Essays on the effect of health care and the environment on health

Mattisson, Linn

2023

Document Version:
Publisher's PDF, also known as Version of record

Essays on the effect of health care and the environment on health

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by Linn Mattisson

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DOCTORAL DISSERTATION
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To be defended at Holger Craafords Ekonomicentrum EC3:211 on June 2 2023 at 10 am.

Thesis advisors: Jan Bietenbeck, Lina Maria Ellegård, Petter Lundborg.
Faculty opponent: Hans Henrik Sievertsen, University of Bristol and the Danish Center for Social Science Research.

Organization LUND UNIVERSITY Department of Economics P.O. Box 7082 SE-220 07 LUND SWEDEN	**Document name** DOCTORAL DISSERTATION **Date of disputation** 2023-06-02
Author(s) Linn Mattisson	Sponsoring organization

Title and subtitle
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Abstract

This thesis consists of three self-contained papers studying different topics in health economics. The first chapter studies the substitution effect between in-person physician visits and a new type of doctor visits, direct-to-consumer (DCT) telemedicine, where a person can call a doctor directly via an app. To causally assess to which degree DCT consultations substitute for in-person consultations, we exploit exogenous changes in patient fees in a fuzzy difference-in-discontinuities analysis of young adults in Sweden. We estimate a degree of substitution of 45%, implying an increase in the consultation volume. While the characteristics of the additional demand raise concerns related to healthcare equity and efficiency, the results also suggest that the increase in volume is close to cost neutral and there is no evidence of decreased quality of care.

The second chapter studies the importance of patient-to-practice continuity of care for patient outcomes. Exploiting plausibly exogenous timing of closures of primary care practices in a Swedish region, I find that patients who experience a practice discontinuity have an immediate 15% decrease in visits to primary care physicians which lasts for at least two years, with some evidence showing this is partially offset by an increase in visits to nurses and other primary care providers. This effect is stronger for patients with no history of chronic diseases and immigrants. I find that a large share of directly affected patients migrate to neighbouring remaining practices which temporarily crowds out previously established incumbent patients.

The third chapter in this thesis studies the effect waterborne disease risk on children's health and learning in Tanzania. Using a difference-in-differences approach, we find that when one-tenth of the local area is covered by simulated disease-prone stagnant water, children are 2.8 percentage points likelier to have diarrhoea, corresponding to an almost 11% increase relative to the baseline incidence. We also find that children have 0.07 standard deviations lower test scores. These results mask important heterogeneities: We find that the most vulnerable children are those who live in urban areas with poor sanitation. Hence, policymakers should consider local environmental risk factor of waterborne diseases when implementing sanitation policies

Key words primary care, digital care, telemedicine, doctor visits, practice closures, continuity of care, health care spillovers, waterborne diseases, sanitation, test scores, child health, children's learning

Classification system and/or index terms (if any)
JEL Codes: I11, I15, I18, I25

Supplementary bibliographical information		**Language** English
ISSN and key title 0460-0029 Lund Economic Studies no. 239		**ISBN print:** 978-91-8039-710-0 **ISBN pdf:** 978-91-8039-711-7
Recipient's notes	**Number of pages** 309	Price
	Security classification	

Signature  Date 2022-04-17

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LUND
UNIVERSITY

LUND ECONOMIC STUDIES NUMBER 239

Lund University School of Economics and Management, Department of Economics

ISBN: 978-91-8039-710-0 (print)
ISBN: 978-91-8039-711-7 (pdf)
ISSN: 0460-0029 Lund Economic Studies no. 239

Printed in Sweden by Media-Tryck, Lund University, Lund 2023

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Contents

Abstract

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Acknowledgements

Economics and I did not have the most auspicious beginning. On the 27th of October 2010 (when I was 16) I posted the following statement to the world on my social media:

Theory of the Firm kan dra åt helvete [...], tack.[1]

I remember feeling frustrated with the seemingly endless number of concepts and models, but something in the promised precision of economics and the connection to real-world issues was alluring. And so I continued to study this subject, but it wasn't until my first class in health economics[2], which introduced me to applied research methods, that I felt economic research could be interesting.

I am beyond grateful I have had the opportunity to pursue these PhD studies and to do so at this particular department of economics. When I started the PhD I was prepared to work hard, feel lonely and out of place among all geniuses, and be stressed. With the benefit of hindsight, I can confirm I have worked hard and I have been stressed. But I have also had a lot of fun, and my colleagues have been nothing but nice, smart and supportive along the whole journey of my PhD studies.

I could never have finished this thesis without the help of a large number of people. First, I would like to thank my supervisors Jan Bietenbeck, Lina Maria Ellegård and Petter Lundborg. I honestly cannot recall a single supervisory meeting where I didn't leave feeling a little bit wiser and less stressed thanks to your advice and encouragement. I thank Jan for always finding the time for another meeting and reading another half-finished draft, and for your ability to give feedback while somehow still making me feel like I've got this. I thank Lina Maria for never failing to be encouraging. You gave me the opportunity to first be your research assistant and then your co-author and I would never have learnt so much about health economics and Swedish healthcare without you! I also thank Petter for your inspiring research and for helping me to remember the big picture in research and policy.

[1] Liked by six people.

[2] Seven years later, mind you.

This PhD would not have been the same without all the colleagues in my department and the profession. I especially thank people in my research group for many shared lunches and seminars: Ana, Bengt, Elin, Eva, Gunes, Mohammad, Petra, Pol and Therese. A special thank you to Pontus, Karin, Petra and Ana for teaching me a lot about teaching, and to Alex, Roel and Sandra for lessons on collaboration. I would also like to thank Pontus Hansson and Carl-Hampus Lyttkens for your encouragement and mentoring already during my master's studies. I thank you both for interesting discussions on philosophy, history and our profession. I also thank the admin team for making the PhD work all the more seamlessly and in particular Jenny for answering many stupid questions and for inspiring me to go to fjällen. I also thank my co-author Gustav Kjellsson. Every time we talk I learn a lot. Finally, I thank Dan Zeltzter, Anna Tompsett and Henning Øien for their excellent comments and feedback on my papers.

I also thank the Jan Wallander and Tom Hedelius Foundation for the opportunity to visit Universitat Pompeu Fabra. I must first thank Libertad González for your excellent feedback on my research, and for being a role model – when I'm a grown-up economist I want to be just like you. I also thank my Barcelona office mate Giulia for many late nights exploring Barcelona, but (unfortunately) even more long days in the office – thank you for always having a kind word to share and for always being up for another adventure. I also thank Matthias, my other office mate in Barcelona, for fun discussions on life and research. I am also grateful to Claudia, Gianmarco and Giulia for lunches in the sun and a memorable brainstorming session in one of the most stressful weeks of my life which eventually led to Paper II in this thesis.

In the PhD program, the people who have made the biggest difference in the day-to-day work are the other PhD students. If we crashed an aeroplane on a deserted island I wouldn't pick you, because you have no practical skills and at least one of you would insist on choosing a currency before finding water and shelter, but if I could choose any people as colleagues for the PhD I would still choose you. I thank David, Demid, Emelie, Iker, Josefin, Hampus, Kajsa, Lotta, Ludvig, Madeleine, Marco, Natalie, Negar, Ovi, Philipp, Prakriti, Sanna, Sara, Shayan, Teppo, Vinzent, Yana and many more. I especially thank Jonas, Matthew and Sandra for being great office neighbours – you enriched my vardag and my research. A massive thank you to Steve, my co-author: It is a pleasure to work with you and I am so proud of our paper.

I am so thankful for going through the PhD program together with Adrian, Markus, Olga and Devon. Adrian – while it's been somewhat demotivating that you wrote seven papers, completed a Bachelor degree and made it to international news during the PhD, I know I can always knock on your door. Markus – I'm always so happy to see you at work, I wish we had seen each other more at the office. Olga – you treat me like I'm your adopted cousin and I wouldn't want it any other way. Devon – I could not wish for a better office mate for my final year in the PhD. Even though we have both been pretty stressed this year, you always have time to cheer me on, cheer me up, or discuss a piece of code or writing. I admire

your skills and integrity as a researcher, and I can't wait to see what you do in the years to come!

Finally, I have to thank the other people in my life who helped me remember there is more to life than economics: Kersti, Mirjami and Martyna for being there for me despite all of us living in different countries. The same goes for my cousins, Kelley and Kevin. Alicia, for squash games and chats about food, books and hating the same people. Gen, for good times in Gràcia. Ronja, for dinners in Copenhagen and fika in Lund. Team Alpha from my master studies, because without you I would never have gotten good enough grades to get into the PhD programme.

I would not be here if it was not for my family. This thesis is dedicated to my grandfather Matti. I thank him for teaching me to enjoy the small things in life, like saunas and watching a good British mystery. I thank my parents for their love and support – you taught me by example that the world is a large and exciting place to explore. I am grateful to my sister Ingrid for her ridiculous sense of humour and ability to make me forget about work. Lastly, thank you, Thomas. You celebrated my small and big victories at work as if they were your own, and when I've cried about work you made me laugh first at you, then at myself, and suddenly it didn't feel so bad. I cannot imagine life without you by my side.

Lund, April 2023
Linn

Introduction

Introduction

Why this thesis is called 'Essays on the effect of health care and the environment on health'

This thesis consists of three self-contained papers. A common theme between them is that all concern the economics of health and health care. More specifically, my choice of research questions is underpinned by my desire to study contemporary policy challenges in health economic topics.

The first chapter analyses how individuals choose between two types of doctor consultations in primary care: Traditional in-person visits at a primary care practice, or a remote consultation via chat or video call to a private company. When we started this project in 2019, it seemed inevitable that remote consultations would become increasingly important. We were right to a degree we could not have predicted – the Covid-19 pandemic put both health care and digitalisation at the forefront of public policy. The second chapter studies how patients are affected when their primary care practice closes, and my interest in this research topic was prompted by the closure of hundreds of practices during and after the pandemic (e.g. in mass media: The Times, 2023; The Pulse, 2021). When I dug into practice closures further, I realised that these occurrences are long-standing issues that have garnered limited attention from policymakers and that causal estimates on the effects on patients were lacking. Lastly, the third paper concerns the effect of waterborne diseases on children's learning. Waterborne diseases are common in developing countries and are likely to increase with climate change (Semenza, 2020) in spite of prevention and treatment being relatively well-known and developed. I hope the findings in this project can inform policies for disease prevention and management.

A second common theme of these thesis chapters relates to the methodology employed in the research design. To talk about the *effect* of something, as I do in my thesis title, one has to talk about *cause*, and both are vital to make informed policy recommendations. All three chapters in this thesis employ applied microeconometrics methods to differentiate causality

from correlation and quantify the effects. The core of these approaches is to use a source of exogenous variation in the institutional or environmental conditions for the individuals in the population in order to isolate causal effects on the outcomes of interest.

To explain this with an illustrative example, if one was to guess which single building in a city with the most deaths one should clearly choose a hospital. But does this mean hospitals are death traps? Not quite. A better way to assess the effect of hospitals on mortality would be to subject every person who visited the emergency department to a coin toss to determine whether they are admitted to the hospital. It is likely that the people who were admitted to the hospital would have a higher survival rate than those who were forced to leave after the coin toss. This example highlights a fundamental tool to separate causality from correlations. Randomly dividing individuals into two groups — a control group that does not receive treatment and a treatment group that does — allows the observed differences between the groups to be interpreted as caused by the treatment. All chapters in this thesis rely on so-called natural experiments to make causal inferences: Settings that introduce a quasi-random division of individuals into control and treatment groups. Identifying causal relationships is crucial to understand how a specific institutional or environmental change affects individuals. Without knowledge of the causal mechanisms, it is difficult to make policy recommendations.

A third common theme of this thesis is that I employ rich, high-quality data in all three chapters. I use Swedish registry data for two of these chapters which has two strengths compared to other data sources. First, they are routinely collected and include detailed information on individuals' use of healthcare as well as other important things that can affect healthcare use such as the socio-economic background. Second, the data covers the whole population in the age groups and study regions of Sweden; a large sample size allows the researcher to make more robust statistical analyses. In my third chapter, I use nationally representative survey data on children in Tanzania. Detailed information on where households live, children's health and test scores is key for our research design.

The rest of this introduction briefly explains the motivation, contribution, empirical strategy and main result of each paper.

Paper I. An app call a day keeps the patient away? Substitution of online and in-person doctor consultations among young adults

The outbreak of the Covid-19 pandemic has accelerated the digitalisation of healthcare services, including the rise of direct-to-consumer telemedicine (DCT) where patients can receive online consultations on demand. Even before the pandemic, DCT services were challenging the traditional in-person care model, offering advantages such as convenience, accessibility, and cost savings. However, little is known about how patients navigate the new landscape of DCT and to what extent it represents a substitution of in-person visits versus new demand. This paper aims to provide causal estimates of the degree of substitution using detailed administrative data on young adults in the two largest regions in Sweden, where DCT consultations accounted for 5% of all primary care physician consultations and as much as 20% in the age groups studied. Understanding the impact of DCT on healthcare utilisation is crucial for health system efficiency, sustainability, and equity. Moreover, the study focuses on young adults, a key group of early adopters of DCT, providing insights into their utilisation patterns and potential substitution effects.

The contribution of this study lies in providing empirical evidence on the degree of substitution between DCT and in-person visits in a pre-Covid-19 context, using plausibly causal estimates. Observing individuals' healthcare choices makes it impossible to disentangle the substitution effect between the two types of doctor visits from their health needs. For example, a person may get sick and see a doctor both online and in-person, while another person only sees a doctor online. Since the first person can be legitimately sicker than the second one, this information is not informative on the substitution between DCT and in-person consultations. Survey data from the US suggest that the degree of substitution is high (Martinez et al., 2018; Nord et al., 2018), but care utilisation studies have obtained smaller estimates(Ashwood et al., 2017; Entezarjou et al., 2022). Both types of studies also only observe correlations. Outside the DCT setting, Zeltzer et al. (2199) has shown that increased access to telemedicine leads to a small increase in primary care visits, but lower healthcare costs.

In this paper, we exploit the rapidly emerging DCT market in Sweden and exogenous variation in regulated user fees to obtain causal estimates of substitution. Specifically, we employ a difference-in-discontinuity design: Individuals face a user fee when they turn 20 which is exogenous to any individual's need or desire for (i.e. demand) of healthcare. But in the event that other factors also change as a person turns twenty, we difference out the

discontinuity of the 20th birthday across two cohorts: A cohort with access to DCT, and an older cohort that turned twenty before DCT was available in Sweden. The data used in this study are collected from detailed administrative registries from the two largest regions in Sweden and cover the years 2012-2019. This analysis period before the Covid-19 pandemic allows us to analyse the market of DCT in the setting preceding the pandemic, more characterised by early adopters.

The main results of the study provide causal estimates of the degree of substitution between DCT and in-person visits for young adults in Sweden. We find that the demand for these services is very sensitive to price: After the onset of the fee, the number of DCT consultations falls by half. Further, our estimate of the substitution rate implies that 45% of DCT consultations replace in-person physician visits. Consequently, around half of all DCT consultations represent additional demand, i.e., consultations that would not have taken place, or would have been dealt with by other professions (e.g., nurses, midwives or psychotherapists), in the absence of DCT. A decomposition exercise suggests that the additional consultations stem primarily from the low barriers to access to DCT services. Additionally, to address concerns that DCT doctors focus on quantity rather than quality, our research finds no evidence of over-prescription of addictive pharmaceuticals or increased complications from infections, indicating that concerns about the quality of care provided through DCT may be unfounded.

Paper II. Patient-to-practice continuity in primary care: The effect of practice closures on patient outcomes

In most high-income countries many practices are closing due to a shrinking stock of primary care physicians, brought on by a large share of practising physicians retiring and few medical graduates choosing to become primary care physicians. For instance, the American Association of Medical Colleges estimates that by 2034 there will be a shortage of more than 20% of the current primary care physician workforce in the USA (AAMC, 2021), with similar patterns emerging in most European countries (OECD, 2008). This looming supply shortage leads to rising concerns about the quality of primary care, in particular as retirements of physicians and practice closures will lead to a loss of continuity of care.

Continuity of care is the extent to which the patient receives care from the same healthcare provider over time. Critically, it is difficult to analyse the value of continuity of care itself, since a patient's continuity of care depends on many factors that would also be the outcome of healthcare in general, such as the type of doctor they see or the extent of their chronic conditions. Therefore, existing literature tends to study how health outcomes changes when there is an exogeneous break in continuity of care. In my case, I use the fact that the timing of a practice closure is quasi-random from the point of view of a patient. Most existing studies analysing the loss of continuity in primary care study shocks to the patient-physician

relationship (Kwok, 2019; Sabety, 2022; Schwab, 2021; Fadlon and Van Parys, 2020; Sabety et al., 2021; Zhang, 2022; Godøy and Dale-Olsen, 2018; Markussen and Røed, 2017). In this paper, I instead focus on how a patient's care utilisation is affected by losing their *practice*.

Kristensen et al. (2022) and Simonsen et al. (2021) both study practice closures in Denmark, but in their context around 80% are single-physician practices, and most practices closed due to retirements. My contribution is to focus on the discontinuity of group practices. In this setting, group practices entail that there are more than one physician per practice, and that there are more professional categories than physicians within a practice, such as nurses or physiotherapists. Additionally, group practices serve a larger patient population. meaning a practice closure is a larger shock to the local primary care market. These three things combined means that changes in care utilisation and patient outcomes are likely to be different here than in a context where patients are more closely tied to a specific physician. Additionally, since practice closures also represent supply shocks, my results may reflect a change in indirect costs to seeking care, such as increased travel distance.

I employ a staggered difference-in-differences strategy to causally analyse the effect of practice closures and the loss of continuity of care for patients. This means I compare the outcomes of directly affected patients to patients who never experience a closure, within the same time period. I find that a practice discontinuity causes an immediate and sustained 15% reduction in physician visits on average for the two years of post-period I study. I find some evidence that some patient groups saw more nurses and other care professionals after the closure. This suggests that rerouting patients to non-physician caregivers may help to improve access to care, which becomes more crucial given an overall shortage of primary care physicians. I also find evidence suggesting remaining practices in the local primary care market immediately absorb a large part but not all of the patients from closures, and this new level is held throughout the post-period. This absorption appears to come at the cost for incumbent patients – patients who have consumed care at the neighbouring practices prior to the closure – who are temporarily crowded out. Incumbent patients face the largest reduction in physician visits one year following the closure, but it then recovers to pre-closure levels after two years.

Paper III. Waterborne diseases and children's learning

Waterborne disease is a leading cause of death and disability, contributing to 5.3 % of DALY's (disability-adjusted life years) from all diseases, and 90% of the disease burden specifically affects children under 5 years (Prüss et al., 2002). However, this disease burden is dramatically unevenly spread across the world: While waterborne disease only represents 0.4 % of the total disease burden of Europe, it makes up upwards of 14 % of the total disease burden in Africa, making waterborne diseases one of the most debilitating conditions for developing countries in Africa. Despite these dramatic costs to human life, waterborne diseases are al-

most completely preventable (as seen by the very low prevalence in high-income countries). Indeed, large gains in health can be made with relatively low-cost investments to prevent the spread of the diseases (Momberg et al., 2021).

Yet, little is still known about how the health costs of waterborne disease affect short-run and long-run investment into human capital. Moreov er, future climate change is projected to dramatically increase the risk of waterborne disease, due to increased flood risk and warmer weather suitable for the spread of waterborne pathogens. This is particularly concerning since developing countries are already at higher risk to experience these exacerbated weather conditions (Funari et al., 2012; Semenza, 2020). Employing a difference-in-differences design, this paper investigates the causal impact of climate-driven risk factors for waterborne disease on a key aspect of human capital accumulation; standardised test scores on school-aged children. The difference-in-differences design relies on variation in when waterborne disease potential affects in which areas of Tanzania. In this way, inherent differences across space such as economic development, long-run precipitation and culture that stay constant over time do not affect our estimates.

To provide causal estimates on the costs of waterborne disease we employ a novel empirical strategy combining hydrological engineering modelling and applied microeconomic models. We develop an algorithm that captures the environmental risk of waterborne diseases by simulating the emergence and disappearance of stagnant water, a critical factor in the exponential growth of waterborne pathogens. We call this waterborne disease potential. We then employ a difference-in-difference strategy to compare the health and learning outcomes of children exposed to different levels of this waterborne disease potential. By focusing on environmental and climatic factors, we ensure waterborne disease potential is exogenous to human activity so we can estimate the causal effect of waterborne diseases. Moreover, the difference-in-differences strategy implies that we control for time-invariant factors, such as inherent flood risk and economic development, by comparing children residing in the same area.

Our study reveals that children residing in areas with more stagnant water exhibit a higher incidence of diarrhoea — the main symptom of waterborne diseases. We also estimate lower test scores from standardised tests, as an indication of decreased learning. Furthermore, we investigate how water, sanitation, and hygiene (WASH) practices interact with waterborne disease potential and its effects. Our analysis reveals that the impact on test scores is more pronounced in dry wards, while WASH practices play a crucial role as co-determinants of the effects on both health, specifically the incidence of diarrhoea, and test scores in rainy and urban wards. These findings align with historical events and documented disease outbreaks, highlighting the significance of sanitation in combating waterborne diseases, particularly in densely populated areas.

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ISBN: 978-91-8039-710-0
ISSN: 0460-0029