Department of Economics

Industrial Organization Study on Spillovers Between Pharmaceutical Markets

Markku Siikanen

Aalto University

DOCTORAL DISSERTATIONS

Aalto University publication series
DOCTORAL DISSERTATIONS 131/2019

Industrial Organization Study on Spillovers Between Pharmaceutical Markets

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Aalto University publication series
DOCTORAL DISSERTATIONS 131/2019

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ISBN 978-952-60-8641-5 (printed)
ISBN 978-952-60-8642-2 (pdf)
ISSN 1799-4934 (printed)
ISSN 1799-4942 (pdf)
http://urn.fi/URN:ISBN:978-952-60-8642-2

Unigrafia Oy
Helsinki 2019

Finland

Publication orders (printed book):
markku.siikanen@vatt.fi

Printed matter
4041-0619

Author
Markku Siikanen

Name of the doctoral dissertation
Industrial Organization Study on Spillovers Between Pharmaceutical Markets

Publisher School of Business

Unit Department of Economics

Series Aalto University publication series DOCTORAL DISSERTATIONS 131/2019

Field of research Industrial Organization, Health Economics

Date of the defence 19 August 2019

Language English

☒ **Monograph** ☐ **Article dissertation** ☐ **Essay dissertation**

Abstract

This thesis is a study in the field of applied industrial organization. The unifying theme of the study are the spillovers between hospital and retail pharmaceutical markets in Finland. This dissertation consists of five chapters where the first chapter serves as the thesis introduction.

The second thesis chapter introduces the Finnish pharmaceutical market. The chapter highlights the institutional arrangements which foster connections between the two pharmaceutical markets and explains the regulation relevant to the analysis presented in this thesis.

The third chapter develops a simple theoretical model which describes the equilibrium relationships between the two pharmaceutical markets. The theoretical model provides testable implications for Chapters 4 and 5.

The fourth thesis chapter investigates the existence of demand spillovers between the two pharmaceutical markets. I examine how pharmaceutical use in the public sector hospitals influences pharmaceutical sales in the retail market. Hospitals use public procurement to obtain pharmaceuticals to the hospital pharmaceutical selection. My research design exploits procurement-induced changes in the hospital selection. I find that retail market sales increase by 2%-47% due to winning the hospital procurement. I also find that reimbursement status and procurement discounts are positively associated with the demand spillover size. For the procurement losers, the effect is mostly negative and ranges from -16% to 2%. A conservative interpretation is that these results represent the upper bound of the actual treatment effect.

The fifth thesis chapter investigates the existence of pricing spillovers between the two markets. I investigate how changes in the price paid by the retail market pharmacies are transmitted to the prices offered in the hospital procurements. The retail market price regulation tries to keep the wholesale prices as low as possible but at the same time the regulator does not take into account the fact that the wholesale prices are used as the reservation price in the hospital procurements. I examine the effect of reference price regulation on pricing in both markets. I find that exogenous changes in the wholesale prices paid by the retail market pharmacies are fully transmitted to the bids hospitals receive. The resulting cross-market price elasticity between the hospital bids and the retail market wholesale price varies between 1.15-1.3, implying that the impact of price regulation reaches more widely than just to the retail market. These results demonstrate the need for incorporating the hospital market into the analysis of the pharmaceutical reforms.

Keywords industrial organization, health economics, pharmaceutical markets, public procurement, spillovers, policy evaluation, reference price regulation

ISBN (printed) 978-952-60-8641-5 **ISBN (pdf)** 978-952-60-8642-2

ISSN (printed) 1799-4934 **ISSN (pdf)** 1799-4942

Location of publisher Helsinki **Location of printing** Helsinki **Year** 2019

Pages 213 **urn** http://urn.fi/URN:ISBN:978-952-60-8642-2

Acknowledgements

This dissertation is the highlight of my academic journey that has contained many missteps and countless hours of work along the way. I have received support, advice and help from many people along the way. Now is the time to thank all of you.

Firstly, I am grateful to my main supervisor Professor Matti Liski. I would have not started my postgraduate studies at the Aalto University without Matti and I am rather confident that I would not have finished my thesis without him. Matti's ability to ask the right questions at the right time has steered me (and my fellow students) on this path of neverending hunt of knowledge. He is patient and thorough in his guidance and I thank him for countless hours of discussions on and off topic.

Secondly, I am happy that Professor Otto Toivanen joined my thesis committee. I have learned much from him about thinking like a true IO-economist. Otto has spent countless hours of guiding me through my thesis challenges, and for that I am forever grateful. I look forward to our future research endeavors, whatever they may bring.

Emeritus Professor Pekka Ilmakunnas has also helped me in the early years of my dissertation project. Pekka was an instrumental mentor in showing what was the best way to start a project on a completely new field for me. I am also glad that I was given the possibility to act as a teaching assistant for Pekka's graduate econometrics course. I believe that for a researcher it is also important to be able to vocalize thoughts and methods in a way that the audience is also able to understand.

I also thank the whole Aalto Economics Department for giving me the possibility to study in an encouraging environment. Since Aalto moved away from the Economicum, the loss of the previous enthusiastic atmosphere has been tangible. I especially would like to thank Professor Marko Terviö who always had the time to discuss and comment my potential research ideas.

Thanks to Marko, I was able to drop non-valid ideas before I put too much effort into them.

I am thankful to my pre-examiners Associate Professor Torsten Santavirta and Professor Thomas Rønde, whose comments and suggestions will be valuable in transforming my thesis chapters into journal articles. I would also like to thank Professor Rønde for agreeing to act as my opponent in my doctoral defence.

I finished writing my thesis at the VATT Institute for Economic Research (VATT). I would like to thank Mika Kortelainen for giving me the opportunity to finish my dissertation while working there. Throughout my studies, I have received support from Tanja Saxell, Janne Tukiainen and Heikki Pursiainen, who all worked at VATT when I was a trainee there almost a decade ago. Your support has been extremely important to me during the years of my doctoral studies.

I gratefully acknowledge the financial support from the Finnish Cultural Foundation, Yrjö Jahnsson Foundation, Social Insurance Institution of Finland and Aalto University.

I would like thank my fellow Economicum PhD students for the support I received during my studies. I shared my office with Krista Riukula, Francesca Valentini, Riikka Savolainen, Krisztina Timko, Milla Nyyssölä and Terhi Ravaska during my studies and I could not have asked for better co-workers. You all have a left mark (a positive one) on my thinking. Also, the members of the Research Group 405 were essential in providing balance and creative chaos to the life at Economicum. I must single out the peer-support I have received from Tuomas Laiho, Artturi Björk, Robin Stitzing, Olena Izhak, Min Zhu, and Jaakko Markkanen.

I appreciate the help that I received from the Aalto University administration. I thank Maria Nyberg for all the help and tips I have received during my studies. I must also thank Oskari Nokso-Koivisto, who has many times successfully demonstrated how economics research should be utilized in the world outside the Aalto Economics Department.

I want thank my mother Anna-Liisa for the unwavering Savonian support that I have received from her during my life. Finally, I thank my family, Hanna and Silja, for their constant patience, love and support that I have received during this project. From your loving feedback, I have understood the there is life also outside the researchers's chamber.

Markku Siikanen

Jäppilä, June 2019

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Chapter 1

Introduction

This thesis is an applied empirical industrial organization study on markets for pharmaceuticals. In my thesis, I focus on the interaction between hospital and retail[1] pharmaceutical markets in Finland. My thesis focuses on the spillovers between these two markets. Regulation of the pharmaceutical industry in Finland considers markets to be independent of each other. I test how price setting and pharmaceutical consumption is influenced by the fact that the same products are simultaneously used in two overlapping markets. This introduction offers a short, nontechnical summary of the results, and contributions of each dissertation chapter.

The second chapter describes the Finnish market for pharmaceuticals and the relevant market institutions. The chapter highlights the institutional arrangements which foster connections between the two markets and explains the regulation relevant to the analysis presented in this thesis. The third chapter develops a simple theoretical model which describes the equilibrium relationships between the two pharmaceutical markets. The theoretical model provides testable implications for the empirical chapters of the dissertation.

The fourth chapter investigates the existence of demand spillovers from the hospital market to the retail market using data from Finland[2]. I am interested in finding out what is the role of public hospitals in determining the retail market pharmaceutical use. Hospitals use public procurement to obtain pharmaceuticals for the treatments provided in inpatient care.

[1] Throughout the thesis I denote pharmaceuticals sold from community pharmacies as the retail market and pharmaceuticals sold to public hospitals as the hospital market.

[2] Demand spillovers from the retail market to the hospital market are outside the scope of this study.

Procurement causes changes to the hospital pharmaceutical selection and it is important to quantify how these changes influence pharmaceutical sales in the retail market. The question is essential because current regulation considers the markets to be independent of each other. The last chapter studies the existence of pricing spillovers from the retail market to the hospital market. The retail market pharmacy purchase price is used as the procurement reservation price when hospitals procure pharmaceuticals. I investigate how changes in the reservation prices are transmitted to the bids public hospitals receive in their procurements. Unintentional pricing spillovers are possible because the retail market price regulation does not take into account the fact that the retail market prices are used as reservation prices in the hospital procurements. I quantify the extent of these spillovers. This chapter also uses data from Finland.

Surveys by Scherer (2000), Scott Morton and Kyle (2012), Morton and Boller (2017) and Lakdawalla (2018) show that the previous economics literature on the pharmaceutical industry has mainly concentrated on retail market questions. It is surprising that the economic analysis of the hospital market has not received much attention, even though the market exists in all industrialized countries (Carone et al., 2012). A plausible explanation for the lack of research on the hospital market questions is poor data availability (Vogler et al., 2012; PHIS, 2009; Pekurinen and Häkkinen, 2005). The existing literature on the hospital market has mainly focused on themes within the market, such as price competition (Hostenkamp, 2011, 2013; Arvate et al., 2013; Yao and Tanaka, 2016; Caves et al., 1991) and countervailing power (Ellison and Snyder, 2010). The literature on demand spillovers is an exception, because these papers try to figure out the role of hospitals in pharmaceutical use of outpatients (Pruckner and Schober, 2018; Gallini et al., 2013). I contribute to the economics literature on pharmaceutical markets by examining both demand and pricing spillovers between the two pharmaceutical markets.

1.1 The Finnish Market for Pharmaceuticals

The second chapter presents the relevant aspects of the Finnish market for pharmaceuticals. The analysis points out three descriptive findings which have policy importance, but have not received much attention. The first descriptive finding is the comparison between the reimbursements paid by the Social Insurance Institution and the hospital market sales. Reimbursements and the

pharmaceutical expenditures from public hospitals are both fully paid from the public funds. Finnish municipalities pay for the pharmaceuticals used in the public hospitals and The Finnish Social Insurance Institution pays the reimbursement costs in the retail market. During 2005-2016, in Finland, only the Higher Special Refunds-category is larger in terms of the reimbursement costs than the hospital market sales[3] (Fimea, 2015). This comparison suggests that the economic analysis of the hospital market has significance. Finland has paid a lot of attention to lowering the pharmaceutical reimbursement costs in the retail market, but there have not been similar efforts to contain the expenditure growth in the hospital market (Hakkarainen et al., 2015). A plausible explanation for this is the institutional setting where both the reimbursement costs and the hospital pharmaceuticals are paid by different public bodies.

The second descriptive finding concerns the procurement cost savings, i.e., a comparison of the procurement prices to the wholesale prices paid by the retail market pharmacies. Interestingly, there are no official statistics on the cost savings arising from the public procurement (Hakkarainen et al., 2015; PHIS, 2009; Fimea, 2015). The current pharmaceutical sales statistics in Finland calculate the hospital market sales using the wholesale prices[4]. This creates a measurement error to the official statistics because the procured prices can be lower than the wholesale prices. My findings show that the cost savings from using a public procurement to acquire pharmaceuticals is approximately 94-99 million euros in a year during 2012-2014. The cost savings are calculated for products which are procured for all health care units of the procurement area. This means that the use of public procurement decreases the pharmaceutical expenditure by 25%-27% in the hospital market compared to buying the pharmaceuticals at existing wholesale prices[5]. My calculations are not completely thorough and may include errors, since I do not observe all pharmaceuticals procured by the public hospitals, and the available quantity data contains hospital sales from public and private hospitals. In addition, I am unaware whether the products hospitals import are included in the pharmaceutical sales data I use. These challenges create bias to the cost savings estimates. Due to these data challenges my calculations can be interpreted as the upper bound for the actual savings. Despite the biases

[3]Hospital market sales are measured using wholesale prices.

[4]The official sales statistics report the hospital specific sales using the purchase price of medicine deliveries. This figure does not give a complete picture of the hospital market sales because medicine dispensaries are not included to the calculation (Fimea, 2015).

[5]My intuition is that the procurement gains were larger in 2014 than in 2017.

calculations are useful because it shows the magnitude of the achieved cost savings.

The third finding is the size of overlap between the pharmaceutical markets. An overlap exists when the same product[6] has sales in both markets at the same time. All analyses presented in this thesis exploit the overlap between the markets[7]. I find that the overlap ranges from 95% - 80% in 2002-2015 and the overlap has a downward sloping trend. Thus, a large share of the overall pharmaceutical sales in Finland comes from products which have sales in both markets[8]. An alternative way to investigate the size of the overlap is to examine the entry to the hospital procurements. I find that on average 42%-68 % of the pharmaceuticals eligible to participate in a procurement participate in the hospital procurements in Finland.

1.2 A Theoretical Model of the Pharmaceutical Industry

In the third chapter I construct a theoretical model of the pharmaceutical industry in a situation where the same products are sold in two different but linked markets. To the best of my knowledge, this is the first attempt in modeling the interactions between the hospital and the retail pharmaceutical markets. The model builds on the horizontal product differentiation framework with consumer switching costs. Markets are connected through consumers who use pharmaceuticals in the both markets[9]. Firm B offers the original (off-patent) brand-name drug while firm G offers a generic substitute. There are no explicit quality differences between the products, but switching costs differ between the products. The model serves as the theoretical motivation for the empirical analyses presented in the thesis. The Chapters 4 and 5 test propositions derived from the model.

I model the pharmaceutical industry as a perfect information two-stage game where the first stage is hospital procurement and the second stage is retail market competition. The model structure is simple but allows retail market regulation and spillovers to influence hospital market pricing. I derive the equilibrium implications of the connection between the markets for pricing and demand spillovers.

[6] Package with a distinct id-number (VNR-code).

[7] Spillovers related to the firm multimarket conduct are outside the scope of this study.

[8] These overlap figures are calculated from the sales data which contains public and private hospital sales. The measurement error most likely inflates the size of the overlap.

[9] I don't explicitly model the possibility that markets are connected through the behavior of the physicians working in the outpatient care.

There are three main results from the model. The first result is the existence of price discounts in the hospital procurements. Hospital market bids are lower than the retail market prices when hospitals have positive demand for a given product. This means that the hospital market prices are lower than the retail market prices whenever the product is used in both markets. I also find that the discount increases when the share of consumers with a previous episode in inpatient care increases. The existence of discounts matches reasonably well with actual procurement data, where the price discounts do exist. Also, the cross-country comparisons between the EU-member states reveal that the hospital prices tend to be lower than the retail market prices (PHIS, 2009; Vogler, 2013). However, the simplicity of the model structure leads to a situation where the prices are always lower in the hospital market than in the retail market.

The second result is the characterization of the demand spillover resulting from winning the procurement. In terms of the model parameters, I quantify the spillover as the profit increase which a firm obtains when the firm wins the procurement compared to losing the procurement. I find that the spillover increases when the number of consumers with a previous episode in inpatient care increases or when the size of the switching costs increase. These propositions mean that large spillovers are found in markets where the hospital market share is large and consumer inertia influences choices greatly. The spillover decreases when coinsurance increases. This means that when cost sharing between the society and the consumer shifts more towards the consumer, the size of the spillover decreases. Consumers become more price sensitive and pay more attention to the prices. In the fourth chapter I investigate whether these propositions have empirical relevance in the case of the Finnish pharmaceutical market.

The last result from the theoretical model is the effect of reference price regulation to the pharmaceutical industry. I introduce reference price regulation to the model and I find that an endogenous reference price policy decreases pharmaceutical prices in retail market compared to a free pricing scenario. Surprisingly, reference price regulation increases the bids in the hospital market compared to a free pricing scenario. This happens because reference price regulation decreases the value of the demand spillover, and therefore the firm has incentive to increase the bid submitted to the procurement. The result is interesting because previous theoretical work on pharmaceutical price regulation has not examined this mechanism before. The fifth chapter tests these propositions by estimating the causal effect of implementing reference price regulation to

both pharmaceutical markets in Finland.

1.3 An Empirical Study of Pharmaceutical Demand Spillovers

In the fourth chapter I investigate the existence of demand spillovers from public hospitals to the retail market in Finland. It is not unheard of that a patient enters the hospital, receives a drug treatment, leaves the hospital, and continues the treatment with the same product in outpatient care. A process like this connects the two pharmaceutical markets. Previous literature in medicine and in economics has examined the role of hospital pharmaceutical use on the pharmaceutical consumption in outpatient care. The literature supports the existence of demand spillovers in pharmaceutical markets (Gallini et al., 2013; Pruckner and Schober, 2018; Wang and Pauly, 2005a). In these papers the spillover happens because the markets are connected through the consumer and (or) physician behavior. The medical literature shows that physicians working in outpatient care tend to take the medications started during inpatient episodes into account while prescribing pharmaceuticals in the outpatient care (Prosser et al., 2003; Feely et al., 1999; Grimmsmann et al., 2007; Müller-Bühl et al., 2009). Physician behavior also allows for demand spillovers between restrictive and more generous health plans within the Medicaid program in the USA (Wang and Pauly, 2005b; Wang, 2006; Virabhak and Shinogle, 2005). The idea is that physicians prescribe drugs included in the restrictive formulary also to consumers with a more generous health plan. In this setting, physician behavior connects the markets. There is also anecdotal evidence on the existence of demand spillovers from the hospital market to the retail market (Ford, 2012). Interestingly, the largest commercial pharmaceutical sales data provider IQVIA[10] lists hospital spillover analysis as one of the permitted uses of their data[11].

In the empirical analysis I exploit the regional variation in the pharmaceutical sales caused by the large scale procurements organized by the public hospitals in Finland. The procurement determines, to a large extent, the set of pharmaceuticals which are included in the hospital pharmaceutical selection in a given geographical area. The institutional setting guarantees that by winning a procurement, a product is included in the hospital selection. If an incumbent

[10] `https://www.iqvia.com`.

[11] `http://legal.imshealth.com/Pages/TPProg.aspx?RootFolder=%2FTPA%2FClient%5FResources%2FTraining%5FResources%2FUse%20Definitions%20for%20Third%20Party%20Access%20Program&FolderCTID=0x0120005E0FB107A79782419E042BE75B85F17F&View=%7BD5C8E73E%2D4FCE%2D4D49%2DA287%2D8C9BC3482E56%7D`.

product loses the procurement, the product is excluded from the selection and then the hospital sales decrease dramatically. Procurement data contains products which always win or lose the procurement, and products which are included or excluded from the hospital selection. I use a differences-in-differences design to compare sales of products with a change in the hospital market status to products which do not have a change in the status. I can estimate separate impacts for both winning and losing a procurement. The analysis is conducted for 12 different ATC3-categories in both pharmaceutical markets[12]. The examined ATC3-categories are selected on the basis of their economic significance.

I start my analysis by examining the effect of the procurement to the pharmaceutical sales in the hospital market. Winning the procurement increases hospital sales tremendously and losing the procurement hurts hospital sales. When a product is included in the hospital selection the sales increase by 40%-250% in a given geographical area compared to a product without a change in the hospital market status in the same area. Results regarding losing the procurement are almost the same. When a product is removed from the selection the sales decrease by 54% - 80% compared to products which have no change in the selection status. The results show that my identification strategy finds the effect of the procurement on a market where the procurement should have a large impact to pharmaceutical sales. The results also show that hospital sales react quickly to the changes in the hospital selection. However, hospital sales have slight persistence because sales don't go to zero after losing the procurement[13]. Overall, these results match well with the institutional features of the hospital pharmaceutical market.

The main results of this chapter are the actual demand spillover effects from the hospital market to the retail market. The retail market sales increase by 2%-47% due to winning the procurement in the same georaphical area for those products which were not previously included in the hospital selection. Spillover estimates have economic and statistical significance[14]. These findings follow the previous literature on the demand spillovers between the markets (Gallini et al., 2013; Pruckner and Schober, 2018; Wang and Pauly, 2005a). My contribution to the existing literature is that I use plausibly exogenous variation from the public procurement to

[12]Included categories are A07, B01, B02, C01, C07, G03, L03, L04, M01, N03, N07, and R03.

[13]A measurement error in the hospital sales data can explain this. Chapter 2 discusses the extent of the measurement error issue.

[14]Conservative interpretation is that these results represent the upper bound of the actual treatment effect.

identify the spillovers. The previous literature has taken the hospital or health plan pharmaceutical selection as given, but I utilize changes in selection status arising from procurements. In addition, the previous literature has not examined the effects of a product being removed from hospital pharmaceutical selection and I consider a wide range of pharmaceutical categories in my analysis. For the procurement losers the effect is negative or slightly positive and ranges from -16 % to 2%. The most important policy implication from the main results is that the pharmaceutical markets are not independent of each other because the retail market sales respond to the changes in the hospital pharmaceutical selection.

The theoretical model predicts that the winner of the hospital procurement charges higher retail market prices after winning the procurement compared to losing the procurement. Interestingly, I find that hospital procurement does not have any significant impact on the retail market price setting[15]. Estimated spillovers are purely demand spillovers. The result means that the procurement does not create externalities for consumers who don't visit the public hospitals but consume drugs included in the hospital selection in outpatient care. The institutional framework in the Finnish market and the existence of external reference price regulation in Europe can explain why prices do not change if a firms wins the procurement (Maini and Pammolli, 2017). Furthermore, the external reference price regulation connects the retail market pharmaceutical pricing in Finland to the pricing in other European countries. A change in the Finnish prices could potentially change prices in a market with much larger economic significance, and, therefore, it is unlikely that pharmaceutical prices respond to the outcomes of the hospital procurements. An alternative explanation is that the wholesale prices in the retail market are national and this decreases the incentive to change retail market prices on the basis of the procurement decision. Also, there are likely multiple winners (of hospital procurements) at a given point in time (for a given drug). This will also affect the national wholesale price setting behavior.

I conclude my analysis of the demand spillovers by examining the heterogeneity of the estimated spillover effects. The propositions of the theoretical model motivate this section. I examine how reimbursements, hospital market size, brand-name status and discounts[16] influence

[15] Wholesale prices are not influenced by the procurement.

[16] A procurement bid is subject to a discount when the bid is lower than the wholesale price at the time of the procurement.

the size of the spillover. I find that spillover effects are larger for products which were subject to a price discount in the procurement. This result can partially rationalize why price discounts exists in the hospital market procurements. Firms can observe products which have good spillover potential. Companies willingly sell the product with a low price to the hospitals and firms recoup their losses through increased future retail market sales.

The empirical literature on the brand-premium suggest that products with brand-value could have larger spillovers than generic products (Bronnenberg et al., 2015; Bronnenberg and Dubé, 2017). If consumers value the perceived quality of the brand-name products, this could strengthen consumer inertia towards brand-name products, which also increases the spillover size. My results suggest that brand-name status is not a key factor in determining the size of the spillover. I do find that the brand-name products suffer negative consequences more from losing the procurement than other products but only in a few categories[17]. In some other categories, the brand-name products have a larger spillover effect for winning the procurement than the other products. It is plausible that consumer inertia arising from pharmacological properties of the products is more important than the possible brand preferences.

Interestingly, I find that the size of the spillover is influenced by the reimbursement status. The absence of price regulation could increase the spillovers because then the regulation does not have any influence on the choice of the consumer. The opposing force is the lack of reimbursements because then the consumer pays the full price for these products. My results suggest that the demand spillovers are larger for the reimbursed products compared to the products outside the reimbursement system. The relationship between the spillover size and the reimbursement status does vary between different ATC3-categories.

The results regarding the hospital market size are the most inconclusive. I find that categories with large hospital market share have better spillover potential than small markets only in a few examined categories. The theoretical model predicts that spillovers should increase when the share of consumers with previous inpatient care episode increases. In the theoretical model the only channel for spillovers are the patients who use the product in both markets. In reality there might also be alternative channels. The previous medical literature has shown that physician prescription behavior is influenced by the the treatments started in inpatient care (Prosser et al.,

[17] Parallel imported products and generics.

2003; Feely et al., 1999; Grimmsmann et al., 2007; Müller-Bühl et al., 2009). This is one possible explanation why the market size is not a good predictor of the spillover size on its own.

1.4 An Empirical Study of Pricing Spillovers Between Pharmaceutical Markets

In the last dissertation chapter I investigate the pharmaceutical pricing between the two pharmaceutical markets in Finland. My research question is simple: how are changes in the prices paid by the retail market pharmacies transmitted to the prices offered in the hospital procurements[18]? These two markets are connected because the price (bid) offered to the hospital procurement is tied to the wholesale price of the product in the retail market. Procurement rules dictate that the hospital market bid cannot exceed the wholesale price. The retail market price regulation tries to keep the wholesale prices as low as possible, but at the same time the regulator does not take into account the fact that the hospital bids are anchored to the wholesale prices. This leads to a scenario where the price setting in the retail market can influence bidding in the hospital market.

Previous studies have shown that pricing spillovers exist between pharmaceutical markets. Papers by Duggan and Scott Morton (2006) , Scott Morton (1997), Alpert et al. (2013) and Duggan and Scott Morton (2010) investigate pricing spillovers in the US pharmaceutical market in the context of Medicare and Medicaid programs. These papers mainly examine the interaction between the retail market and the Medicare/Medicaid market. The general finding is that pricing spillovers between different pharmaceutical markets do exist, when regulation ties prices in one market to prices other market (Maini and Pammolli, 2017; Lakdawalla, 2018). This generates incentives to change prices in one market in order to maximize profits in the other market.

In this chapter I estimate an elasticity between pharmaceutical prices in the two markets. The cross-market price elasticity measures how changes in the wholesale prices are transmitted to the bids submitted in the hospital procurements. I acknowledge the obvious endogeneity problem between the prices and bids. My empirical strategy uses reference price regulation implemented

[18] Previous chapter investigated how hospital procurements influence pharmaceutical consumption in the retail market and now I examine how price setting in the retail market influences bidding in the hospital procurements.

in the retail market in 2009 as a instrument to identify the cross-market price elasticity. The instrument is valid because motivation behind the policy was to decrease pharmaceutical prices in the retail market and the policy was a major change in the Finnish pharmaceutical market. The instrument is not correlated with the hospital market pricing shocks because the instrument cannot vary geographically and I control for the country-level demand shocks through the date fixed effects.

This chapter has three main results. The first two results are the effects of reference price regulation on the retail and hospital market. The reference price policy decreased the wholesale prices on average by 13%-18% in the retail market. The result follows the previous literature on the causal effects of reference price regulation (Brekke et al., 2009, 2011). The reference price regulation also decreased the bids submitted to the hospital procurements by 14%-20%. The hospital market result is a contribution to the existing literature on pharmaceutical regulation and pricing. The previous literature has only considered the direct effects of the policy, but I can show that the policy also has unintended spillovers with economic significance.

The main contribution of this chapter is the cross-market price elasticity. Results from the instrumental variables regression suggest that the cross-market price elasticity ranges between 1.10-1.3. This means that price changes are larger in the hospital market than in the retail market[19]. This finding is consistent with the previous literature on pricing spillovers between pharmaceutical markets (Duggan and Scott Morton, 2006; Scott Morton, 1997; Alpert et al., 2013; Duggan and Scott Morton, 2010; Jascisens, 2017). The result is important because it shows that the regulation of the pharmaceutical industry could become more effective by taking both markets into consideration. An immediate implication of the elasticity is that only now the overall effects of price regulation to pharmaceutical pricing can be uncovered. Previous studies on the effectiveness of pharmaceutical policies have not captured all benefits of the programs because the hospital market was left outside of the analysis. The results presented in this chapter demonstrate the need to incorporate the hospital market into the analysis of the pharmaceutical reforms.

The last chapter examined spillovers which happen because the hospital market bidding is

[19] I find that the elasticity size is partially driven by the hospital market anticipation effects of the reference price regulation.

linked to the pharmaceutical wholesale prices. My analysis captures only the direct pricing effects. I don't examine how changes in the retail market price setting influence entry decisions to the procurements. It is likely that low wholesale prices discourage entry. Without knowledge on the entry outcomes, the overall welfare impact of the pricing spillover remains unambiguous. Future research should investigate how retail market price regulation influences entry decision to hospital pharmaceutical procurements. Only then the welfare effects of this spillover are known.

Aalto-DD 131/2019

ISBN 978-952-60-8641-5 (printed)
ISBN 978-952-60-8642-2 (pdf)
ISSN 1799-4934 (printed)
ISSN 1799-4942 (pdf)

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ART + DESIGN + ARCHITECTURE

SCIENCE + TECHNOLOGY

CROSSOVER

DOCTORAL DISSERTATIONS