect to n indicates what happens to the optimal value p_E as product market gets more competitive:

$$\frac{d(\Gamma(p_E) + p_E\Gamma'(p_E))}{dn} = -\frac{d}{dn}(\frac{(\alpha - c)^2}{(n+2)^2} - F - G) > 0 \tag{4.17}$$

So, p_E decreases with the number of firms, owing to the strictly concave nature of the expected cost reduction.

Q.E.D.

Proposition-6 explains one of the reasons of a prevalent situation, especially seen in developing countries. If sale of the innovation to an incumbent firm is not possible or not often, the start-up chooses a riskier project with an expectation of market entry as product market gets more competitive. This means more creative destruction if the invention is a success, but also less frequency of innovations arriving the product market despite substantial government supports for such innovations. Hence, the proclivity of developing countries to favor entrepreneurial entry over cooperation with incumbent firms causes smaller number of innovations arriving the product market when product market competition is fierce. Bridging between outsider innovators and incumbent firms for future cooperations to commercialize the innovations would be the optimal policy to increase the number of innovations coming from these start-ups into really competitive product markets; since this results in the start-ups choosing safer R&D projects to conduct. Thus, the frequency of innovations arriving the product market increases.

CHAPTER 5

CONCLUDING REMARKS

Governments evidently provide financial support for R&D expenditures of start-ups and subsidies for commercialization costs of entrepreneurs with the aim of promoting innovation and increasing welfare. In developing countries, for instance Turkey, it can be easily observed that government supports are supplied symmetrically to any start-up for any level of innovation and any market producing any good. However, the success of such policies depend on the ability to answer differing needs of distinct situations. In other words, any policy component should be tailored according to the characteristics, which define, to a large extent, the relationships among entrepreneurship, innovation, and social welfare. This study focuses on four of these characteristics: innovation type, innovation quality, differentiation level of goods produced in the market and product market competition. To this end, I construct a model in which a start-up can commercialize its innovation either by product market entry or by sale to an incumbent firm, where the product market is an oligopolistic one producing homogeneous goods.

One can rationally expect that entrepreneurial entry would bring about substantial benefits if it is with an innovation about a technologically new product or with an innovation which makes the old production techniques obsolete. This is why a great deal of respect has been accorded to the Schumpeter's "creative destruction" phenomenon so far while discussing economic progress. But, in most cases, innovations are not to present brand-new products or pioneering technologies. As the results obtained in this thesis indicate, under some certain conditions, non-drastic process innovations and fixed cost innovations, which lack the ability to make prior techniques obsolete, do not make entrepreneurial entry necessary, and even favorable for increasing social welfare.

The differentiation level of goods produced in the market also has significant implications on the relationship between entrepreneurial entry and social welfare. The original model in this study shows that, when goods are homogeneous, an entrepreneur, even with an innovation, can cause profit stealing effect to be larger than the positive effect a market entry imposes on consumer surplus. This finding would most likely reverse, if the goods were sufficiently differentiated; because consumers would like better a market entrant which brings additional variety of products to the market. Nonetheless, as long as the goods are not differentiated enough, expectations for market entry bringing about positive welfare implications are quite questionable.

It is assumed by some recent studies that innovation quality determines the mode of commercialization that a start-up chooses. However, as my original model shows, in the sense of backward induction, it is more plausible to think that the expected commercialization strategy chosen by the start-up determines the quality of a process innovation instead. Therefore, governments' tendency to facilitate one of the commercialization modes that a start-up could pursue has quite an influence on how much R&D a start-up will conduct. General belief is that subsidizing commercialization costs inclines start-ups to create innovations with bigger inventive steps, since such a support encourages their innovative endeavors. In a total agreement, my findings indicate, for non-drastic process innovations, that if start-ups are able innovators just like the ones in developed countries whereby there is an established innovation culture, governments' favoring entrepreneurial entry over commercialization by sale brings about higher-quality start-up innovation. However, if a start-up creates an innovation with an inventive step less than some threshold when responding to market incentives for entrepreneurial entry, the expectation of commercialization by sale would incline the start-up to conduct more R&D than it does for product market entry. These results, again, point out the insufficiency of symmetric application of government supports for innovation. In countries where start-ups are not innovative enough, governments' favoring entrepreneurial entry over commercialization by sale causes a start-up to conduct less R&D, and that the resulting process innovation level is below the level that would be generated with an expectation of commercialization by sale. Hence, under such circumstances, governments must act in the opposite way to the general proclivity of facilitating market entry, and must favor cooperation between start-ups and incumbent firms while commercializing non-drastic process innovations.

The level of market competition and innovation intensity are always acknowledged as two interrelated characteristics of economy. These two are also hand in hand in real life policy applications to promote high growth and employment. Nevertheless, they can sometimes work in opposite directions to each other, as both models of this study reveal. For non-drastic process innovations, if start-ups are only able to generate low innovation levels when responding market incentives for either entrepreneurial entry or commercialization by sale, just like the ones in most of the developing countries, both the R&D expenditures and the inventive steps of the obtained innovations diminish as product market gets more competitive by increasing the number of incumbent firms. For fixed cost innovations, increased level of market competition, that means again more incumbent firms, inclines the start-ups to conduct riskier R&D projects when product market entry is possible, which result in success less frequently. So, intense market competition leaves governments with very low levels of non-drastic process innovations when start-ups are not innovative enough, and risky fixed cost reduction projects that are not probably to arrive the markets. To put it differently, governments' tendency to facilitate entrepreneurship with or without an innovation so as to get more firms producing and creating employment seems to dissipate the effort that an outsider start-up makes pursuing an innovation, when this start-up is not innovative enough.

Another common belief about the relationship between innovation level and social welfare is that entrepreneurial innovations are beneficial to society thanks to their riskier nature. My results dispute this belief, when the innovation under scrutiny is a fixed cost innovation. I show that, if market entry is possible, the start-up chooses a riskier R&D project than an incumbent firm would prefer without a competitive threat from the start-up. And this riskiness may be suboptimal for the economy. If the start-up chooses to sell this riskier innovation to an incumbent firm, the results are clear: Conducting a riskier R&D project has detrimental welfare implications. If the start-up decides to enter the market with the same innovation, the results are ambiguous. Hence, it is not always advantageous for the society to face riskier innovations. In some cases, just like the one presented in this thesis, governments ought to align the choices of the start-ups on riskiness of innovations with the preferences of incumbent firms, by hampering market entry and incentivizing cooperation between outsider innovators and incumbent firms.

This study deals with a large range of relationships within the context of entrepreneurial innovation, but also makes lots of simplifying assumptions. Relaxing those assumptions would open new paths to look into the entrepreneurship phenomenon from different angles. For instance, both models in this study abstract from adverse selection and moral hazard problems, which are really hard to avoid in real life applications. Additionally, an important dimension of studies regarding entrepreneurial innovations is focused on external financing, particularly venture capital, to which I do not give place in this study. External financing or capital constraints would be a concern of incumbent firms too, since in this study I assume that an incumbent always has enough capital to acquire an innovation from a start-up, which is, to be honest, an unrealistic assumption. Also, capacity constraints for production, especially of an entrepreneur, would affect both the start-up's choice of commercialization mode for a given innovation level and the innovation level generated by the start-up. Assuming symmetry between incumbent firms is too strong likewise. Introducing asymmetry among incumbent firms would alter both the outcomes of the entry-acquisition auction game played by incumbent firms and the start-up, and the level of R&D expenditure made by the start-up. Future research involving those missing parts and others will highlight more areas on the process from R&D in start-ups to commercialization of the resulting innovation.

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APPENDIX A

PROOFS

Proof of Lemma-1:

In order to see how a valuation changes relative to another one with the effect of higher market competition, one can take derivatives of the difference between the valuations with respect to n. Since the model is interested in showing which commercialization mode is favored over its alternative by higher market competition, I will look into how entry-deterring valuation and preemptive valuation change, respectively, relative to reservation price with the effect of higher market competition.

$$\frac{d(v_{ie}-v_e)}{dn} = -2\frac{(\alpha-c+nk)(\alpha-c-k)}{(n+1)^3} + 2\frac{(\alpha-c-k)^2}{(n+2)^3} + 2\frac{(\alpha-c+(n+1)k)(\alpha-c-k)}{(n+2)^3} \tag{A.1}$$

$$= 2\frac{(\alpha-c-k)}{(n+1)^3(n+2)^3}((n^3-6n-6)(\alpha-c)-(3n^3+9n^2+7n)k)$$

If $k < \overline{k_2} = \frac{(n^3-6n-6)}{(3n^3+9n^2+7n)}(\alpha-c)$, $\frac{d(v_{ie}-v_e)}{dn} > 0$.

That is, entry-deterring valuation is affected less negatively by increasing level of market competition than reservation price is, when the innovation level is below $\overline{k_2}$.

If $k > \overline{k_2} = \frac{(n^3-6n-6)}{(3n^3+9n^2+7n)}(\alpha-c)$, $\frac{d(v_{ie}-v_e)}{dn} < 0$.

That is, reservation price is affected less negatively by increasing level of market competition than entry-deterring valuation is, when the innovation level is above $\overline{k_2}$.

The threshold, $\overline{k_2}$, appoaches the limit of $\frac{1}{3}(\alpha-c)$ as n grows larger.

$$\begin{aligned} \frac{d(v_{ii} - v_e)}{dn} &= -2k\frac{(\alpha - c - k)^2}{(n+1)^2} + 2\frac{(\alpha - c + (n+1)k)(\alpha - c - k)}{(n+2)^3} \\ &= 2\frac{(\alpha - c - k)}{(n+1)^2(n+2)^3}((n+1)^2(\alpha - c) - (3n^2 + 9n + 7)k) \end{aligned} \tag{A.2}$$

If $k < \overline{k_3} = \frac{(n+1)^2}{(3n^2+9n+7)}(\alpha - c)$, $\frac{d(v_{ii}-v_e)}{dn} > 0$.

That is, preemptive valuation is affected less negatively by increasing level of market competition than reservation price is, when the innovation level is below $\overline{k_3}$.

If $k > \overline{k_3} = \frac{(n+1)^2}{(3n^2+9n+7)}(\alpha - c)$, $\frac{d(v_{ii}-v_e)}{dn} < 0$.

That is, reservation price is affected less negatively by increasing level of market competition than preemptive valuation is, when the innovation level is above $\overline{k_3}$.

The threshold, $\overline{k_3}$, appoaches the limit of $\frac{1}{3}(\alpha - c)$ as n grows larger.

Q.E.D.

Proof of Lemma-2:

In order to see how a valuation changes relative to another one when the innovation quality is improved, one can take derivatives of the difference between the valuations with respect to k. Since the model is interested in showing which commercialization mode is favored over its alternative by higher-quality innovations, I will look into how entry-deterring valuation and preemptive valuation change, respectively, relative to reservation price with the effect of increasing innovation level.

$$\begin{aligned} \frac{d(v_{ie} - v_e)}{dk} &= 2\frac{(\alpha - c + nk)n}{(n+1)^2} + 2\frac{(\alpha - c - k)}{(n+2)^2} - 2\frac{(\alpha - c + (n+1)k)(n+1)}{(n+2)^2} \\ &= 2\frac{(2n^2 + 3n)(\alpha - c) - (3n^2 + 6n + 2)k}{(n+1)^2(n+2)^2} \end{aligned} \tag{A.3}$$

If $k < \overline{k_4} = \frac{(2n^2+3n)}{(3n^2+6n+2)}(\alpha - c)$, $\frac{d(v_{ie}-v_e)}{dk} > 0$.

That is, increasing innovation level gives rise to entry-deterring valuation more than reservation price when the innovation level is below $\overline{k_4}$.

If $k > \overline{k_4} = \frac{(2n^2+3n)}{(3n^2+6n+2)}(\alpha - c)$, $\frac{d(v_{ie}-v_e)}{dk} < 0$.

That is, increasing innovation level gives rise to reservation price more than entry-deterring valuation when the innovation level is above $\overline{k_4}$.

The threshold, $\overline{k_4}$, appoaches the limit of $\frac{2}{3}(\alpha - c)$ as n grows larger.

$$\begin{aligned}\frac{d(v_{ii} - v_e)}{dk} &= 2\frac{(\alpha - c + nk)n}{(n+1)^2} + 2\frac{(\alpha - c - k)}{(n+1)^2} - 2\frac{(\alpha - c + (n+1)k)(n+1)}{(n+2)^2} \\ &= 2\frac{(2n^2+5n+3)(\alpha - c) - (3n^2+8n+5)k}{(n+1)^2(n+2)^2}\end{aligned} \tag{A.4}$$

If $k < \overline{k_5} = \frac{(2n^2+5n+3)}{(3n^2+8n+5)}(\alpha - c)$, $\frac{d(v_{ii}-v_e)}{dk} > 0$.

That is, increasing innovation level gives rise to preemptive valuation more than reservation price when the innovation level is below $\overline{k_5}$.

If $k > \overline{k_5} = \frac{(2n^2+5n+3)}{(3n^2+8n+5)}(\alpha - c)$, $\frac{d(v_{ii}-v_e)}{dk} < 0$.

That is, increasing innovation level gives rise to reservation price more than entry-deterring valuation when the innovation level is above $\overline{k_5}$.

The threshold, $\overline{k_5}$, appoaches the limit of $\frac{2}{3}(\alpha - c)$ as n grows larger.

Q.E.D.

Proof of Proposition-3:

Since (3.46) and (3.48) are assumed to be strictly concave, their first-order conditions give the unique levels of R&D expenditure that maximize them respectively.

The first-order condition of (3.46) is:

$$-2\frac{(\alpha - c + (n+1)(c - c(R_E)))}{(n+2)^2}(n+1)c'(R_E) - 1 = 0 \tag{A.5}$$

Direct calculations yield:

$$c'(R_E) = -\frac{(n+2)^2}{2(n+1)(\alpha - c + (n+1)(c - c(R_E)))} \tag{A.6}$$

The first-order condition of (3.48) is:

$$\begin{aligned} -c'(R_A)\frac{2(\alpha - c) + (n-1)(c - c(R))}{(n+1)} - \frac{(n-1)c'(R_A)}{n+1}(c - c(R_A)) - 1 \\ = -2c'(R_A)\frac{(\alpha - c + (n-1)(c - c(R_A)))}{(n+1)} - 1 = 0 \end{aligned} \tag{A.7}$$

Direct calculations yield:

$$c'(R_A) = -\frac{(n+1)}{2(\alpha - c + (n-1)(c - c(R_A)))} \tag{A.8}$$

Suppose that $R_A = R_E = R$, so $c'(R_A) = c'(R_E) = c'(R)$ and $c(R_A) = c(R_E) = c(R)$.

$$\begin{aligned} -\frac{(n+2)^2}{2(n+1)(\alpha - c + (n+1)(c - c(R)))} = -\frac{(n+1)}{2(\alpha - c + (n-1)(c - c(R)))} \\ (2n+3)(\alpha - c) = (3n+5)(c - c(R)) \\ c - c(R) = \frac{(2n+3)}{(3n+5)}(\alpha - c) \end{aligned} \tag{A.9}$$

So, when the innovation level is $\overline{k_6} = \frac{(2n+3)}{(3n+5)}(\alpha - c)$, the R&D expenditures for respective commercialization strategies are equal to each other.

Suppose that $R_E > R_A$, $c'(R_E) > c'(R_A)$ and $c(R_A) > c(R_E)$. Then, there must be an expenditure level, R_M, such that $R_E > R_M > R_A$ and $c(R_A) > c(R_M) > c(R_E)$.

If I put R_M into (A.5) replacing R_E, (A.5) becomes positive:

$$-2\frac{(\alpha - c + (n+1)(c - c(R_M)))}{(n+2)^2}(n+1)c'(R_M) - 1 > 0 \tag{A.10}$$

So,

$$-2\frac{(\alpha - c + (n+1)(c - c(R_M)))}{(n+2)^2}(n+1)c'(R_M) > 1 \tag{A.11}$$

If I put R_M into (A.7) replacing R_A, (A.7) becomes negative:

$$-2c'(R_M)\frac{(\alpha - c + (n-1)(c - c(R_M)))}{(n+1)} - 1 < 0 \tag{A.12}$$

So,

$$-2c'(R_M)\frac{(\alpha - c + (n-1)(c - c(R_M)))}{(n+1)} < 1 \tag{A.13}$$

The ordering between (A.11) and (A.13) is apparent:

$$\begin{aligned} -2c'(R_M)\frac{(\alpha - c + (n-1)(c - c(R_M)))}{(n+1)} &< \\ -2\frac{(\alpha - c + (n+1)(c - c(R_M)))}{(n+2)^2}(n+1)c'(R_M) & \\ (2n+3)(\alpha - c) < (3n+5)(c - c(R_M)) & \\ c - c(R_M) > \frac{(2n+3)}{(3n+5)}(\alpha - c) & \end{aligned} \tag{A.14}$$

Since $c(R_M) > c(R_E)$, when the innovation level obtained by the start-up with an expectation of market entry is above $\overline{k_6} = \frac{(2n+3)}{(3n+5)}(\alpha - c)$, $R_E > R_A$ and $c(R_E) < c(R_A)$.

Suppose, now, that $R_E < R_A$, $c'(R_E) < c'(R_A)$ and $c(R_A) < c(R_E)$. Then, there must be an expenditure level, R_M, such that $R_E < R_M < R_A$ and $c(R_A) < c(R_M) < c(R_E)$.

If I put R_M into (A.5) replacing R_E, (A.5) becomes negative:

$$-2\frac{(\alpha - c + (n+1)(c - c(R_M)))}{(n+2)^2}(n+1)c'(R_M) - 1 < 0 \tag{A.15}$$

So,

$$-2\frac{(\alpha - c + (n+1)(c - c(R_M)))}{(n+2)^2}(n+1)c'(R_M) < 1 \tag{A.16}$$

If I put R_M into (A.7) replacing R_A, (A.7) becomes positive:

$$-2c'(R_M)\frac{(\alpha - c + (n-1)(c - c(R_M)))}{(n+1)} - 1 > 0 \tag{A.17}$$

So,

$$-2c'(R_M)\frac{(\alpha - c + (n-1)(c - c(R_M)))}{(n+1)} > 1 \tag{A.18}$$

The ordering between (A.16) and (A.18) is apparent:

$$\begin{aligned} -2c'(R_M)\frac{(\alpha - c + (n-1)(c - c(R_M)))}{(n+1)} &> \\ -2\frac{(\alpha - c + (n+1)(c - c(R_M)))}{(n+2)^2}(n+1)c'(R_M) & \\ (2n+3)(\alpha - c) &> (3n+5)(c - c(R_M)) \\ c - c(R_M) &< \frac{(2n+3)}{(3n+5)}(\alpha - c) \end{aligned} \tag{A.19}$$

Since $c(R_M) < c(R_E)$, when the innovation level obtained by the start-up with an expectation of market entry is below $\overline{k_6} = \frac{(2n+3)}{(3n+5)}(\alpha - c)$, $R_E < R_A$ and $c(R_E) > c(R_A)$.

Q.E.D.

Proof of Corollary-4:

In order to examine how the R&D expenditure level and the resulting innovation level is affected when the market gets more competitive, or, equivalently, the number of incumbent firms increases, I will make use of the strictly concave nature of $c(.)$.

$$\begin{aligned} \frac{d(c'(R_E))}{dn} &= -\frac{d}{dn}\left(\frac{(n+2)^2}{2(n+1)(\alpha - c + (n+1)(c - c(R_E)))}\right) \\ &= -\frac{(n^2+2n)(\alpha - c) - (2n+2)(n+2)(c - c(R_E))}{2(n+1)^2(\alpha - c + (n+1)(c - c(R_E)))^2} \end{aligned} \tag{A.20}$$

If $c - c(R_E) < \overline{k_7} = \frac{n}{2n+2}(\alpha - c)$, $\frac{d(c'(R_E))}{dn} < 0$.

That is, if the innovation level generated with an expectation of market entry is below $\overline{k_7}$, increasing the number of incumbent firms causes the start-up to reduce its R&D expenditure, and the level of the resulting innovation gets lower.

If $c - c(R_E) > \overline{k_7} = \frac{n}{2n+2}(\alpha - c)$, $\frac{d(c'(R_E))}{dn} > 0$.

That is, if the innovation level generated with an expectation of market entry is above

$\overline{k_7}$, increasing the number of incumbent firms inclines the start-up to increase its R&D expenditure, and the quality of the resulting innovation improves.

$$\begin{aligned}\frac{d(c'(R_A))}{dn} &= -\frac{d}{dn}\left(\frac{(n+1)}{2(\alpha - c + (n-1)(c - c(R_A)))}\right) \\ &= -\frac{\alpha - c - 2(c - c(R_A))}{2(\alpha - c + (n-1)(c - c(R_A)))^2}\end{aligned} \tag{A.21}$$

If $c - c(R_A) < \overline{k_8} = \frac{\alpha - c}{2}$, $\frac{d(c'(R_A)}{dn} < 0$.

That is, if the innovation level generated with an expectation of commercialization by preemptive incumbent acquisition is below $\overline{k_8}$, increasing the number of incumbent firms causes the start-up to reduce its R&D expenditure, and the level of the resulting innovation gets lower.

If $c - c(R_A) > \overline{k_8} = \frac{\alpha - c}{2}$, $\frac{d(c'(R_A)}{dn} > 0$.

That is, if the innovation level generated with an expectation of commercialization by preemptive incumbent acquisition is above $\overline{k_8}$, increasing the number of incumbent firms inclines the start-up to increase its R&D expenditure, and the quality of the resulting innovation improves.

Q.E.D.

Proof of Lemma-4:

Let W denote the initial social welfare level before an innovation arrives the market, while W_E denotes the expected welfare level for the economy after entrepreneurial entry and W_{II} denotes the expected welfare level for the economy after preemptive incumbent acquisition. Also, ΔPS denotes the change in producer surplus, and ΔCS denotes the change in consumer surplus following entrepreneurial entry.

$$W_E = W + p_E(\Delta PS + \Delta CS - F + \Gamma(p_E) - G) - R \tag{A.22}$$

$$W_{II} = W + p_A(\Gamma(p_A) - T) - R \tag{A.23}$$

Hence, comparing W_E and W_{II} to each other solely depends on the ordering between $p_E(\Delta PS + \Delta CS - F + \Gamma(p_E) - G)$ and $p_A(\Gamma(p_A) - T)$.

From direct calculations from (3.9) and equations (4.4) to (4.7), it is easily obtained that, where PS_2 denotes the producer surplus and CS_2 denotes the consumer surplus after entrepreneurial entry, and PS_1 denotes the producer surplus and CS_1 denotes the consumer surplus before entrepreneurial entry,:

$$PS_1 = n\frac{(\alpha - c)^2}{(n+1)^2} \tag{A.24}$$

$$PS_2 = (n+1)\frac{(\alpha - c)^2}{(n+2)^2} \tag{A.25}$$

$$\Delta PS = -(n^2 + n - 1)\frac{(\alpha - c)^2}{(n+1)^2(n+2)^2} \tag{A.26}$$

$$CS_1 = \frac{n^2(\alpha - c)^2}{2(n+1)^2} \tag{A.27}$$

$$CS_2 = \frac{(n+1)^2(\alpha - c)^2}{2(n+2)^2} \tag{A.28}$$

$$\Delta CS = (2n^2 + 4n + 1)\frac{(\alpha - c)^2}{2(n+1^2)(n+2)^2} \tag{A.29}$$

$$\Delta PS + \Delta CS = \frac{(2n+3)}{2}\frac{(\alpha - c)^2}{(n+1)^2(n+2)^2} \tag{A.30}$$

which is obviously less than $\Pi_E(e) = \frac{(\alpha-c)^2}{(n+2)^2}$ as it is shown in (4.5).

As a result, Assumption-7 cannot guarantee W_E being higher than W_{II}. The ordering between them is ambiguous.

Q.E.D.

Proof of Lemma-5:

Let W denote the initial social welfare level before an innovation arrives the market at any commercialization cost, while W_{IE} denotes the expected welfare level for the economy after entry-deterring incumbent acquisition and W_{II} denotes the expected welfare level for the economy after preemptive incumbent acquisition, as it is shown mathematically in (A.23).

$$W_{IE} = W + p_E(\Gamma(p_E) - T) - R \tag{A.31}$$

Hence, comparing W_{IE} and W_{II} to each other solely depends on the ordering between $p_E(\Gamma(p_E) - T)$ and $p_A(\Gamma(p_A) - T)$.

According to the maximization problem (4.10), p_A is the optimal value to maximize $p(\Gamma(p) - T)$. So, W_{II} is unambiguously higher than W_{IE}.

Q.E.D.

APPENDIX B

TURKISH SUMMARY / TÜRKÇE ÖZET

Ciddi sayıda makroekonomik model inovasyonun, ekonomik büyümenin arkasındaki temel dinamik olduğunu ifade etmektedir. Romer'in (1990) modelinde ekonomik büyüme, daha verimli üretim süreçleri isteyen firmaların taleplerini karşılamak üzere yeni ara mamuller üreten, yani inovasyon geliştiren, firmaların sebep olduğu teknolojik değişimin neticesinde elde edilmektedir. Benzer şekilde Aghion ve Howitt (1992), ekonomik büyümenin sadece teknolojik gelişmeden kaynaklandığı bir model kurmuş ve buradaki teknolojik gelişmenin, son mamul imalatı yapan firmaların üretim süreçlerini daha verimli hale getirmek üzere inovasyon geliştiren firmalar arasındaki rekabetten kaynaklandığını göstermiştir. Bunlara ek olarak, Grossman ve Helpman (1994), bilimsel bulguları pratik değeri olan ürünlere dönüştürürken yüksek miktarda yatırım yapmanın gerektiği gerçeğine dayanarak, teknolojik gelişmenin, büyük oranda, endojen olduğunu ve ekonominin kar amacı güden paydaşları tarafından inovasyonlar geliştirilerek sağlandığını ortaya koymuştur. Çalışmalarında bu durumun önemi olarak, tekrar üretilemeyen kaynakların hızla tüketildiği şartlar altında, teknolojik gelişmenin güçlü ve sürdürülebilir ekonomik büyüme için en iyi yol olması vurgulanmıştır.

Ekonominin bütün paydaşları tarafından yapılan bütün inovatif faaliyetler içinde girişimci inovasyonu kritik bir rol oynamaktadır. Baumol (2010) girişimciliğin ekonomik büyüme için önemine vurgu yapmış ve gelişmiş ülkelerle düşük ekonomik performans göstererek yavaş gelişen ülkeler arasındaki farkın büyük ölçüde girişimci yetenekten ve onu motive eden piyasa mekanizmalarından ileri geldiğini iddia etmiştir. Onun bu ifadeleri, günlük hayattaki politika setlerinde devletlerin tercihlerine ilişkin gözlemlerle desteklenebilir. Dünya genelinde devletler, sağladıkları Ar-Ge ve inovasyon desteklerinde büyük firmalar yerine yeni kurulmuş girişimlere ağırlık vermektedir. Örneğin, Özçelik ve Taymaz (2008) Türkiye'de devlet eliyle verilen Ar-Ge ve inovasyon desteklerinden küçük firmaların daha fazla yararlandığını ortaya koymuştur.

Türkiye'de devletin, yeni girişimlerin yaptığı Ar-Ge çalışmalarına destek verme tercihi, mevcut teşvik mekanizmalarından da anlaşılmaktadır. TÜBİTAK, 1512 Teknogirişim Sermayesi Destek Programı vasıtasıyla inovatif fikri olan bireylerin, fikirlerinin teknolojik ve ekonomik fizibilitesini yapma ve prototip oluşturma sürecindeki harcamalarına hibe olarak sermaye desteği sağlamaktadır. Bu destek, inovatif fikir hangi piyasaya ilişkin olursa olsun ve amaçlanan inovasyonun türü ne olursa olsun, yeterince yenilikçi ve yapılabilir bulunan bütün fikirlere simetrik olarak verilmektedir. Bu aşamayı başarıyla atlatan bireylerden şirket kurması istenmektedir. Kurulan yeni girişimler, bir önceki aşamada prototipini oluşturduğu fikirlerini inovasyona dönüştürürken devlet desteklerinden yararlanmak için, 1507 KOBİ Ar-Ge Başlangıç Destek Programına başvurabilir. Söz konusu süreçte yapılan harcamalar, %75' e varan oranlarda hibe yoluyla desteklenmektedir.

Biraz daha yakından incelenirse, devletlerin, uyguladıkları politikalarla yeni girişimlerin sadece Ar-Ge harcamalarını değil, elde ettikleri inovasyonlarla piyasaya girişlerini de destekledikleri, hatta diğer ticarileştirme alternatiflerine nazaran, tercih ettikleri görülecektir. Örneğin yine Türkiye'de, TÜBİTAK destekleriyle inovasyonunu elde etmiş bir girişim, bu inovasyonu ile ilgili piyasaya girmeyi seçtiği takdirde, karşılaştığı ticarileşme maliyetlerinin %75'i için KOSGEB'in sağladığı Endüstriyel Uygulama Destek Programı vasıtasıyla devletten hibe olarak destek alabilmektedir. Buna karşılık, girişimin inovasyonunu lisanslama ya da doğrudan satış yoluyla, zaten piyasada faaliyet gösteren bir şirkete kullandırması için hiçbir teşvik mekanizması olmaması, devletin inovasyonu satarak ticarileştirme yerine piyasaya girişi destekleme eğilimini ortaya koymaktadır. Bu eğilim, Türkiye gibi gelişmekte olan ülkelerde gözlenmekle beraber, gelişmiş ülkelerde de yaygındır. Mirrlees ve diğerleri (2011) Birleşik Krallık'taki vergi sisteminin, girişimcilerin en yüksek geliri kurdukları girişimleri ile piyasaya girmeleri durumunda elde edecekleri şeklinde tasarlandığını ve böylece yeni girişimlerin piyasaya girişinin teşvik edildiğini göstermiştir. Ayrıca, Avrupa Birliği'nin Avrupa 2020 stratejisi, Birlik ekonomilerinde piyasalara yeteri kadar yeni firma girişinin gerçekleşmediğini;

bu yüzden, güçlü ekonomik büyümeyi sağlamak ve yüksek istihdam rakamlarına ulaşmak için girişimciliğin teşvik edilmesi gerektiğini belirtmektedir.

Yine de yeni girişimler farklı bir yol tercih edebilir. Muhtelif ampirik çalışmalardan elde edilen sonuçlar, girişimlerin sıklıkla inovasyonlarını zaten piyasada yer alan firmalardan birine ya da daha fazlasına lisanslayarak ya da doğrudan satarak ticarileştirdiğine işaret etmektedir. İlgilenen okuyucular Granstrand ve Sjölander (1990), Hall (1990), Lerner ve Merges (1998) ve Blonigen ve Taylor (2000) gibi çalışmaları inceleyebilir. Bu çalışmalardan bir diğeri olan Gans ve diğerleri (2002), inovasyonların alınıp satılabildiği piyasaların verimli işlediği durumlarda, zaten ürün piyasasında yer alan firmaların, yeni girişimlerden gelecek rekabeti önlemek için onların inovasyonlarını satın alacağını göstermiştir. Ulaştıkları ampirik sonuçlara göre, ancak inovasyon alım-satımı piyasasındaki kusurlar, yeni girişimleri daha rekabetçi bir stratejiyle piyasaya girişe sevk etmektedir.

Devletlerin inovasyon teşviklerinde piyasaya girişi destekleme yanlısı tutumunun ve ampirik çalışmaların işaret ettiği inovasyonların lisanslanarak ya da satılarak ticarileştirilmesi sıklığının teşkil ettiği tezat karşısında, hem inovatif faaliyetleri teşvik edecek hem de sosyal refahı artıracak optimal politika tasarısının nasıl inşa edileceği üzerine bazı sorular akla gelmektedir. Hangi koşullar altında yeni girişimin piyasaya girişi ya da inovasyonunu satarak ticarileştirmesi, sosyal refah açısından, alternatifine nazaran, daha fazla fayda getirmektedir? İnovasyonun girişim tarafından piyasaya girerek mi yoksa piyasada yer alan bir firmaya satarak mı ticarileştirilmesi, girişimi daha fazla Ar-Ge yapmaya ve daha kaliteli bir inovasyon geliştirmeye sevk etmektedir? Ürün piyasasının yapısı, daha ziyade ürün piyasasındaki rekabet, yeni girişimin inovasyon yapma isteğini piyasaya girmeyi tercih etmesi halinde ve satarak ticarileştirmesi durumunda, ayrı ayrı, nasıl etkilemektedir?

Bu çalışmada, girişimciliğin ve inovasyon için verilen devlet desteklerinin homojen mallar üreten bir oligopol piyasa üzerindeki böylesi etkilerini incelemek için, yeni bir girişimin inovasyonunu piyasaya girerek ya da inovasyonu zaten piyasada yer alan bir firmaya satarak ticarileştirebildiği bir model kurulmuştur. Bu modelde, bir oligopol ürün piyasasında n adet firma olduğu varsayılmış ve Ar-Ge yapma becerisine sahip tek firmanın piyasa dışındaki yeni bir girişim olduğu farz edilmiştir. Bu varsayımla, daha önce literatürde çokça incelenmiş olan, firmalar arası patent yarışı senaryosu bu modelin dışında kalmaktadır. Piyasada yer alan bir firma, yeni girişimin piyasaya girişini ya da başka bir firmanın bir inovasyona sahip olarak ürün piyasasında avantaj yakalamasını ancak yeni girişimin inovasyonunu herkesten önce satın alarak engelleyebilir. Ayrıca, Arrow'un (1962) modelini takiben, yeni girişim tarafından geliştirilen inovasyonun başka bir firma tarafından taklit edilemeyeceği de varsayılmıştır. İnovasyonun kalitesi sadece yeni girişimin inovasyon yapma isteğine ve kabiliyetine bağlıdır. Bu bağlamda Spence'in (1984) bahsettiği ve bir firmanın Ar-Ge kapasitesinin piyasada yapılan toplam Ar-Ge çalışmalarına bağlı olduğunu ifade eden yayılma etkisi de bu çalışmada yok sayılmaktadır. Halihazırda sadece yeni girişimin Ar-Ge yapabiliyor olması, yayılma etkisi ihtimalini zaten ortadan kaldırmaktadır.

Homojen mallar üreten piyasaları inceleyen literatürdeki önceki çalışmalara uygun olarak, firmaların ürün piyasasında miktar (Cournot) rekabetine girdikleri farz edilmiştir. Bu çalışmada, piyasada yer alan firmaların simetrik olduğu kabul edilmiş ve aynı sabit marjinal maliyetle üretim yaptıkları varsayılmıştır. Eğer yeni girişim, inovasyonunu piyasaya girerek ticarileştirirse, Norbäck ve Persson (2012) tarafından tanımlandığı şekliyle, sabit bir ticarileşme maliyetine maruz kalacaktır. Bu ticarileşme maliyeti, yeni bir firmanın karşılaşacağı üretim tesisi kurulması için yapılacak yatırımları, tedarik zinciri teşkili için gerekli harcamaları, iş dünyasında kendini tanıtma ve reklam giderlerini ve bunun gibi diğer masrafları içermektedir. Yeni girişim ürün piyasasına dahlinden sonra, bu çalışmada yapılan varsayımla, hiçbir üretim kapasitesi kısıtı ya da tam kapasite üretime ulaşmak için zaman gereksinimi ile karşılaşmamaktadır. Bu varsayım, piyasanın simetrik yapısını muhafaza etmek için elzemdir. Bunun aksine, eğer yeni girişim inovasyonunu satarak ticarileştirmeyi seçerse, inovasyonu satın alan firma, Norbäck ve diğerleri (2016) tarafından tanımlandığı şekliyle, sabit bir işlem maliyetine maruz kalacaktır. Bu işlem maliyeti, bir malın alışverişinden doğan idari ve yasal masrafları (örneğin, bir patentin lisanslanması gibi), inovasyonun getirdiği yeni teknolojinin mevcut üretim hattına monte edilmesi esnasında doğan gecikmeleri ve fırsat maliyetlerini ve, inovasyonu satın alan firmanın yeni girişim ile arasındaki bilgi asimetrisinden kaynaklanan, inovasyonun kalitesini tasdik etme sürecinin getirdiği gecikmeleri ve masrafları içermektedir.

Bu çalışma bir sosyal refah analizi yapacağı için, ekonominin talep tarafı da uygun şekilde tanımlanmalıdır. Böyle bir analizi toplam talep üzerinde yapabilmek için kurulacak model, bireysel talep üzerinde oluşacak gelir etkilerinden arındırılmalıdır. Bu sebeple, kuasilineer fayda fonksiyonuna sahip bir temsilci tüketici varsaymak akla yatkındır. Ayrıca, böyle bir fayda fonksiyonu ile çalışmak, ekonomide genel dengeyi kollamak yerine, sadece modelin ilgilendiği oligopol piyasa üzerinde kısmi denge analizi yapılmasına imkan sağlamaktadır. Bu modelde kullanılan temsilci tüketici fayda fonksiyonu kuasilineer olması hasebiyle ayrılabilir yapıdadır ve, Singh ve Vives'in (1984) çalışmasını takiben, modelin ilgilendiği oligopol piyasada üretilen homojen mallar için kuadratik, ekonomideki diğer mallar için lineerdir.

İnovasyon için devlet destekleri, bu çalışmada, iki adım olarak tasavvur edilmiştir. Öncelikle, Ar-Ge harcamaları için finansal destek, yeni girişimin inovasyonu ticarileştirme stratejisi ne olursa olsun, sabit miktarda hibe olarak sağlanmaktadır. Ar-Ge çalışmaları sonucunda inovasyon elde edildikten sonra, ikinci adım olarak, devlet ya girişimin inovasyonu ile piyasaya girişi sırasında karşılaştığı ticarileşme maliyetine sübvanse sağlamakta ya da girişimin inovasyonu zaten ürün piyasasında yer alan bir firmaya satması durumunda alıcı firmanın karşılaştığı işlem maliyetine sübvanse sağlamaktadır. Devlet hangi tür desteği tercih ederse etsin, ikinci adımdaki bu destek de sabit miktarda bir hibedir ve iki alternatif için de birbirine eşittir. Böylece, devletin inovasyonu teşvik etmek üzerine yaptığı toplam harcama, ister inovasyonla piyasaya girişini ister satarak ticarileştirmeyi desteklesin, sabittir. Dolayısıyla devletin teşvik sistemine, getirdiği mali yükü düşünerek değil, yeni girişimin alternatif ticarileştirme stratejilerinin sosyal refah üzerine, ayrı ayrı, yaptığı katkıyı kıyaslayarak şekil vermesi beklenmektedir. Devletin gelirleri bu çalışmada mevzu dışıdır, zira bu çalışmadaki modeller sadece homojen mallar üreten bir oligopol ürün piyasası üzerinde kısmi denge analizi yapmaktadır.

Bu çalışmada iki model kullanılmıştır. Esas modelde inovasyon, şiddetli olmayan bir proses inovasyonu olarak ele alınmıştır. Bir ek model kapsamında ise, inovasyonun sabit üretim maliyetini düşüreceği farz edilmiştir. Şimdi bu modeller sıra ile açıklanıp elde edilen sonuçlar aktarılacaktır.

Esas modelde, ürün piyasasında faaliyet gösteren bütün firmalar için, ister inovasyondan önce piyasada yer alanlar olsun ister piyasaya inovasyonuyla yeni katılan girişim olsun, sabit üretim maliyetinin olmadığı varsayılmıştır. Bu varsayım, incelenilen inovasyon marjinal üretim maliyetini düşürecek şiddetli olmayan bir proses inovasyonu olduğu için makuldür. Bu noktada, şiddetli olmayan bir proses inovasyonu tabiri ile neyin kastedildiği tanımlanmalıdır. Böylesi bir inovasyon, bu inovasyonu kullanan firmanın marjinal üretim maliyetini, piyasada üretim yapan başka hiçbir firmayı piyasa dışına çıkmaya zorlamayacak seviyede düşürmektedir. Bir diğer deyişle, yeni düşük marjinal maliyete karşılık gelen monopol piyasa fiyatı, inovasyonu kullanmayan firmaların marjinal maliyetinden büyüktür. Bu sebeple, girişim inovasyonunu ister piyasaya girerek ister satarak ticarileştirsin, piyasada meydana gelen verimlilik asimetrisi, inovasyonu kullanmayan firmaların piyasadan çıkmasına yol açmamaktadır.

Bu model, Ar-Ge aşamasından elde edilen inovasyonun ticarileştirilmesine kadar olan süreci aydınlatabilmek için üç adımda kurgulanmışır.

Birinci adımda, yeni girişim ne kadar Ar-Ge harcaması yapacağına karar vermektedir. Bu modelde Ar-Ge sürecinin deterministik olduğu varsayılmıştır. Yani, Ar-Ge çalışması her zaman bir inovasyonla sonuçlanmaktadır ve yapılan Ar-Ge harcaması miktarı inovasyonun derecesini belirlemektedir. İnovasyonun derecesi, inovasyonun kalitesini ifade etmektedir ve inovayonu kullanan firmanın marjinal maliyetinde yaratılan düşüşe eşittir. Ar-Ge harcamasının miktarı ise, yeni girişim tarafından seçilecek ticarileştirme stratejisine bağlı olarak tespit edilir. Yeni girişim, izlenecek ticarileştirme stratejisi sonucu elde edilecek karı maksimize eden Ar-Ge harcaması miktarını hesap etmektedir.

İkinci adım, Norbäck ve Persson (2012) ve Norbäck ve diğerleri (2016) çalışmalarındaki ticarileştirme adımı ile temelde aynıdır. Bu adımda, yeni girişim, birinci adımda elde edilen derecedeki inovasyonunu nasıl ticarileştireceğine karar vermektedir. Bunun için bir müzayede oyunu tanımlanmıştır. Müzayede ilk fiyat tam bilgi müzayedesidir ve herbir oligopolist firma, inovasyon için bir teklif sunmaktadır. Söz konusu teklifler, firmaların inovasyona sahip olmaya verdikleri değere göre belirlenmektedir. Girişim, bu teklifleri, piyasaya girmesi halinde elde edeceği kara eşit olan, çekince fiyatıyla kıyaslamaktadır. Eğer tekliflerden en yüksek olanı, çekince fiyatından büyükse, inovasyon teklif sahibine teklif ettiği fiyat karşılığı satılmaktadır. Bu teklifi birden fazla firma yapıyorsa ki firmaların simetrik yapısı bunu getirecektir, firmaların herbiri inovasyona eşit olasılıkla sahip olacaktır. Hiçbir teklifin çekince fiyatından büyük olmaması halinde, girişim, inovasyonuyla ürün piyasasına girmektedir.

Üçüncü adımda firmalar ürün piyasasında miktar rekabeti etkileşimine girmektedir. Eğer, ikinci adımdaki müzayede oyunu sonucu, girişim birinci adımda belirlenen derecedeki inovasyonuyla piyasaya dahil oluyorsa, ürün piyasasında artık n+1 firma miktar rekabeti etkileşimine girmektedir. Bunlardan biri yeni girişimdir ve daha düşük bir marjinal maliyetle üretim yaptığı için ürün piyasasındaki verimli firmadır. Diğer n firma ise inovasyondan önceki sabit marjinal maliyetle üretime devam etmektedir ve verimsizdir. Eğer, ikinci adımdaki müzayede oyunu sonucu, inovasyon zaten piyasada yer alan bir firmaya satılıyorsa, ürün piyasasında yine aynı n firma miktar rekabeti etkileşimine girmektedir. Ancak, bu durumda, inovasyonu satın alan firma daha düşük marjinal maliyetle üretim yapan verimli firma olurken, diğer n-1 firma, inovasyondan önceki yüksek sabit marjinal maliyetle üretim yapmaları hasebiyle, verimsizdir.

Nash alt-oyun tam denge kavramına uygun olarak, bu üç adımdan oluşan oyun, sondan başa doğru ele alınmış ve çözülmüştür.

Üçüncü adımdaki hesaplamalar göstermektedir ki, sabit derecedeki bir inovasyon için, herbir ticarileştirme stratejisi sonucu elde edilen sosyal refah seviyeleri kıyaslandığında, eğer inovasyon derecesi belli bir eşik değerin üzerindeyse, inovasyonu satarak ticarileştirmek yeni girişimin piyasaya girmesinden daha fazla sosyal refah artışına yol açmaktadır. Bu sonuç Mankiw ve Whinston (1986) tarafından tanımlanan piyasaya yeni giren firmanın diğerlerinden iş çalma etkisinin ve Lahiri ve Ono (1988), Shapiro (1989) ve Zhao (2001) gibi araştırmacılar tarafından ortaya konan maliyet düşürmenin refah üzerindeki olumsuz etkisinin bağlaşımıdır. Eğer yeni girişim piyasaya girerek inovasyonu ticarileştirmeyi seçerse, oligol ürün piyasasında n tane verimsiz firma olacaktır. Bu durum, n tane verimsiz firmanın, verimli yeni girişimden iş çalması demektir. Eğer, inovasyon satılarak ticarileştirilirse, oligopol ürün piyasasında n-1 tane verimsiz firma yer alacaktır ve bu firmalar verimli alıcı firmadan iş çalacaktır. Bir tane daha fazla verimsiz firmanın piyasada yer almasına ve verimli firmadan iş çalmasına müsaade ettiği için, eğer Zhao'nun vurguladığı gibi verimlilik farkı, yani inovasyon derecesi, yeterince büyükse, yeni girişimin inovasyonuyla piyasaya girmesi, inovasyonu satmasına nazaran, olumsuz refah etkilerine sahip olacaktır.

Yukarıda belirtilen bu eşik değer, oligopol piyasadaki rekabet seviyesi artıkça, bir diğer deyişle inovasyon gelmeden önce ürün piyasasında yer alan firma sayısı artıkça, azalmaktadır. Bu sebeple, ürün piyasasındaki rekabet artıkça, daha geniş bir interval içindeki şiddetli olmayan proses inovasyonları için satılarak ticarileştirilmek, yeni girişimin piyasaya girmesine nazaran, daha fazla sosyal refah artışına yol açmaktadır.

İkinci adımda ticarileştirme stratejisine karar verecek müzayede oyunu üç tane değerlemeyi dikkate almak durumundadır. Birincisi çekince fiyatıdır ve daha önce tanımlandığı gibi, yeni girişimin belirli bir derecedeki inovasyonla ürün piyasasına girmesi halinde elde edeceği kazanca eşittir. İkincisi, inovasyondan önce de ürün piyasasında yer alan bir firmanın piyasaya yeni girişi önlemeye verdiği değerdir. Bu değer, bu firmanın inovasyona sahip olduğu zaman elde edeceği karla yeni girişimin inovasyonuyla piyasaya girdiğinde yine aynı firmanın elde edeceği karın arasındaki farktan işlem maliyetinin çıkarılmasıyla bulunur. Üçüncü değerleme, inovasyondan önce de ürün piyasasında yer alan bir firmanın inovasyonu diğer oligopolistlerden önce satın almaya verdiği değerdir ve herkesten önce satın alma değeri olarak tanımlanabilmektedir. Bu değer, bu firmanın inovasyona sahip olduğu zaman elde edeceği karla başka bir oligopolist firma inovasyona sahip olduğunda yine aynı firmanın elde edeceği kar arasındaki farktan işlem maliyetinin çıkarılmasıyla bulunur.

Herkesten önce satın alma değeri ne zaman çekince fiyatından yüksek olursa, inovasyon bu değer karşılığında bir oligopolist firmaya satılmaktadır. Bu tarz ticarileştirme, herkesten önce satın alma olarak adlandırılmaktadır. Aksi halde, çekince fiyatının, piyasaya yeni girişi önleme değerinden yüksek olduğu durumlarda, yeni girişim, inovasyonuyla piyasaya girmektedir. Ancak, piyasaya yeni girişi önleme değeri, çekince fiyatından yüksekse, inovasyon bir oligopolist firmaya, satış fiyatı çekince fiyatına eşit olacak şekilde satılmaktadır. Bu tarz ticarileştirme, piyasaya yeni girişi önleyici satın alma olarak adlandırılmaktadır.

Ürün piyasasındaki rekabet artıkça, yani, inovasyondan önceki oligopolist firma sayısı artıkça, ikinci adımdaki müzayedede konu edinilen üç değerleme de azalmaktadır. Fakat hangisinin diğerine göre daha az negatif etkilendiğini görmek kolay değildir. Norbäck ve Persson (2012) sürekli artan ürün piyasası rekabetinin yeni girişimi, sonunda inovasyonunu satarak ticarileştirmeye yönlendireceğini iddia etmiştir. Çünkü, onların görüşüne göre, artan ürün piyasası rekabeti karşısında piyasaya yeni girişi önleme değeri ve herkesten önce satın alma değeri, yeni girişimin çekince fiyatından daha az olumsuz etkilenmektedir. Böylece, ürün piyasasındaki rekabeti sürekli artırmak, bir noktada, bu iki değerden en az birinin çekince fiyatını aşması anlamına gelecektir. Ancak benim modelimde elde edilen sonuçlar Norbäck ve Persson'un iddialaryla çelişmektedir. Hesaplamalar göstermektedir ki piyasaya yeni girişi önleme değeri ve herkesten önce satın alma değeri, ayrı ayrı, artan rekabet karşısında çekince fiyatına kıyasla monotonik olarak değişmemektedir. Bu sebeple, ürün piyasasındaki rekabetin sürekli artması, bir noktada bu değerlerin çekince fiyatını aşmasını garanti etmemekte ve yeni girişimi, kesin olarak, inovasyonunu satarak ticarileştirmeye sevk etmemektedir.

Benzer şekilde, önceki literatürde, inovasyonun derecesinin, yani kalitesinin, de ticarileştirme stratejisi üzerinde etkili olduğu iddia edilmiştir. Norbäck ve diğerleri (2016) inovasyon kalitesini sürekli artırmanın piyasaya yeni girişi önleme değerini ve herkesten önce satın alma değerini, çekince fiyatından daha fazla artıracağını ve böylece, bir noktada, satarak ticarileştirmenin gerçekleşeceğini kuvvetle savunmuştur. Ancak benim modelimin bulguları, yine, bu iddialarla çelişmektedir. Hesaplamalar göstermektedir ki piyasaya yeni girişi önleme değeri ve herkesten önce satın alma değeri, ayrı ayrı, artan inovasyon kalitesinin etkisiyle, çekince fiyatına kıyasla, monotonik olarak değişmemektedir. Bu sebeple, inovasyon kalitesini sürekli ilerletmek, bir noktada bu değerlerin çekince fiyatını aşmasını garanti etmemekte ve yeni girişimi, kesin olarak, inovasyonunu satarak ticarileştirmeye sevk etmemektedir.

Sonuç olarak, modelin ikinci adımı, ne ürün piyasasındaki rekabet seviyesinin ne de inovasyonun kalitesinin, bir noktada, inovasyonu satarak ticarileştirmeyi daha karlı hale getirmeyi garanti etmediğini göstermektedir. Halbuki bunu başarmak önemlidir, zira, birinci adımda gösterildiği üzere, belirli bir inovasyon derecesi için, satarak ticarileştirme, eğer bu inovasyon çok küçük değilse, yeni girişimin inovasyonuyla ürün piyasasına girmesinden daha fazla sosyal refah artışına yol açmaktadır. Bu sebeple, satarak ticarileştirmenin gerçekleşmesini garanti etmek için, devlet teşviklerinin, inovasyonla piyasaya giriş yerine inovasyonu satarak ticarileştirmeye destek vermesi, bir diğer deyişle satın alan oligopolist firmanın karşılaştığı işlem maliyetine sübvanse sağlaması, faydalı olmaktan öte, gereklidir

Birinci adımdaki hesaplamalar göstermektedir ki, eğer yeni girişim piyasaya giriş beklentisiyle belli bir eşik değerin üzerinde inovasyon derecesi üretiyorsa, ikinci adımda ticarileştirme stratejisi olarak inovasyonla beraber piyasaya girişin seçilmesi, inovasyonun satılarak ticarileştirilmesine kıyasla, yeni girişimin daha fazla Ar-Ge harcaması yapmasına neden olmaktadır. Elde edilen inovasyonun kalitesi de satılmak üzere geliştirilecek olandan daha yüksektir. Aksine, eğer yeni girişimin piyasaya giriş beklentisiyle geliştirdiği inovasyon derecesi aynı eşik değerin altındaysa, ikinci adımda satarak ticarileştirmenin seçilmesi, yeni girişimin daha fazla Ar-Ge harcaması yapmasına neden olmaktadır. Elde edilen inovasyonun kalitesi de piyasaya girmek üzere geliştirilecek olandan daha yüksektir.

Bu sonuç işaret etmektedir ki, yeni girişimlerin yeteri kadar inovatif olmadığı ülkelerde, devletlerin teşvikler aracılığıyla piyasaya girişi desteklemesi, üretilebilecek inovasyon kalitesinden daha düşük inovasyon dereceleriyle yeni girişimlerin, ürün piyasalarına girmesine neden olmaktadır. Bunun yerine, satarak ticarileştirme desteklenirse, yani, satın alan oligopolist firmanın karşılaştığı işlem maliyetine sübvanse sağlanırsa, yeni girişimler daha kaliteli inovasyonlar geliştirmeye sevk edilmiş olacaktır.

Ek modelde bir sabit maliyet inovasyonu incelenmektedir. Bu nedenle, esas modelin aksine ek modelde, ürün piyasasında yer alan her firmanın aynı sabit üretim maliyetine maruz kaldığı varsayılmaktadır. Esas modelden bir diğer ayrışma Ar-Ge sürecine ilişkindir. Ek modelde Ar-Ge sürecinin stokastik olduğu varsayımı yapılmıştır. Bu bağlamda, yeni girişim sonsuz sayıda Ar-Ge projesi arasından birini seçmektedir. Bu Ar-Ge projeleri, bir başarı olasılığı ve eğer başarılı olursa sabit üretim maliyetinde sebep olacağı düşüşle tanımlanmaktadır. Her alternatif proje için, başarı ihtimali daha büyük olan projenin, başarılı olması halinde sabit üretim maliyetinde sebep olacağı düşüş daha küçüktür. Diğer bir deyişle, daha riskli projeler, başarılı olması halinde daha büyük fayda getirmektedir. Bu durumda beklenen sabit maliyet düşüşü tam olarak konkav kabul edilmiş, bu sayede yeni girişimin karşılaştığı her durum ve seçtiği her ticarileştirme stratejisi için tek bir risk seviyesi seçmesinin önü açılmıştır. Ek model, esas modelden bir varsayımla daha ayrışmaktadır. Bütün alternatif Ar-Ge projeleri için yapılacak Ar-Ge harcamaları, bu modelde eşit kabul edilmiştir. Böylece, alternatif Ar-Ge projeleri sadece sahip oldukları risk seviyeleri aracılığıyla birbirinden farklılaşmaktadır.

Ek model, matematiksel olarak, Damsgaard ve diğerlerinin (2017) çalışmasına çok benzemektedir. Onların kurgusu ürün piyasasında yer alan bir monopolist firma ile ürün piyasası dışındaki bir yeni girişimden oluşmaktadır. İki firma da sabit maliyet inovasyonu elde etmek için Ar-Ge yapma kabiliyetine sahiptir. Eğer monopolist firma Ar-Ge projesinde başarılı olursa, yeni girişimin ürün piyasasına girişine engel olmaktadır. Eğer monopolist firma başarısız olursa ve yeni girişim bir inovasyon geliştirirse, ürün piyasası duopol piyasa haline gelmektedir. Benim modelim ürün piyasasını oligopol olarak tanımlamamla ve yeni girişime, piyasaya giriş seçeneğine alternatif olarak, inovasyonunu satma opsiyonu tanımamla Damsgaard ve diğerlerinin modelinden ayrışmaktadır. Ayrıca benim modelimde, sadece yeni girişim Ar-Ge becerisine sahiptir. Bu nedenle, eğer bir oligopolist firma, yeni girişimin piyasaya girişini engellemek istiyorsa, onun inovasyonunu satın almak zorundadır.

Ek modelde ürün piyasası dinamiklerinin ve devlet teşviklerinin, yeni gişimlerin inovasyon geliştirirken riske karşı tutumlarını nasıl etkilediği incelenmektedir. Bu doğrultuda, devlet destekleri olmadan, yeni girişimin ürettiği inovasyonla ürün piyasasına giremediği varsayılmıştır. Bu şartlar altında, yeni girişim inovasyonunu sadece herkesten önce satın alma değeriyle bir oligopolist firmaya satabilmektedir. Eğer bir tür devlet desteğiyle yeni girişimin, inovasyonuyla beraber ürün piyasasına girmesi sağlanırsa, yeni girişimin ilk durumdan daha riskli bir Ar-Ge projesi seçtiği matematiksel olarak bulunmuştur. Demek oluyor ki, bu senaryoda devletin piyasaya girişi desteklemesi, inovasyonu artırma hedefine hizmet etmektedir. Ancak bu desteği, ticarileşme maliyetine sübvanse sağlayarak vermesi, amaçlananın aksine etki göstermektedir. Çünkü piyasaya yüksek giriş masrafları, yeni girişime daha riskli Ar-Ge projesi seçtiren ana etmendir. Bunun yerine, sabit Ar-Ge harcamalarının sübvanse edilmesi doğru araç olacaktır.

Daha kaliteli inovasyon getirmesi sebebiyle yeni girişimin ürün piyasasına girişinin desteklenmesi, devletin bir hedefine ulaşmasına imkan sağlamaktadır. Ancak bu durumun sosyal refah için anlamını ortaya çıkarmak daha detaylı bir analiz gerektirmektedir. Piyasaya girmesi mümkün olduktan sonra, yeni girişimin önünde iki seçenek vardır: Ya seçtiği riskli projeyle ürün piyasasına girecek ya da bu projeyle elde ettiği inovasyonu bir oligopolist firmaya satarak piyasaya yeni girişi önleyici satın alma ile ticarileştirecek. Eğer çekince fiyatı, piyasaya yeni girişi önleme değerinden yüksekse, ürün piyasasına giriş gerçekleşmektedir. Bu durumun sosyal refah açısından etkisi belirsizdir. Aksine, piyasaya yeni girişi önleme değeri daha yüksekse, aynı riskli proje bir oligopolist firma tarafından piyasaya yeni girişi önleme satın almasıyla ticarileştirilmektedir. Bu durumda ise, sosyal refah üzerindeki negatif etkiler net olarak tespit edilmiştir. Piyasaya girişin mümkün olduğu ama piyasaya yeni girişin gerçekleşmediği bu durumda, seçilen bu proje, sosyal refahı maksimize eden risk düzeyinden çok daha risklidir.

Bu sonuç, benim modelimi Damsgaard ve diğerlerinin sonuçlarından ayıran temel bulgudur. Onlar, homojen mallar üreten simetrik firmalar için, yeni girişimin her zaman, sosyal refahın gerektirdiğine kıyasla çok az riskli projeler seçtiğini bulmuştur. Bu modelin sonuçları ise, inovasyonun satılarak ticarileştirilmesinin mümkün olduğu durumlarda, yeni girişimin, eğer piyasaya yeni girişi önleyici satın alma bekleniyorsa, sosyal refahı maksimize edecek seviyeden çok daha riskli bir Ar-Ge projesi seçtiğine işaret etmektedir.

Ek modelde ürün piyasası rekabeti artıkça, yani, inovasyondan önce ürün piyasasında yer alan firma sayısı artıkça, yeni girişim, piyasaya girmesi mümkün olduğunda, sürekli olarak daha riskli Ar-Ge projeleri seçmektedir. Bu da daha az sıklıkla başarıya ulaşan çok riskli projelere yönelmek anlamına gelmektedir. Eğer piyasaya girişi mümkün olmazsa, inovasyonunu herkesten önce satın alma değeriyle bir oligopolist firmaya satma beklentisi altında, seçtiği Ar-Ge projesi riskliliği, artan ürün piyasası rekabeti karşısında değişmemektedir. Bu durum işaret etmektedir ki, devletler açısından piyasaya ulaşan inovasyon sayısını artırmak için, artan ürün piyasası karşısında, piyasaya yeni girişleri mümkün kılmak yerine, inovasyonların oligopolist firmalar tarafından satın alınmasını kolaylaştırmak daha tercih edilir bir opsiyondur.

Bu tez sonuç olarak, inovasyon teşviklerinin her koşulda ve her proje için simetrik dağıtılmasının her zaman optimal sonuç vermeyeceğini göstermektedir. Buradaki iki modelin işaret ettiği koşullar altında, yeni girişimlerin ürün piyasasına girişini desteklemek yerine, inovasyonların zaten ürün piyasasında faaliyet gösteren firmalar tarafından satın alınmasını kolaylaştırmak, daha arzu edilir neticelere yol açacaktır.

APPENDIX C

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