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Essays in Labor Markets
Gender, Fertility and Education

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The PhD School in Economics and Management is an active national and international research environment at CBS for research degree students who deal with economics and management at business, industry and country level in a theoretical and empirical manner.
Foreword

This thesis is the result of my doctoral studies as Ph.D. Fellow at the Department of Economics at Copenhagen Business School. I am very grateful for the financial support provided by the Copenhagen Business School (CBS) and the Independent Research Fund Denmark throughout my Ph.D. This dissertation would not be possible without the help of many individuals and I would like to spend a moment to acknowledge them personally.

First and foremost, I wish to express my sincere gratitude to my two supervisors, Birthe Larsen (CBS) and Mario D. Amore (Bocconi), for their numerous comments and suggestions, for our co-authorship, and more generally for always being so supportive and always being available. I wish to thank Morten Bennedsen (University of Copenhagen and INSEAD) not only for our co-authorship but also for providing so much guidance and insight throughout our relationship and for sponsoring my research stay at INSEAD in 2015. During 2017, I was fortunate to visit Columbia University, I am grateful to Daniel Wolfenzon not only for the invitation, but also for all his support, and to everyone else who provided feedback and insight during my stay. During 2018, I was again fortunate to stay abroad. This time at Paris School of Economics and I am thankful to Elena Stancanelli for the invitation and for many fruitful discussions on the topic of Household Economics. I also wish to thank CBS and the board of directors who acknowledged my work by awarding me the CBS Centenary Ph.D.-award in 2017 given to the most talented Ph.D. with international research career prospects. With the prize followed an additional fully funded year of research. I also wish to acknowledge the financial support from Otto Mønsteds Fond, Augustinus Fonden, Oticon Fonden, Knud Højgaards Fond and Christian & Ottilia...
Brorsons Rejselegat, who all supported my various research stays and conference travels. I also wish to thank all of those who have taught me throughout my academic career at various the academic societies in Denmark, Norway, France and USA.

I wish to thank University of Copenhagen for providing me with office space and letting me use their facilities as if I was one of their own students. Specifically, I am grateful for the Center of Excellence headed by Morten Bennedsen for extraordinary academic inspiration and financial support.

I wish to thank my Ph.D. colleagues from near and far, not only for inspiring ideas and discussions but also for support and good company during many difficult hours of coursework, researching and writing - your presence will be missed.

A special thanks goes to my parents, who have supported me in so many ways. My mother has often been my first editor, reading every single word, and meticulously proofreading endless editions of my papers with nothing but a smile and encouraging comments in return. Our inspirational discussions on gender roles and what gender inequality encompasses in the modern society have also been central to my research. It is safe to say, that my Ph.D.-process would have been far less enjoyable without her support.

To anyone who I mistakenly left out, please know I appreciate your efforts and please accept my sincere apologies for the omission.

Philip Rosenbaum – Copenhagen, Denmark, 2019
Abstract

This Ph.D. thesis, titled *Essays in Labor Markets – Gender, Fertility and Education*, analyzes different economic problems within the field of labor economics. It consists of three independent research papers that can be read separately. Although the topic in each chapter is different, they have common ground in the empirical methods applied.

The first chapter of this thesis, *Does Early Childbearing Matter? New Approach Using Danish Register Data*, studies how women’s timing of fertility affects their long-term labor market outcomes. This paper is currently resubmitted to the academic journal *Labour Economics*.

Work interruptions related to childbearing are expected to affect mothers’ wages directly through changes in the formation of human capital. This effect is proposed as being exceptionally strong for early childbearing women who are about to start their working careers. This study investigates whether the poor long-term labor market outcomes experienced by women who first gave birth before turning 25 reflect previously existing disadvantages or are a consequence of the timing of childbearing. The purpose is also to observe whether a new combination of the best identification practices of earlier studies serves as a better estimation method. This is done by applying a within-family estimator while treating miscarriages as an exogenous variation, thereby mitigating family and individual heterogeneity, which might have biased earlier results based on either of the two identification strategies alone. It is found that early childbearing has no long-term effects on women’s earnings. There is a significant yearly earnings gap in the early 20s, which disappears by the age of 28, after which the trajectories are symmetric for the early and non-early childbearing mothers. I argue that a combination of the within-family method and the use of miscarriages as an exogenous variation serves as a better method for estimating the causal effect of early childbearing on women’s earnings.
In the second chapter of this thesis, *The Family Earnings Gap Revisited: A Household or a Labor Market Problem?*, I study the gender inequality in the child penalty in earnings. In this paper, I take on a new approach to analyze this puzzle. I exploit the intra household difference in gender composition between heterosexual and lesbian couples. There are multiple advantages in evaluating the child penalty in same-sex couples compared to heterosexual couples. First, the partners in same-sex relations will, by default, face the same kind of labor market treatment i.e., gender based advantages and disadvantages. Second, the comparative advantages and division of labor within the households are non-gender specific. First, I show that the child penalty on aggregate is lower in lesbian households relative to heterosexual households, even after controlling for education, timing of parenthood, and area of residence. Second, looking at the individual parents’ child penalty and comparing heterosexual women to the lesbian partner with less bargaining power shows that the child penalty is not due to intra household bargaining position. Lesbians with low bargaining power experience relatively low child penalty compared to the heterosexual mothers. The analysis also reveals that this difference in child penalty does not come from changes in labor market participation, but primarily from wage rates and the higher tendency for heterosexual women to take on part-time rather than full-time positions. Third, I show that the intra household earnings gap increases significantly due to parenthood in heterosexual households while it does not in lesbians households.

All together, these results indicate that the observed gender inequality in child penalty is not a universal gender entity. The child penalty for mothers is much dependent on the partner and household organization and less dependent on labor market attitudes against mothers per se – although discrimination cannot be rejected and is still most certainly a significant problem. The results show that the child penalty can be lowered by sharing the household production with a
partner that is more engaged in childrearing and that this household organization most likely does not lower the overall household earnings, but rather the opposite.

The third chapter, *CEO Education and Corporate Environmental Footprint*, is forthcoming in *Journal of Environmental Economics and Management* and is written together Mario D. Amore, Morten Bennedsen and Birthe Larsen. In this paper we analyze the effect of CEO education on environmental decision-making. Estimating a wide array of regressions on a panel dataset of Danish firms from 1996 to 2012, we deliver the following findings. First, we find a positive association between CEO education and the firms’ energy efficiency: better educated CEOs use significantly less energy inputs (electricity and gas) per employee. Second, we seek to establish the causal direction of our findings by using CEO hospitalization events, which generate temporary and arguably exogenous separations between CEOs and their firms without changing the matching between the two. Third, we estimate the effects of long education in different fields showing a positive association between electricity efficiency and a CEO’s advanced education in business-related fields. Fourth, using a comprehensive survey on individual values and preferences, we show that highly educated CEOs exhibit stronger personal concerns for climate change. They are also significantly more likely to own environment-friendly vehicles, such as fuel-efficient cars and electric cars. Taken together, our findings suggest that education shapes managerial styles giving rise to greater sustainability in corporate actions.
Resumé (Danish)


Studiet viser, at indkomstomkostningerne ved at få børn er lavere for lesbische husstande end for heteroseksuelle hustruer. Dernæst undersøges omkostningerne på individniveau ved at sammenligne heteroseksuelle kvinder med lesbische kvinder. For at danne et sammenligneligt grundlag sammenholdes kvinder, der har samme relative styrkeposition i forhold til human og økonomisk kapital forældrene imellem inden for parforholdet. Jeg viser, at lesbische mødre oplever en lavere omkostning ved at få børn end heteroseksuelle kvinder og at dette er gældende uanset hvilken styrkeposition kvinderne har. Analysen viser også, at indkomstforskellene ikke skabes pga. forskelle i arbejdsmarkedssdeltagelsen, men primært er båret af at de lesbiske kvinder har en højere lønstigning og arbejder flere timer efter de bliver forældre. Til sidst vises der, at løndifferencen imellem forældrene indenfor hustandende stiger for heteroseksuelle par men ikke for lesbiske par, når de bliver forældre.

Det tredje kapitel, *CEO Education and Corporate Environmental Footprint*, er udarbejdet sammen med Mario D. Amore, Morten Bennedsen og Birthe Larsen, og er accepteret til publicering i tidskriftet *Journal of Environmental Economics and Management*. I dette kapitel undersøger vi, hvordan direktores
uddannelse påvirker deres klimabeslutninger, både inden og uden for virksomhedsregi. Til
analysen anvendes der unik energidata for danske virksomheder løbende fra 1996 til 2012, der
sammenholdes med mikrodata for virksomhedernes regnskaber og direktørernes
personkarakteristika. Vi finder en stærk positiv sammenhæng mellem direktørernes
uddannelsesniveau og virksomhedernes energi-effektivitet. Vi prøver dernæst at identificere de
kausale forhold, ved at anvende eksogene sundhedsstød til direktøren. Der vises, at når en
direktør med høj uddannelse bliver indlagt på et sygehus og dermed er fraværende fra
virksomhedsdriften, falder virksomhedens energieffektivitet markant. Det samme gør sig dog
ikke gældende for direktører med lavere uddannelses niveauer. Ydermere fremgår det, at
uddannelsesniveauet er korreleret med større klimabevisthed, hvor højtuddannede direktører
udviser en større bekymring for klimaændringerne – en bekymring der omsættes til handling,
også i privatlivet, hvor de på gennemsnittet vælger mere miljøvenlige biler. De samlede resultater
indikerer, at mere uddannelse er med til at skabe lederen, der kan forbedre virksomhedernes
bæredygtighed.
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Introduction

This Ph.D. thesis is composed of three chapters. It should be noted that while all three chapters are independent research papers and can be read as such, they all address topics within the broad field of Labor Economics. The first chapter analyzes whether long-term labor market outcomes experienced by women who gave birth at an early age reflect previously existing disadvantages or are a consequence of the timing of the childbearing.\(^1\) The second chapter analyzes whether the child penalty in earnings experienced primarily by women is a universal gender entity or due to the partner’s characteristics or gender. The third and last chapter, analyzes the effect of CEO education on environmental decision-making.\(^2\) While the first two chapters are within the field of household economics and analyze the labor market’s outcomes for individuals around childbirths, the last chapter lies within the intersection of educational, environmental and management economics. Although the chapters are not entirely within the same branch of economics they all address highly relevant societal questions. Gender equality, the influence family formation has on careers and climate saving causations are debated more than ever and are matters all societies need to address.

Traditionally, arguments in economics dealt with the broad questions. Is free trade better than mercantilism? Is capitalism a better system than communism? Why do the economies of some countries grow so much faster than others? Later economists have turned to address questions that are narrower but still very important. The first economists were philosophers and political thinkers as much as they were economists. Today many of us see ourselves more like engineers designing bridges and dams. Like engineers with cranes, calipers and slide rulers, we use our own tools – logical theoretical models, mathematics and econometrics – to solve specific

\(^1\) This chapter is currently resubmitted to the academic journal *Labour Economics*

\(^2\) This chapter is forthcoming in the academic journal *Journal of Environmental Economics and Management*
Economists have a specific way of thinking about societal problems. The British economist Lionel Robbins (1898-1984) once defined economics as the study of scarce resources (Robins, 2007). Where there are scarcities, there are costs, since they force us to choose between resources and how to allocate them. One of the most important scarcities is time, which is omnipresent in most economic studies. This choice set is asymmetric, since we often deselect multiple things every time we select only one. The choice set seems to grow with the technological progress, providing ever more possibilities. This together with the “fear of missing out” (FOMO) - which has coined the Millennium Generation - and the illusion of unique rights to abundancy – which has manifested a righteous belief that we can have everything at once - are increasing the complexity and pressure of choosing. Every choice is dear. The pressure of choice is affecting us all and when faced with unrealistic beliefs and without training choosing can be stressful. In economics, this cost of not obtaining everything else is called *Opportunity Cost*, which simply sums up all the forgone utility you could have obtained if you had chosen otherwise. Rationally, we should calculate whether the utility of our choice is higher than for all other possible choices. The opportunity is often gone before we are done calculating and then what is left is only the cost of calculating. No wonder economist live their lives obsessing about lost opportunities. There are so many of them. On the other hand, this is also what brings food to the tables of economists. If there was no opportunity cost to study, there would be no need for our skills. “Luckily” for new aspiring economists the opportunities seem endless and so does our job.

The span of resources analyzed often stretches far beyond pecuniary items. It covers all sorts of valuables such as be the bricks used to build a kindergarten, the books in a library or the
drugs needed to cure diseases. Or as in this thesis the cost of parenthood on labor market outcomes and human capital gains on green decision making. Gary Becker (1930-2014), the groundbreaking Chicago-economist, is one of the reasons that economics does not only deal with industries, firms, prices and profit. He broke down the division between the “economic” and the “social” - or as some might argue, he economized the social. The philosophy of the Chicago School of Economic was that markets and prices are the basis of how society works. Becker took this further than most. Firms calculate costs and benefits to earn the biggest profit, but Becker reasoned that the same calculations are made on a household level (Becker, 1992).

Although controversial at the beginning, Becker laid the foundation most of the present time labor/household economists base their work on today, where economists are getting used to analyze topics as the marriage “markets”, child “penalties” and household “production”. Even the wording of core social decisions have been economized. A crucial input to household production is time, which is the omnipotent scarce resource for humanity. Children are time-intensive “goods”. Few choices will have a higher demand on your time. The cost of having children is for Becker similar to the cost of leisure; the income you give up by not working. This means that every second you read a book you also forgo income, the same intuition can be used when you spend time with your loved ones. There are some fixed costs of getting children such as the cost of food, housing, clothing etc., but more importantly are the non-fixed opportunity costs. These can vary for many reasons. Example given, the higher wages the higher is the cost of children, since you forgo more income. On the other hand, it is important to account for the benefits. Just as reading can be beneficial for your cultural and human capital, children can serve as an income and caretaking insurance in the long run.3

3 In this case, long run is being pre-death. I am specifying this so not to discourage any Keynesian readers.
In this thesis, I study three economic problems, all of which address the opportunity costs in different situations. All the studies are empirically based. The key to all three chapters is to find the counterfactual. Just observing and reporting the outputs for each group will not provide any meaningful identification of the problems. Using the term counterfactual might lead the reader to think about great “what-if” books, where the author presents an alternative existence that could have been reality if some detrimental historical situation had turned out differently. In some ways, the job of an empirical economist mirrors the one of the “what-if” novelist. In other ways, it does not. The most important difference is that the counterfactual used in research must be grounded in theory and data, and not only serve as an interesting thought experiment, which sometimes makes the job and the results less fun and dramatic.

Empirical research is most valuable when it uses data to answer specific causal questions, as if in a randomized clinical trial. Ideal experiments are often hypothetical, but even hypothetical experiments are worth considering and are useful when formulating a realistic research question. A good starting point is to imagine how to study the research question with no financial constraints or ethical boundaries. If you cannot formulate or design an experiment that can provide the answers in a world where all is allowed, the chances that any empirical research can provide meaningful insights are slim. Thinking about the ideal experiment also helps pinpoint the identifying causation of the problem in hand and to identify which mechanisms you would want to vary and which to be constant.

In the absence of a real experiment, it is common to look for the second best, which often can be found using well-controlled comparisons and/or natural quasi-experiments. Common to all of my studies is that real clinical trials are infeasible. Although intriguing, it is neither possible nor ethical to randomly assign individuals to have children or not, nor to assign the CEOs to firms. I then had to search for quasi-natural experiments unfolding in the real society.

4 E.g., The Plot Against America – Philip Roth, The Man in the High Castle – Philip K. Dick, and The Yiddish Policemen’s Union – Michael Cabon.
Of course, some quasi-natural experimental research designs are more convincing than others, but the econometric methods used in my studies are almost always fairly simple. The belief is that estimators in common use almost always have a simple interpretation that is not heavily model-dependent. Good econometrics cannot save a shaky research agenda, but the promiscuous use of fancy econometric techniques can sometimes bring down a good one.

This approach puts a high demand on the quality of data, its availability and level of detail. We live in a data-centric era that presumes Big Data to be the solution to all our problems. Data science skills are demanded everywhere, from social media companies to public policy administrations. But data is profoundly dumb in itself. Big Data can tell us “everything” about correlations among endless variables. The fetish of obtaining countless observations in order to find these hidden correlations has diluted the commonsense and often serves as a veil of ignorance more than being unveiling. In economics 101, I learned to chant “correlation is not causation” and with good reason. The chant increases the awareness to separate the two effects, but does not give the tools to do so. Although it does not take an economics degree to know that the rooster’s crow does not cause the sun to rise or that playing basketball does not increase your height, formal training in administering data together with social theory surely helps in solving societal problems of higher complexity. The chant has followed me every step through my research, where I have tried to combine the power of data with solid economic theory, in order to avoid spurious correlations, reverse causalities or formulating theories with no place in the observed world.

All three studies exploit the highly detailed and powerful data available on the Danish population. The possibility to identify each individual and to match information from several registers and surveys over long periods is a luxury many economists only dream of. This data, or what people today might call Big Data, provides excellent ground to seek the causes of the economic problems addressed in this thesis.
Having a huge population can be exploited in two ways. One is to apply general models on the full population to exploit all the statistical power while controlling for a wide range of confounding variables. This is effective for analyzing overall trends, heterogeneity effects, and localizing a high proportion of the variance of the effect in question. Although powerful, it sometimes overlooks the details forming the causal relation between two effects. The other way to exploit the data is to carefully select subsamples that might work as a quasi-natural experiment. Each strategy has its advantages. I have chosen the latter. Common for all three chapters is the strong selection criteria applied to address each research question. I have focused on finding equivalent treatment and control groups, where they are as identical in the main metrics as possible. This allows me to isolate the effect of interest and analyze how it affects the treated and controlled population differently. This tedious selection process comes at a cost. The final sample sizes are significantly reduced after imposing the inclusion criteria, leaving me with less statistical power, which otherwise could have been used to do further heterogeneity tests. The goal of this thesis is to study economic problems using novel empirical identification strategies, which can be re-applied on other, greater or later data. The contribution should therefore be twofold, one is the results and knowledge obtained on Danish data, the other is the methodological precedence.

In chapter 2, I try to compare how parenthood affects the labor market outcomes of men and women differently. Comparing men and women is interesting in many ways. We hold a strong identification in our gender, which is internalized through a vast socialization process. We are divided and categorized as either he or she from an early age, often long before our bodies are aware of this distinction. As in many other aspects, we identify much of our economic outcomes to be affected by the gender we are given (or in some cases, the gender we take). A thorough discussion of this enveloping socialization process is beyond the scope of this thesis and therefore only briefly discussed in the chapters.
“The woman is both Eve and Virgin Mary. She is an idol, a servant, the origin of Life, the power of darkness; she is the elementary silence of Truth, she is artifice, gossip and lies; she is the healer and the sorceress, she is man's prey, she is his ruin, she is everything he is not and wants; his negation and his raison d'être. She is the Other, she is Evil through which Good can exist.”

- Simone de Beauvoir (Les Temp modernes’ 1948)

This quote by de Beauvoir encapsulates some of the ways we think about gender. First, it pinpoints that when comparing genders, it is often from a masculine viewpoint. Women is “the other” while Men is the first, the main, and most of all the default gender. All comparisons made are therefore embedded in this power relation, where women are compared to men and not vice versa. This was the case in 1948, but remains so in many aspects to this day. Especially in questions of labor and household economics, where one of the major objectives is to identify why women do not work as much as men, take different educations than men, work in different sectors than men, followed by the overall question of why women earn less than men. These analyzes are often conducted without noticing that men’s situations is set as the bar, indicating that the man’s way of living is the preferable. In my view, identical earnings between men and women is not the goal in itself, since every woman and every man, or for that matter every person has unique preferences, and the average of that is merely a measure of anybody’s. Preferences changes in time and culture, which makes a universal goal rather meaningless. The question about gender equality often masks other meritocratic determinants for how to conduct our lives. Thus, the true goal of equality for anybody of any gender is to be able to live their lives based on their merits. The foremost job of gender economics must be to unmask what is causing the gender differences in possibilities rather than in outcomes.

Second, de Beauvoir’s quote also states that much is demanded of the women. A women has to be many things at once in order to fulfill her feminine role. She has to be Eve and Virgin Mary. To be “both” rather than “either” also influences the woman’s role as a mother. In chapter 2, I address the trade-off between working and staying at home to take care of the children. In Denmark, we call women who work so hard outside the home that they barely have time for
their children for Ravnemødre (“raven mothers”). It is meant as an insult. The opposite is a Hønemor (“hen mother”), who dotes on her children as a hen dotes on her eggs. This is hardly complimentary, either. In chapter 2, I address the issue of when to have children. For financial reasons, women are told that they are supposed to finish their studies and be well established in the labor market before having children. For biological considerations, women are told not to wait until they are too old, since fertility drops significantly with age. These “kind” suggestions provide a narrow window for when the women are supposed to feel confident in having children. Whatever mothers do, it seems, they are expected to feel guilty about it. It is not my job to decide or judge how mothers should live their lives, but merely to map what determines their course of lives. This is the first step in localizing the societal obstacles that hinder women to live the lives they want.

Third, de Beauvoir articulates the philosophical problem of even comparing the genders. This comparison is more than just an economic exercise and demands strong methodological considerations, for how to compare outcomes of genders on the basis of exactly the gender? Without taking further epistemological considerations, it might end up in a vicious tautological circle. All attempts at explanation depend, whether explicitly or implicitly, on drawing parallels between the thing to be explained and some other thing that we believe we already understand. But the fundamental problem in explaining the experience of gender is that there is nothing remotely like it to compare it with. It is itself so imbedded in all of our experiences. We can never try to be the other – or if we try by changing sex, we can never not have tried to be both, which also separates us from the pure binary experience of biological uniqueness in experience. Phenomenologically it is unique. There is an irresistible temptation for an analytical process to move from uniqueness to its assumed non-existence, since the reality of the unique would have to be captured by concepts that apply to nothing else. Thus comparing men and women is only possible to the extent that we shall never assume the separate genders to become the other. We
can turn to literature and the arts for inspiration where there is a long history of describing a counterfactual world where men are perceived as women or vice versa. Rosalind fooled everybody by her disguise as Ganymede in Shakespeare’s As You Like It. Similar transformations have been made in other stories in order for the woman to gain the privileges of the man (e.g., Dorothea in Don Quixote and Éowyn in Lord of the Rings) and in legendary stories of war heroines (e.g., Jeanne d’Arc and Hua Mulan). This phenomenon also extends to real life where female authors have taken a male alter ego, where Karen Blixen became Isak Dinesen, Mary Ann Evans became George Elliot and Charlotte Brontë became Currer Bell. Fictitious or not, common to all these example is that the women dipped their toes in the pool reserved for the men, only for once again to return to their own pool. The water may have been mixed but the pools still have their assigned gender.

In economics, we analyze the gender on a higher stratum, meaning that we do not necessarily need to understand the depth of the socialization process involved. We often see the genders as zeroes and ones, rather than socialized ideographic identities. This comes at a cost, but enables us to evaluate the difference between the genders on an aggregate level. This is a powerful tool and economics is thus important to identify key gender differences in the societies. Our results should aim at drawing broad conclusions and highlight unfairness based on systematic and nonsensical differences between the genders. In order to do that we ought to forget about the ideographic destinies while conducting our studies, since these would inhibit any form for macro-level social theory or general empirical results. However, it is important that we recall the idea of individualism again, when our results are done and our conclusions are to be made. Alfred Marshall, one of the founding fathers of economics, described the economic doctrine as “not a body of concrete truth, but an engine for the discovery of concrete truth” (Hodgson, 2005).
In Chapter 1 and 2, I show that women bear a high labor market cost of having children, while men do not. This is in line with the long strand of research documenting gender inequality in child penalty. In this light, it may seem like a mystery why any woman would like to have children. Although economists tend to focus on materialized outcomes, it is indeed important to mention the non-quantifiable benefits of having children. Bertrand (2013) finds that the biggest premium to life satisfaction is associated with having a family and that it is much higher than the premium of having a career. Furthermore, working too much and having spent too little time with their family is often one of the biggest regrets among the elderly (Connolly & Zeelenberg, 2002). Thus, one might ask why we evaluate the child penalty as a penalty and not as a life satisfaction premium. Is there a general glorification of the career way of living in the western world and do we obsess too much about our work-life? Maybe it is possible for women to have both career and family, as men have been able to. This raises the question whether a family can master two career-orientated spouses at once. Maybe we are too embedded in the Beckerian terminology or maybe we economists tend to neglect what is not easily quantified? Whereas income is graspable, concepts of satisfaction, contentment and love are not. One question is, if any society or individual can survive even the smartest subordination to the efficiency of love. The other question is, whether we can survive without it.

The French economist Thomas Piketty is afraid that economics has isolated itself and that it should never have sought to divorce itself from the other social sciences (Piketty, 2014). He claims that social sciences collectively know too little to waste time on foolish disciplinary squabbles. If we are to progress in our understanding, we must take a pragmatic approach and avail ourselves of the methods of historians, sociologists, and political scientists as well.

The philosophers of ancient Greece, at the very early stage of what can be categorized as economics, were concerned with life’s most fundamental questions, questions that we still
struggle with to this day. What does it take to live well in a human society? What do people need to be happy and fulfilled? What makes them truly thrive? That is where economics started and, after all it is where it must begin from again.

References:

Chapter 1

Does Early Childbearing Matter?
New Approach Using Danish Register Data
Does Early Childbearing Matter?
New Approach Using Danish Register Data

Philip Rosenbaum*
December 2018

Abstract

Work interruptions related to childbearing are expected to affect mothers' wages directly through changes in the formation of human capital. This effect is proposed as being exceptionally strong for early childbearing women who are about to start their working careers. This study investigates whether the poor long-term labor market outcomes experienced by women who first gave birth before turning 25 reflect previously existing disadvantages or are a consequence of the timing of childbearing. The purpose is also to observe whether a new combination of the best identification practices of earlier studies serves as a better estimation method. This is done by applying a within-family estimator while treating miscarriages as exogenous variation, thereby mitigating family and individual heterogeneity, which might have biased earlier results based on either of the two identification strategies alone. It is found that early childbearing has no long-term effects on women’s earnings.

JEL Codes: I21, J13, J24, J31

Keywords: Fertility, child penalty, female labor outcomes

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1. Introduction

Estimating the causal effect of early childbearing on women’s labor market outcomes is a longstanding challenge for researchers. Early childbearing is often perceived as both a social and an economic problem, creating challenges for both society and the mother in question. There is a widespread belief that early childbearing is negatively correlated with women’s educational attainment, employment prospects, and lifetime earnings. I investigate whether the long-term socioeconomic problems experienced by women who give birth before age 25 reflect already-existing disadvantages or are a consequence of the timing of childbearing. In contrast to common belief, I find no evidence that early childbearing has long-term negative effects on women’s earnings.

To do this, I analyze the full population of Danish mothers in the years from 1980 to 2014. The advantages of the data are threefold. First, the data are register-based, which makes it possible to observe the entire population of Danish mothers to obtain a very large panel. Second, the data include a large number of demographic, educational, income, labor market, and health variables, which makes it possible to control for a large set of important confounding factors. The detailed health registers provide an especially strong advantage to the identification strategy outlined below by distinguishing terminated pregnancies into miscarriages and induced abortions. Third, the administration of the registers’ historical information is highly reliable.

These features make it possible to analyze the impact of early childbearing in a novel way by combining two strong identification strategies, each of them designed to identify causal effects of early childbearing on adult labor market outcomes in different ways. Some previous studies used a within-family estimator to account for family heterogeneity (Geronimus & Korenman, 1992). Others treated miscarriages as an exogenous variation on women’s childbirth timing (Hotz et al., 1997). This paper constructs three samples to compare and implement both strategies and evaluate whether a combination of the two provides better estimates.
The first sample consists of pairs of early and non-early childbearing sisters. The second consists of early childbearing women and non-early childbearing women who were also pregnant early but were forced to delay their first childbirth due to a miscarriage. These samples are constructed to replicate earlier studies and examine whether the same results can be obtained with Danish women. The results for both suggest that early childbearing has a significant negative effect on earnings and educational attainment.

The third sample is a combination of the first two. It consists of early childbearing women and their non-early childbearing sisters who also were pregnant early but delayed their first childbirth due to miscarriage. The negative effects of early childbearing on earnings disappear and the effect on education diminishes substantially when a within-family estimator is applied using sisters who miscarried at an early age.

These results show the advantages of this novel combination of identification strategies, which eliminates the potential biases each strategy faces when applied on its own. Even though sisters share backgrounds, adolescence, and genes, there may remain some unobserved heterogeneity between early childbearing women and their non-early childbearing sisters, as birth timing is highly endogenous to individual features. On the other hand, even though miscarriages are highly random and delay childbirth, they are not entirely unbiased to biological and social features. I incorporate a highly detailed health variable to address the biological bias. Aschraft et al. (2013) showed that socially disadvantaged women have a higher risk of miscarrying even after controlling for health, which suggests that studies using miscarriages for exogenous variation without further controls for family heterogeneities may also biased.

A combination of the two identification strategies addresses these biases. The use of a within-family estimator assures the validity of treating miscarriages as exogenous variation by addressing the heterogeneity in social and family backgrounds between the miscarrying and non-miscarrying women. Together with controlling for the possible negative correlations between
health and miscarriages, this produces a better causal estimate of the effect of early childbearing on adult labor market outcomes.

The main result of this study is that early childbearing has no persistent effect on women’s earnings, which suggests that the inferior earnings of early childbearing women are not due to having children young but to pre-existing disadvantages in ability and social factors. This paper thus makes two contributions. The first is methodological: showing that a combination of earlier practices is a better estimation method. The second is the result for Danish women: that early childbearing does not need to have long-term effects in a country with strong public welfare institutions.

In this study, early childbearing is defined as giving birth to a child before turning 25.\textsuperscript{5} However, the results are robust to different threshold ages and specifications.

The paper proceeds as follows. Section 2 gives a short literature review. Section 3 summarizes the institutional settings. Section 4 outlines the data used in the study. Section 5 explains the econometric strategy. Section 6 presents the results and robustness checks. Finally, Section 7 concludes.

2. Literature Review

Academics face a great challenge in identifying the effects of fertility on labor market outcomes, because career and family planning can rarely be separated and often influence one another. This simultaneity problem is difficult to resolve and casts doubt on the reliability of earlier results based on cross-sectional evidence or individual fixed effects methods.

Leung et al. (2016) showed that Danish women who delay childbirth have higher earnings. This is either due to (i) the child penalty, in which childbirth causes significant disruptions to education and career, leading to lower human capital accumulation and reduced wages; or

\textsuperscript{5} This benchmark age of early childbearing is discussed thoroughly in Section 4.
(ii) selection, in which early childbearing women are inherently different from later childbearing women and would not have performed as well in the labor market whenever they gave birth.

Childbirths have in general been found to be costly for women. Just as the “gender gap” describes the discrepancy between male and female wages, the “family gap” refers to the discrepancy between mothers’ and non-mothers’ earnings. Becker’s household production theory (1965) claims that the opportunity cost of working increases after having a child, and as a result effort and productivity in the workplace decrease. The family gap has been confirmed repeatedly in empirical studies. Goldin (2014) and Blau and Kahn (2017), among others, found large wage loses associated with motherhood in the U.S.A. The same has been found in Germany (Adda et al., 2017; Schönberg & Ludsteck, 2014; Ejrnæs & Kunze, 2013), France (Wilner, 2016; Coudin et al., 2018), Canada (Phipps et al., 2001), and even the relatively gender-equal Scandinavian countries (Light & Ureta, 1995; Simonsen & Skipper, 2006; Angelov et al., 2016; and Kleven et al., 2018). Although the gap has narrowed, it is still significant in most countries (Kleven & Landais, 2017).

The timing of childbearing may have several direct and indirect effects. An early drop in human capital investment—whether a result of interruptions to education or to work—has been shown to have long-term negative effects in the labor market (Gerster et al., 2014). This results in a self-reinforcing spiral of lower employment and slower human capital build-up, resulting in an inferior career path (Mincer & Ofek, 1982; Baum, 2002). People who miss or disrupt good opportunities early in their careers can be locked into poor career paths (Mroz & Savage, 2006; Bell & Blanchflower, 2011).

Alternatively, the timing of first childbirth can be seen as an indicator of women’s endowed human capital. By reversing the causality, we can see the timing of first childbirth as an economic marker of women’s labor productivity and preferences regarding working careers. For example,

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the price of their time is lower than that of highly productive women, which Gronau (1974) dubbed the “shadow-price” of early childbearing.

The empirical literature contains ambiguous results on whether the child penalty is bigger for early childbearing women. Depending on the statistical approach and the age that defines early childbearing, the estimated effects range from big to almost zero. There is a vast range of empirical studies on teenage motherhood. The earliest cross-sectional studies found large negative effects of teenage childbearing (e.g., Card & Wise, 1978). A stream of sister studies found reduced but still significant negative effects on labor and educational outcomes (Geronimus & Korenman, 1992; Hoffman et al., 1993, on US data; and Holmlund, 2005, on Swedish data). Hotz et al. (1997 and 2005) were the first to use miscarriages as an instrument to study the effects of delaying age at first birth. They found negative short-term effects of teenage childbearing but insignificant or small positive long-term effects for some outcome variables using U.S. data. Other studies using miscarriages as an instrument for birth timing have tended to estimate modest effects of teenage childbearing on women’s subsequent education and earnings (Ashcraft et al., 2013; Fletcher & Wolfe, 2009; and Ermisch, 2003, and Goodman et al., 2004, on English surveys). Other identification strategies have been used to elicit the causal effect of childbirth timing: Ribar (1994) used age at menarche and found nonexistent or adverse effects of teenage childbearing on high school completion, whereas Klepinger et al. (1999) found significant reduction in years of education and subsequent earnings, both of them using the same strategy on U.S. data. Using propensity-score matching with different weights has also been popular, often showing negative effects of teenage childbearing (Diaz & Fiel, 2016; Chevalier & Vittanen, 2003). Levine and Painter (2003) used within-school propensity-score matching and found that a large part of the disadvantage teenage mothers face in high school completion is due to previously existing disadvantages, not to the childbirth itself.

Delaying motherhood can be beneficial in adolescence but also later in life. A smaller set of
studies have analyzed the effects of delayed motherhood among older women. Hofferth (1984) used cross-sectional methods on U.S. data and found positive results of delay. Albrecht et al. (1999) and Taniguchi (1999) found similar results by applying longitudinal methods to Swedish and U.S. data, respectively. Miller’s (2011) study was the most recent to exploit miscarriages as exogenous variation and found that delayed motherhood led to substantial increases in earnings for American women. Other creative identification strategies have been used in this literature: Cristia (2008) used variation in pregnancy outcomes due to fertility treatment and found increased employment for American women who delayed due to unsuccessful fertility treatment. Molland (2016) used abortion availability to study fertility delay in Norway and found a positive effect of delay on educational attainment. Wilde et al. (2010) criticized the instruments used in earlier studies, questioning both measurement errors and the validity of the exogeneity when using time-varying instruments; they instead used events occurring in early age and the characteristics of parents, but still found positive effects of delayed childbirth. Fitzenberger et al. (2013) also questioned the non-dynamic approach of earlier studies and used an explicit dynamic-treatment approach on German data. Arguing that non-treated individuals today may be treated in the near future and incorporating these dynamics into their study, they found significant evidence of lost employment due to becoming a mother. The effect was particularly pronounced for the medium-skilled. Herr (2016) also addressed the heterogeneity in the effect by skill set, comparing women with the same educational levels who differed in having a child before or after entering the labor market. Herr (2016) argued that estimates based on age understate the return on delayed motherhood for women who are still childless at labor market entry. Diaz and Fiel (2016) claimed that the consequences of early motherhood are heterogeneous and vary greatly by socioeconomic background.7

Ambiguous predictions can be drawn from these alternative theories and findings. Some

7 Other studies have suggested that the responsibilities of motherhood could even serve as a positive turning point in the lives of troubled youth (Brubaker & Wright, 2006; Edin & Kefalas, 2005).
offer reasons to believe that early childbearing mothers can encounter substantial short- and long-term difficulties in the labor market, while others claim that the observed child penalty is due to selection rather than the timing of first childbirth.

3. Institutional Settings

Denmark has a strong welfare state of the Scandinavian model, which combines considerable redistribution through high taxes with generous family policies intended to support the female labor supply, among other inequality-depleting objectives. Public childcare is universal and heavily subsidized from around 6 to 12 months after birth. Universal job-protected and paid maternal leave is provided until the child reaches the age at which public childcare is available. Mothers who have a child during their studies are also supported, both with extended time to complete their degrees and by receiving double the universal government student stipend for a year.⁸ In addition, all parents who live with their children are eligible for supplementary child support from their local municipalities. The support starts when the child is born and ends when the child turns 18.⁹ Although parents are not fully compensated for the direct costs of raising a child, these fees are non-trivial, especially for the lowest earners. The opportunity costs of early motherhood in a Scandinavian welfare state model are thus expected to be low relative to countries whose institutional settings provide fewer social benefits and higher returns on human capital investments. Nonetheless, as mentioned in the previous section, studies in a Scandinavian context have still found non-trivial educational and labor market penalties for early childbearing women (e.g. Leung, 2016; Holmlund, 2005; Albrecht et al., 1999; and Mølland, 2016). It is therefore an ongoing puzzle whether the effect of early childbearing on labor market outcomes is

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⁸ All students enrolled in tertiary educations get a monthly fee transferred from the public system. In 2018 this fee was DKK 6,018 a month.

⁹ The fee in 2018 is around DKK 4,500 a month when the child is an infant and declines through adolescence, ending around 1,000 a month when the child is a teenager. Furthermore, if either parent is eligible for social welfare, parents living with the child about half the time receive extra child supplements. The rules and fees have changed several times, but the basic principles have remained the same.
caused by the timing of childbearing or selection, even in the Scandinavian countries.

4. Data

I use the Danish administrative register data, covering the full population of Danish mothers in the years from 1980 to 2014. These data are provided by Statistics Denmark and include many different registers. I use registers with annual information on socioeconomic variables (e.g., age, gender, education), income (yearly income, earnings, and a crude measure of wage rates), employment status (e.g., employed, self-employed, unemployed), and family identifiers. The parents in the sample are connected with their children through family links and personal identification numbers.

For the final population, I can observe each individual’s family situation, number and gender of children, age, and marital status. I exclude individuals whose datasets are incomplete in any of these metrics. All monetary values are converted in real terms to year-2014 price levels using the Danish Consumer Price Index, obtained from Danish National Accounts.

Central to this study are the special health data provided by the Danish National Patient Register, which holds records of every individual patient’s contacts with Danish Secondary Health Care from 1977. The data include detailed descriptions of all contacts with the health services, including diagnoses. In this study, all pregnancies are investigated and categorized as either completed or aborted. The ability to distinguish between intentionally and unintentionally terminated pregnancies (abortions and miscarriages, respectively) is essential to this study. Unspecified diagnoses are excluded.

I construct three samples. The first consists of sister pairs of early and non-early childbearing sisters; early childbearing is defined as giving birth before turning 25. The second

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10 The data are anonymized for privacy by Statistics Denmark. The family links and variables are pulled from the FABE register up until 1986 and from the BEF register thereafter.

11 All diagnoses are reported in the International Classification of Diseases (ICD) system. The use of the Danish National Patient Register serves as a non-subjective measure of the women’s health levels, as opposed to surveys.
consists of women who gave birth before turning 25 and women who did not but who were pregnant before turning 25, suffered a miscarriage, and were forced to postpone their first childbirth until after 25. Women in the last group who had induced abortions after their miscarriage but before turning 25 are excluded from the second sample, thereby removing women who clearly wished to postpone motherhood. The third sample is a combination of the first two. It consists of women who gave birth before turning 25 and their non-early childbearing sisters, who were pregnant before turning 25, but suffered a miscarriage and, were forced to postpone their first childbirth until after 25. Sisters who had induced abortions after their miscarriage but before turning 25 are also excluded from sample 3. For comparability, I select only women who do become mothers before turning 40. In some families, more than two sisters meet the inclusion criteria.

For some families more than two sisters meet the inclusion criteria. This leaves me with 34,784 families in sample 1 (S1), with 36,093 early childbearing mothers and 37,042 non-early childbearing mothers. For sample 2 (S2), in which I do not restrict the mothers to being sisters but do require the non-early childbearing mothers to have had an early miscarriage, there are 123,825 early childbearing mothers and 4,880 non-early childbearing mothers. After the very stringent inclusion criteria of sample 3 (S3) are imposed, the sample size diminishes to 938 families, with 1,076 early childbearing mothers and 938 non-early childbearing mothers. Despite these strict inclusion criteria, the final samples are large in comparison with other studies on early childbearing that use within-family models or estimation methods treating miscarriages as exogenous variation.

Defining young mothers

I define first-time mothers aged 24 or younger as early childbearing in this study. In general,

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12 This also include women who adopt. Adoptions account for less than 1% of the total fertility.
13 Geronimus & Korenman (1992) used three different panel data sets, containing, respectively, 129, 182, and 223 sister pairs. Hotz et al. (2005) had 1,042 women with early pregnancies, but only 72 of these ended in miscarriage.
Danish women have children relatively late in life, with first-time mothers being older than 29 on average. The U.K. and U.S. have the highest proportions of teenage mothers among Western countries, and Denmark has one of the lowest. In 1995, the teen birth rate in Denmark was 0.83%, while it was 2.84% and 5.44% in England/Wales and the U.S. respectively (Sedgh et al. 2014). In the mid-1990s, the proportion of Danish women giving birth to their first child before turning 25 was lower than the proportion of American women giving birth to their first child before turning 20 (National Vital Service).

Having children while studying can be extremely demanding and may lead to lower educational attainment and lower adult wages. Danes finish school at a relatively high age; whereas the majority of British women graduating from their tertiary education are in their early twenties, most Danish women are in their late twenties.14

Previous studies using Scandinavian data have also defined early childbearing as having a child before the age of 25 (Jacobsen, 2010; Duus, 2007; Jørgensen et al., 2013; Leung et al., 2016, on Danish data; and Olausson et al., 2011, on Swedish data). Lastly, Danish public policy often uses 25 as the upper threshold for being a young mother.15

Figure 1 shows the distribution of the age at first childbirth for the relevant cohorts in Denmark. Twenty-three percent of Danish mothers are early childbearing mothers, defined as giving birth before turning 25.

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14 The relatively high graduation age could be a consequence of different societal and cultural influences. Education is free of charge in Denmark, and all students are financially supported by the government with a monthly stipend of about DKK 6,000. It is also normal to take a gap year after high school and to work while taking tertiary education. Together, these factors relieve the financial pressure of rushing through studies. See Table A1 and A2 in the appendix for details on graduation ages in Denmark as compared to the U.K.

15 So does the major private aid organization for Danish mothers, Mothers Aid. See for example the Annual Report 2013 of Mothers Aid (in Danish, Mødrehjælpen).
Figure 1 - Age at First Childbirth for Women Born in 1967

Note. The graph shows the distribution of age at first birth for women in the 1967-cohort. 1967 is the average year of birth for the women of this study.

Main Variables

The three main outcome variables in this study are (i) yearly earnings, (ii) adult earnings, and (iii) educational attainment. Yearly earnings consists of all labor earnings in a given year. Adult earnings is aggregated labor earnings from age 25 to 40, the longest I could follow the individual mothers in the data. Educational attainment is the length of education in years, from entering elementary school to finishing the highest-ranked education program. It can take years for women's work lives to balance after childbirth, which is why I use measures capturing both dynamic and cumulative labor earnings. Most studies have focused on the penalties to yearly earnings at a certain age, and a few have looked at cumulative earnings penalties over time.

Table 1 shows summary statistics for the main variables and variables for educational level, wage rate, labor participation, year of birth, average number of diagnoses in adolescence, and parental educational level. The time-invariant variables are shown at age 40. The wage rate is the

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16 The yearly earnings are pulled from the IND (income) register from Statistics Denmark. The variable used is LOENMV, which consists of all labor income, fringe benefits, other tax-free income, employee bonuses, and realizations of stock options (https://www.dst.dk/da/Statistik/dokumentation/Times/personindkomst/loenmv).

17 The ranking is as follows: primary and lower-secondary school (9–10 years of schooling mandatory for all Danes), high school (upper secondary school, which is optional and takes 3 years), vocational education (an alternative to high school with a typical duration of 3 years), short academy profession post-high school programs (with a maximum duration of 2 years). Undergraduate degree programs are 3- to 3.5-year post-high school professional, bachelor, and undergraduate programs (academic bachelor's programs). Master's and PhD programs are university graduate programs; a master's degree takes 2 years (on top of the 3 years for the undergraduate degree), and a PhD requires an additional 3 years. The education levels and lengths are pulled from Statistics Denmark’s Educational Register (UDDA), and the variables used to create educational length are HFPR1A and HFAUUD.
hourly wage estimated by Statistics Denmark. Labor participation is a dummy taking the value 1 if the woman had any labor earnings in a given year and 0 otherwise. The table shows that the mothers of sample 1 are in general better off with regard to the measures of labor earnings and education, followed by the mothers in sample 2, and the mothers in sample 3 are worst off. There are significant within-sample differences between the early and non-early childbearing mothers in samples 1 and 2, with the early childbearing sister being worse off in every variable. This within-sample difference disappears in sample 3 for most variables. One of the exceptions is the educational level and length, where the non-early childbearing sisters are doing better, although the differences are smaller than in sample 1 and 2. The non-early childbearing sisters have 0.72, 0.78, and 0.38 years longer education on average than the early childbearing mothers in Sample 1, 2, and 3, respectively.

The other significant difference between sisters in sample 3 is in the health variable, which is the women’s average number of diagnoses per year in adolescence (ages 12–18). All diagnoses relating to pregnancy, birth, and fertility treatment are excluded in order not to bias the variable with pregnancy-related health problems. The mean value of this health variable across the samples is shown in Table 1. In general, there are no extreme differences among sisters, but unsurprisingly the non-early childbearing mothers in sample 2 and 3 have the most diagnoses. Lastly, the table also shows that the mothers in sample 3 come from the least educated backgrounds, with their parents having lower educational attainment than those of the mothers in sample 2 or in sample 1, which has the best-educated parents. The big difference between the early and non-early childbearing mothers in sample 2 indicates that it is important to control for family background, either by including parental education in the regressions or differencing it out.

Although wage rate is an appealing measure of productivity, the wage rate provided by Statistics Denmark is only estimated on the basis of several metrics, and is not a directly observed hourly wage. The variable is TIMELON, pulled from the IDA register up to 2007 and from the LONN register from then on. I only include the observables indicated as high quality or marked as highly reliable (TLONKVAL < 40). Only a subset of about 70% have usable hourly wage estimates after cleansing and quality-proving the variable, which is why this is not used as a main variable in this study.
in a family fixed effect model.

### Table 1 - Summary Statistics by Sample and Childbearing Timing

<table>
<thead>
<tr>
<th>Sample</th>
<th>1NEC</th>
<th>2NEC</th>
<th>3NEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Sample 1</td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>2</td>
<td>(4)</td>
<td>(5)</td>
<td>(6)</td>
</tr>
<tr>
<td>3</td>
<td>(7)</td>
<td>(8)</td>
<td>(9)</td>
</tr>
<tr>
<td><strong>Log(Adult earnings)</strong></td>
<td>14.80</td>
<td>14.59</td>
<td>0.21***</td>
</tr>
<tr>
<td></td>
<td>(0.82)</td>
<td>(1.02)</td>
<td>(1.02)</td>
</tr>
<tr>
<td><strong>Education Length</strong></td>
<td>13.12</td>
<td>12.39</td>
<td>0.72***</td>
</tr>
<tr>
<td></td>
<td>(2.13)</td>
<td>(2.18)</td>
<td>(2.23)</td>
</tr>
<tr>
<td><strong>Primary and Secondary Education</strong></td>
<td>0.20</td>
<td>0.29</td>
<td>-0.09***</td>
</tr>
<tr>
<td></td>
<td>(0.40)</td>
<td>(0.45)</td>
<td>(0.41)</td>
</tr>
<tr>
<td><strong>Vocational Education</strong></td>
<td>0.45</td>
<td>0.48</td>
<td>-0.03***</td>
</tr>
<tr>
<td></td>
<td>(0.50)</td>
<td>(0.50)</td>
<td>(0.50)</td>
</tr>
<tr>
<td><strong>Tertiary Education</strong></td>
<td>0.35</td>
<td>0.23</td>
<td>0.12***</td>
</tr>
<tr>
<td></td>
<td>(0.48)</td>
<td>(0.42)</td>
<td>(0.47)</td>
</tr>
<tr>
<td><strong>Yearly Earnings</strong></td>
<td>269,761.6</td>
<td>249,410.0</td>
<td>20,351.6***</td>
</tr>
<tr>
<td></td>
<td>(155,496.3)</td>
<td>(153,075.1)</td>
<td>(161,809.8)</td>
</tr>
<tr>
<td><strong>Wage Rate</strong></td>
<td>186.39</td>
<td>172.82</td>
<td>13.58***</td>
</tr>
<tr>
<td></td>
<td>(62.44)</td>
<td>(55.27)</td>
<td>(63.56)</td>
</tr>
<tr>
<td><strong>Labor Participation</strong></td>
<td>0.90</td>
<td>0.87</td>
<td>0.02***</td>
</tr>
<tr>
<td></td>
<td>(0.30)</td>
<td>(0.33)</td>
<td>(0.34)</td>
</tr>
<tr>
<td><strong>Age at first Birth</strong></td>
<td>28.92</td>
<td>22.02</td>
<td>6.91**</td>
</tr>
<tr>
<td></td>
<td>(3.65)</td>
<td>(1.82)</td>
<td>(3.23)</td>
</tr>
<tr>
<td><strong>Birth Year</strong></td>
<td>1967.74</td>
<td>1966.77</td>
<td>0.97***</td>
</tr>
<tr>
<td></td>
<td>(4.48)</td>
<td>(4.42)</td>
<td>(4.64)</td>
</tr>
<tr>
<td><strong>Diagnoses</strong></td>
<td>0.25</td>
<td>0.26</td>
<td>-0.005***</td>
</tr>
<tr>
<td></td>
<td>(0.48)</td>
<td>(0.51)</td>
<td>(0.54)</td>
</tr>
<tr>
<td><strong>Mother's Education</strong></td>
<td>10.08</td>
<td>9.39</td>
<td>0.69**</td>
</tr>
<tr>
<td></td>
<td>(3.16)</td>
<td>(2.90)</td>
<td>(3.16)</td>
</tr>
<tr>
<td><strong>Father's Education</strong></td>
<td>10.56</td>
<td>10.48</td>
<td>0.07***</td>
</tr>
<tr>
<td></td>
<td>(3.34)</td>
<td>(3.32)</td>
<td>(3.40)</td>
</tr>
<tr>
<td><strong>Observations</strong></td>
<td>37,042</td>
<td>36,993</td>
<td>11,318</td>
</tr>
</tbody>
</table>

Note. 1EC and 1NEC are the early and non-early childbearing sisters in sample 1. 2EC and 2NEC are the early and non-early childbearing mothers in sample 2. 3EC and 3NEC are the early and non-early childbearing sisters in sample 3. Log(Adult Earnings) is the natural logarithm of the labor earnings from ages 25 to 40. Education Length is the years of the education from entering elementary school to finishing the highest ranked education. Primary and Secondary Education is a dummy indicating if the highest obtained education is either elementary or high school. Vocational Education is a dummy indicating if the highest obtained education is vocational training. Tertiary Education is a dummy indicating if the highest obtained education is any tertiary education, such as short cycle, medium cycle, bachelor, master or doctoral degrees. These three categories are mutually exclusive. Yearly Earnings consists of all labor earnings at age 40. Wage Rate is the hourly wage at age 40. The observation numbers for this variable is lower since wage rates are only recorded for a subsample of the working population: 27,543; 25,919; 3,504; 86,449; 636; and 731 observations for 1NEC, 1EC, 2NEC, 2EC, 3NEC, and 3EC, respectively. Labor Participation is a dummy taking the value 1 if the women have any labor earnings in the given year. Diagnoses is the average number of diagnoses per year excluding all pregnancy related diagnoses. Mother's and Father's Education is the educational length of the sample women's parents – the small differences in the fathers' education length between the sisters in sample 1 and 3 are due to the few sisters with different fathers. The observation number for the father's education is also lower since some of the fathers' education length are not available: 34,271; 33074; 842; and 968 observations for 1NEC, 1EC, 3NEC and 3EC. There are none-missing for S2, since it is a control variable used in the regressions on this sample are women with missing information on their father's education excluded. Monetary values are translated into year-2014 DKK using the Consumer Price Index from the Danish National Accounts. 1DKK≈0.13€. T-test for the difference in means between the early and non-early childbearing within the sample are shown at significant levels: *p<0.10, **p<0.05, ***p<0.01.

## 5. Empirical Strategy

My goal is to estimate the causal effect of early childbearing on women’s labor market outcome and educational attainment against the alternative of waiting. The first step in identifying this effect is to control for observable factors associated with both alternatives. One approach is to
estimate the parameters in the following equation:

\begin{equation}
 y_{ijt} = \gamma EC_{ij} + X'_{ijt} \beta_1 + F'_{ij} \beta_2 + \delta Year_t + a_j + \delta_{ij} + \mu_{ijt},
\end{equation}

where $y_{ijt}$ is the outcome variable of interest for individual $i$ in family $j$ at time $t$, whether it is the natural logarithm of adult earnings, yearly earnings, or educational length. $EC$ is a dummy indicating early childbearing. $\gamma$ is the coefficient of interest, estimating the effect of early childbearing. $X$ is a vector of observable family- and individual-variant variables, such as the woman’s age, number of diagnoses, and birth order. $F_j$ is a vector of observable family-invariant variables: immigration status and parental education level. $Year$ is a year dummy included to absorb time effects common to all women. Let $\delta$ be the individual unobservable heterogeneity and $a$ be the unobserved family heterogeneity, which is the same for all members of the same family – for example, parental involvement and social background. Cross-sectional models produce biased estimates if $EC$ is correlated with the error term $\varepsilon$, as a result of omitted variables or reverse causality. Women may have differing priorities for family and career that lead some of them to both invest less effort in work and begin childbearing sooner. Further bias arises if women’s fertility timing is responsive to actual or anticipated career outcomes. If women with higher earnings potential postpone motherhood in order to reduce the financial penalty, the cross-sectional estimates will overestimate the benefits of postponing childbearing.

For my first approach, I follow Geronimus and Korenman (1992) and apply a within-family estimator to remove any family heterogeneity. This method compares sisters, one of whom is early childbearing and the other not. By taking the family averages, (2), and then subtracting it from the individual levels, (3), both the observed, $F$, and unobserved, $a$, family characteristics are removed from the model, (4). The idea is that after the heterogeneity that comes from the women’s social background is removed, the remaining differences between the

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19 Some studies have proposed that parental involvement actually differs between their children. Hence, the parents are more involved in their first born than in the rest of their children. This phenomenon will be discussed in details later.
sisters’ outcomes should be due to the difference in their age at first childbirth. The equations below show the within-family transformation of the family fixed effects estimator:

\[ y_{jt} = \alpha_j + \delta_j + \gamma E_{ij} + X_{ij}\beta_1 + F_{ij}\beta_2 + \delta \text{Year}_{ij} + \epsilon_j \]

\[ y_{jt} - F_{jt} = (\alpha_j - \alpha_i) + (\delta_j - \delta_i) + \gamma (E_{ij} - E_{ij}) + (X_{ij} - X_{ij})\beta_1 + (F_{ij} - F_{ij})\beta_2 + \delta (\text{Year}_{ij} - \text{Year}_{ij}) + (\epsilon_j - \epsilon_i) \]

\[ y_{jt} - F_{jt} = (\theta_j - \delta_j) + \gamma (E_{ij} - E_{ij}) + (X_{ij} - X_{ij})\beta_1 + (F_{ij} - F_{ij})\beta_2 + \delta (\text{Year}_{ij} - \text{Year}_{ij}) + (\epsilon_j - \epsilon_i) \]

The family fixed effects model requires strict exogeneity within each family to be unbiased, which implies that early childbearing should be random among sisters, conditionally on \( X \). Individual heterogeneities between the sisters certainly still exist and may be correlated both with likelihood of early childbearing and with labor market outcomes. This problem can be partially resolved by controlling for pre-childbearing observables. Unobserved individual heterogeneities between the sisters, such as abilities and priorities for family and career, may still bias the estimator if no further measures are taken.

For my second approach, I follow Hotz et al. (1997) and exploit miscarriages as exogenous variation in timing of childbearing. There should not be any pre-pregnancy life-planning differences between the miscarrying and the non-miscarrying women, because all of them were pregnant with no evident intention of terminating the pregnancy. This addresses the selection problems between the early and non-early childbearing women.

Although miscarriages are perceived as highly random, three concerns must be raised: (i) Miscarriages may adversely affect the women psychologically. This could lead to later labor market effects if the miscarrying women suffer from longer spells of depression. Regan (2001) found that severe psychological effects of miscarrying predominantly affect women who experience recurrent miscarriages, which he estimates to be less than 1% of women. It is therefore doubtful that this effect will bias the results. (ii) Women with poor health and risky behavior during pregnancy may be more likely to miscarry. Both of these factors are also correlated with women’s labor market outcomes. Individuals with health problems generally
perform worse in the labor market (Smith, 2009). This makes it difficult to separate differences in labor market performance due to miscarriage from those due to poor health. Although I cannot observe the pregnant women’s behavior, medical evidence does not support a strong impact of behavioral factors on risk of miscarriage (Merck, 1999). To address the health concern, I apply a control variable that captures the systematic health differences between the sisters, explained in detail in section 3. (iii) Ashcraft et al. (2013) and Fletcher and Wolfe (2009) found that even if miscarriages are biologically random, they are not socially random. Women from more disadvantaged backgrounds have a higher probability of miscarrying even after health differences are controlled for.

Finally, I combine the two approaches and estimate the effect of early childbearing on women’s adult earnings, yearly earnings and educational attainment by applying a within-family estimator and using sisters who postponed childbearing due to miscarriage. This strategy has the advantages of both strategies and also exhibits significant synergistic effects when the two are applied together. While miscarriages serve as an exogenous variation in timing of childbearing, addressing most of the selection issues, the within-family estimator addresses the bias due to family and social heterogeneities, which might affect both childbearing timing and the social bias in miscarriages. Lastly, I use controls for the sisters’ health and birth orders to address possible biases due to biological heterogeneities in miscarriages and intra-family biases, respectively.

To implement the three identification strategies, I construct three samples, described in detail in section 3. I apply the standard family fixed-effects model on sample 1, with additional controls for health, birth order, and year dummies. On sample 2, I apply an OLS regression in which members of the control group were all pregnant before age 25 but miscarried and thus postponed childbearing until after turning 25, while also controlling for health, birth order, and

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20 Chatenoud et al. (1998), George et al. (2006), and Venners et al. (2004) found mixed results on the impact of smoking on pregnancy losses.

21 This strategy is an extension of my previous work presented in my Master Thesis (Rosenbaum, 2014).

year dummies. For this sample, I also control for the observed time-invariant family variables such as parental education level and being immigrants. On sample 3, I apply the family fixed effects model, conditioning it so that the control sister was pregnant before 25 but miscarried and thus postponed childbearing until after turning 25, while also controlling for health, birth order, and year dummies.

**Visual Evidence**

To evaluate the common trend assumption and the strength of treating miscarriages as exogenous variation, I reorganize the panel as an event study to show the exact timing of the labor market divergence between early and non-early childbearing mothers. I define the event $t_0$ as the age at first birth for the early childbearing mother and as the age at miscarriage for the non-early childbearing mother. Since the non-early childbearing sisters in sample 1 do not have a natural event benchmark, the early childbearing sister’s age at first birth is defined as the event, $t_0$, for all sisters in the family. I follow the women from $t_0-5$ to $t_0+16$.

The panels in figure 2 show a high degree of common trend up until $t_{0.1}$ for the early and non-early childbearing women in sample 2 and 3, indicating similar labor, educational, and marital trajectories. The figure shows that there are bigger pre-event differences within sample 1, where fewer non-early childbearing sisters are married and more are undertaking an education. Panel A shows that the trajectories in yearly earnings are similar before the event but diverge at that time: the early childbearing mother falls behind just after the event for all samples. The gap between the early childbearing and non-early childbearing mothers then persists through the time series for sample 1 and 2, but it narrows and almost disappears for sample 3. The trajectories are similar for labor participation, shown in Panel C.

The trends are in fact also similar when looking at panel C, where the ratio of women who

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23 Immigrant is defined as a dummy equal to 1 if the mother is a first- or second-generation immigrant.

24 If the non-early childbearing woman had multiple miscarriages, I use the last one before age 25 as the event.
are either married or in cohabiting relationships is depicted. The pre-event gap in married women is much larger in sample 1 compared to sample 2 and 3. Lastly, panel D shows the ratio of women under education, defined as not having completed their highest educational attainment. This panel shows similar trends for all women and does not indicate any drastic change in pursuing education due to having or expecting to have a child. One small difference remains, the panel shows that the non-early childbearing women in sample 1 are pursuing education for a bit longer than the rest of the women. Altogether, this is in line with the prediction that there would be less pre-pregnancy differences between the miscarrying and the non-miscarrying women, because all of them were pregnant with no evident intention of terminating the pregnancy. This suggests that treating miscarriage as exogenous variation addresses the possible pre-birth heterogeneities between the mothers.

\[25^\text{This may be due to Danish institutional settings, where education is free and students are subsidized with a monthly transfer from the government of around DKK 6,000 while undertaking any tertiary education. The consequences of the specific Danish institutional settings will be discussed in the next section.}\]
Figure 2 – Time Trends, Crude Means by Sample and Early Childbearing

Panel A. Yearly Earnings
Panel B. Labor Participation
Panel C. Marriage
Panel D. Under Education

Note. The figures show the crude means around the event from t-5 to t+16 of the early and non-early childbearing women in Yearly Earnings (panel A), Labor Participation (panel B), Marital Status (panel C), and being in Education (panel D). The event is defined as the age of first birth for the early childbearing mother and as the age of the miscarriage for the non-early childbearing mother. For Sample 1 the early childbearing sister’s age at first birth is defined as the event for all sisters in the family. Labor Participation is a dummy taking the value 1 if the women have any labor earnings in the given year. Marriage is defined as either marriage by law or being in a cohabiting relationship. Under Education is defined as not having completed their highest educational attainment. Monetary values are translated into year 2014 DKK using the Consumer Price Index from the Danish National Accounts. 1DKK≈0.13€.
Amenability to Generalization: Global or Local Treatment Effect?

Ideally, the sample selection process of this study provides a universe in which the only systematic difference between the sisters is the timing of their first births. This is done by imposing strict inclusion criteria and thus focusing on the few specific women who are very much alike. Murphy (2005) argued that the number of early pregnancies in a family is correlated with poor socioeconomic status, indicating that the estimates obtained on the basis of the samples might be interpreted as a local treatment effect that does not account for the entire population of early childbearing mothers. On the other hand, the majority of early childbearing mothers come from economically disadvantaged backgrounds in the first place, which suggests that this study is relevant for most of the cases.

6. Results

The main outcome variables of this study are yearly earnings, the natural logarithm of adult earnings, and educational attainment. As shown in the summary statistics and in the time-trends panels of figure 2, there are significant differences in earnings and educational attainments within and across the samples. For sample 3, the within sister differences are smaller and the gap in yearly earnings diminishes over time. Table 2 shows the results on adult earnings and educational length at age 40 for the women from all three samples. In these regressions, I only include non-early childbearing related controls to get the total effect of early childbearing on the outcome variables. That is controlling for health and birth order, while also controlling for parental education and immigration status when applying the non-sister sample 2. For sample 1, the family fixed effects results show that early childbearing before age 25 lowers the women’s adult earnings from age 25 to 40 significantly, by 18.4%, in comparison to their non-early childbearing sisters. This implies that early childbearing imposes a substantial earnings penalty even after family heterogeneities are controlled for. The results also show that early childbearing is
associated with lower educational attainment by 0.62 years. For sample 2, the estimated cost of early childbearing is reduced to 9% for adult earnings and to 0.59 years for educational length.\textsuperscript{26}

However, the results from sample 3 show that early childbearing does not have any significant impact on adult earnings, with a point estimate close to zero. It also produces a reduced though still significant estimate of 0.29 years for the penalty of early childbearing on the education length.

This shows that there is a big difference between applying the two methods separately and together to estimate the early childbearing effect. The combined method addresses the unobserved individual and social heterogeneities better, which may indicate bias in the results of the first two methods. The standard family fixed effects model and the use of miscarriages as exogenous variation alone may overestimate the negative consequences of early childbearing.

The coefficients for \textit{Diagnoses} are negative, large, and significant for the regression outputs of all three samples, which shows the size of the effect of health on earnings and educational attainment. Together with the fact that health is (weakly) negatively correlated with the non-early childbearing mothers of samples 2 and 3, this indicates that omitting health controls can lead to bias in estimates when miscarriages are used for exogenous variation. The negative effect of early childbearing decreases a little when the health variable is excluded, but the difference is insignificant.\textsuperscript{27} Overall, the results are consistent with the predictions.\textsuperscript{28}

\textsuperscript{26} In untabulated regressions, I include controls correlated with the timing of early childbearing, such as the women’s educational level, total number of children and marital status at age 40. The estimates of the early childbearing coefficient is then a measure of the partial effect of early childbearing on adult earnings and educational level. The partial effect is significant lower, but remains negative at 7% and 5% on adult earnings for sample 1 and 2, respectively. The estimates for educational length stay intact at 7.5 months and 7 months negatively for sample 1 and 2, respectively. For sample 3, the partial effect of early childbearing on adult earnings are now positive but insignificant at 1%, while it is negative and significant at 2 months of education. These regressions should be interpreted with caution, since the post-birth controls are highly endogenous to the early childbearing variable.

\textsuperscript{27} Even though I control for the women’s health, concerns remain about how to specify the health variable optimally. A good control variable must capture the important health differences between the sisters, i.e. the factors that are highly correlated with labor market outcomes. The health variable is the yearly average number of non-pregnancy-related diagnoses. Some diagnoses might be more relevant than others however. Although this variable weighs all diagnoses evenly, it does capture the most important variations. Serious illnesses such as cancer are often complex and involve several diagnoses, which is captured in the health variable.

\textsuperscript{28} Applying a threshold age for early childbearing has advantages, but it does not exploit all the variations in the data.
<table>
<thead>
<tr>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Sample 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log(Adult Earnings)</td>
<td>Education</td>
<td>Log(Adult Earnings)</td>
</tr>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>Early Childbearing (EC)</td>
<td>-0.1838***</td>
<td>-0.6173***</td>
</tr>
<tr>
<td>Diagnoses</td>
<td>-0.0957***</td>
<td>-0.1351***</td>
</tr>
<tr>
<td>Birth order</td>
<td>0.0074</td>
<td>0.1775***</td>
</tr>
<tr>
<td>Father's Education</td>
<td>0.0190***</td>
<td>0.0861***</td>
</tr>
<tr>
<td>Mother's Education</td>
<td>0.0286***</td>
<td>0.1504***</td>
</tr>
<tr>
<td>Immigrant</td>
<td>-0.4533***</td>
<td>-0.8228***</td>
</tr>
<tr>
<td>Year Dummies</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Individual Obs.</td>
<td>73,135</td>
<td>73,135</td>
</tr>
<tr>
<td>Group Obs.</td>
<td>32,588</td>
<td>32,588</td>
</tr>
<tr>
<td>R^2</td>
<td>0.022</td>
<td>0.050</td>
</tr>
</tbody>
</table>

Note. Column (1), (2), (5) and (6) are estimated using a family fixed effect model. Column (3) and (4) are estimated using a cross sectional OLS. EC is a dummy indicating early childbearing. Education is the length of the women’s total education measured in years, Log(Adult Earnings) is the natural logarithm of the adult earnings from 25 to 40., Birth Order is a dummy indicating whether the sister is the oldest, Diagnoses is the average number of diagnoses per year in adolescence. Father’s and Mother’s education is the education length of the women’s parents measured in years. Immigrant is a dummy indicating being a first or second-generation immigrant. Significant levels: 10% (*), 5% (**), 1% (***). Robust std. err. in the parenthesis, clustered at sister level.

These results show the effect of early childbearing on the level effect at 40. It is interesting to evaluate the trajectories in yearly earnings between the early and non-early childbearing women from age 20 to 40. Figure 3 depicts the point estimates and confidence intervals at the 95%-level of the effect of early childbearing on yearly earnings, obtained using the same identification strategies as the one for table 2. It shows significant negative effects starting in the early 20s (around first childbirth) for all samples. This effect diminishes with age but remains significantly negative throughout the women’s late 20s and 30s for samples 1 and 2. While the early childbearing mothers of sample 2 are catching up faster than those in sample 1, the yearly earnings penalty is statistically significant, at around DKK 12,000 and 15,000 at age 40,
respectively. However, the estimated effect of early childbearing for sample 3 is only significantly negative until the sisters turn 28, suggesting that the earnings penalty is short-lived. The point estimates are very close to zero from the age 28 on, indicating no difference in long-term earnings trajectories due to the timing of first childbirth.

Figure 3 - The Point Estimates of Early Childbearing on Yearly Earnings (DKK)

Note. The figure shows the point estimates of early childbearing on yearly earnings in Danish Kroner (DKK). Legend. S1 is the point estimates based on the family fixed effect model for sample 1, S2 is the point estimates based on the OLS for sample 2, S3 is the point estimates based on the family fixed effect model for sample 3. For S1 and S3, untabulated controls for health, birth order and year dummies are applied. For S2, untabulated controls for health, birth order, parental education, immigration status and year dummies are applied. The upper and lower bound for the point estimates indicate the 95% confidence intervals. Monetary values are translated into year-2014 DKK using the Consumer Price Index from the Danish National Accounts. 1DKK≈0.13€.

The earnings differences can come primarily from two margins: labor participation and wage rate. It is thus interesting to decompose the effects and observe what is causing the earnings trajectories. Figure 4 shows the point estimates of early childbearing for the three samples on labor participation and wage rates at the ages 20 to 40. The pattern from figure 3 is intact: There are significant negative effects on labor participation in the early 20s for all samples, and these diminishes with age but remains significant and negative throughout the late 20s and 30s for samples 1 and 2. At age 40, the effect is small but statistically significant and negative, at around 2 percentage points and 4% lower wage rates.\textsuperscript{29} The estimated effects for sample 3 are very close to

\textsuperscript{29} The reverse effect of early childbearing on wage rate in the start 20s might be due the difference in the ratio of students and age of full time labor market participants. You might expect higher hourly wage rates for non-students or those who have worked more years.
zero from age 28, indicating no difference in labor participation or wage-rate trajectory due to the timing of first childbirth.

Figure 4 - Point estimates of early childbearing on labor market participation and wages

Panel A. Labor Market Participation

Panel B. Log(Wage Rate)

Note. Panel A shows the point estimates of early childbearing on labor market participation, which is a dummy taking the value 1 if the woman has any labor earnings in the given year, and 0 if she has zero. Panel B shows the point estimates of early childbearing on the natural logarithm of the hourly wages. Legend: S1 is the point estimates based on the family fixed effect model for sample 1, S2 is the point estimates based on the OLS for sample 2, S3 is the point estimates based on the family fixed effect model for sample 3. For S1 and S3, untabulated controls for health, birth order and year dummies are applied. For S2, untabulated controls for health, birth order, parental education, immigration status and year dummies are applied.

Overall, the results suggest that the prevailing differences in earnings found in samples 1 and 2 are not caused by early childbearing but probably by unobserved individual heterogeneities between the sisters and unobserved social and family heterogeneities across women. After individual and family heterogeneities are controlled for in sample 3, the effect of early childbearing largely disappears. The results show that there is a short-term negative shock but no long-term difference in labor participation or wage rates for sample 3, and the differences in yearly earnings observed in samples 1 and 2 are due to diverging trajectories in both labor participation and wage rates.

Robustness Tests

I construct three different tests that address the robustness of the presented results. These tests evaluate several possible factors on the estimated effects. (i) I test whether the results are sensitive to the chosen age-threshold for early childbearing. I am able to lower the threshold to
age 21 while still obtaining a fair amount of observations for sample 3. (ii) Throughout the study, women with shared mother were defined as sisters - meaning that some of the sisters do not share the same father. The mother is often perceived as the anchor of the family, which is why having the same mother often entails shared adolescence. The assumption that sister studies remove family heterogeneity depend primarily on cultural similarity, but also to some degree on genetic similarity. I therefore exclude the few sister pairs with different fathers to test if they influence the results.30 (iii) There are some sisters that give birth at very different ages in a few of the families. Siblings whose ages at first birth are widely spread could potentially differ along other unobserved dimensions too. In order to test the importance of these cases, I run two regressions excluding the sisters with more than 9 and 4 years of differences in age at first birth. The original results are robust to all the tests. The point estimates of early childbearing for the different tests are shown in the Appendix Tables A3-A6.

7. Conclusion

Early childbearing women earn less than the average Danish woman. The question is whether this is due to the early childbearing or to confounding factors in the women’s backgrounds, abilities, and pre-motherhood situations. The purpose of this study is twofold: (i) to estimate the true effect of early childbearing on Danish women’s earnings and educational attainment, and (ii) to test the two best practices used in earlier studies and whether a combination of them produces better and less biased estimates. This is feasible due to the unparalleled detail of the fertility and labor market data for the universe of Danish women.

Both the within-family method without the use of miscarrying sisters and the cross-sectional method using miscarriages as exogenous variation on the non-sister sample lead to estimates that early childbearing has a large and significant negative effect on women’s earnings and educational attainment. But the effect on earnings disappears when the model is applied

30 The share of sister pairs with the same father: SS1: 85.44% and SS2: 84.97%.
together with the use of control sisters who were pregnant before 25 but miscarried and postponed childbearing until after age 25; and the effect on education declines substantially, though it remains significant and negative. There is a significant yearly earnings gap in the start 20s, which disappears at the age of 28, where after the trajectories are symmetric for the early and non-early childbearing mothers.

This result indicates that some unobserved individual heterogeneity remains when only a family fixed effects model is applied, and that some unobserved social and family heterogeneity remains when only miscarriages are used as exogenous variation. It also indicates that both of these heterogeneities can be removed when miscarrying sisters are used as controls. The combination of these two approaches is effective for addressing the risk that social bias in miscarriages.

These results are obtained for Danish women and might be influenced by the specific Danish institutions, which provide relatively generous public welfare schemes. Nonetheless, they show that in a welfare society of the Scandinavian model, early childbearing does not necessarily impose long-term labor-market penalties on mothers, suggesting that institutions can be designed to alleviate penalties due to early childbearing.

I argue that a combination of the within-family method and the use of miscarriages as an exogenous variation serves as a better method for estimating the causal effect of early childbearing on women’s earnings and educational attainment.
References

### Appendix

**Table A1 - Age Distribution of Graduating First Stage of Tertiary Education in 1998 (Females)**

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Denmark (%)</th>
<th>United Kingdom (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 or younger</td>
<td>18</td>
<td>66</td>
</tr>
<tr>
<td>25-29</td>
<td>51</td>
<td>10</td>
</tr>
<tr>
<td>30-34</td>
<td>15</td>
<td>7</td>
</tr>
<tr>
<td>35-39</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>40 or older</td>
<td>8</td>
<td>11</td>
</tr>
</tbody>
</table>

Source: Eurostat

**Table A2 - Average Age at Entering Different Tertiary Education in 1998 (Whole Danish Population)**

<table>
<thead>
<tr>
<th>Tertiary Education</th>
<th>Average Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short</td>
<td>26.2</td>
</tr>
<tr>
<td>Medium</td>
<td>26.8</td>
</tr>
<tr>
<td>B.Sc.</td>
<td>23.4</td>
</tr>
<tr>
<td>M.Sc.</td>
<td>27.7</td>
</tr>
<tr>
<td>PhD</td>
<td>31.1</td>
</tr>
</tbody>
</table>

Source: The Danish Ministry of Education (2000), Short is short cycle tertiary degrees of 1 to 2 years of length, Medium is medium cycle tertiary degrees of 2.5 to 3.5 years of length. B.Sc. is bachelor degrees of 3 years of length. M.Sc. is master degrees of 5 years of length. PhD is doctoral degrees adding 3 years to the 5 years of a master degree.

**Table A3 - Adult Earnings Income and Educational Length at Age 40 – Early Childbearing <23**

<table>
<thead>
<tr>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Sample 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log(Adult Earnings)</td>
<td>Education</td>
<td>Log(Adult Earnings)</td>
</tr>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td><strong>Early Childbearing (EC)</strong></td>
<td>0.2311***</td>
<td>-0.7430***</td>
</tr>
<tr>
<td></td>
<td>(0.012)</td>
<td>(0.022)</td>
</tr>
<tr>
<td>Individual Obs.</td>
<td>30,126</td>
<td>30,126</td>
</tr>
<tr>
<td>Group Obs.</td>
<td>13,674</td>
<td>13,674</td>
</tr>
<tr>
<td>R^2</td>
<td>0.033</td>
<td>0.076</td>
</tr>
</tbody>
</table>

Note: Column (1), (2), (5) and (6) are estimated using a family fixed effect model. Column (3) and (4) are estimated using a cross sectional OLS. EC is a dummy indicating early childbearing. Education is the length of the women's total education measured in years. Further untabulated controls are: Log(Adult Earnings) is the natural logarithm of the adult earnings from 25 to 40, Birth Order is a dummy indicating whether the sister is the oldest, Diagnoses is the average number of diagnoses per year in adolescence. Father's and Mother's education is the education length of the women's parents measured in years. Immigrant is a dummy indicating a first or second-generation immigrant. Significant levels: 10% (*), 5% (**), 1% (***) Robust std. err. in the parenthesis, clustered at sister level.
### Table A4 - Adult Earnings Income and Educational Length at Age 40 – Early Childbearing <22

<table>
<thead>
<tr>
<th></th>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Sample 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Log(Adult Earnings)</td>
<td>Education</td>
<td>Log(Adult Earnings)</td>
</tr>
<tr>
<td>Early Childbearing</td>
<td>Log(Adult Earnings)</td>
<td>Education</td>
<td>Log(Adult Earnings)</td>
</tr>
<tr>
<td>(EC)</td>
<td>-0.0419***</td>
<td>-0.7893***</td>
<td>-0.1536***</td>
</tr>
<tr>
<td></td>
<td>(0.015)</td>
<td>(0.026)</td>
<td>(0.027)</td>
</tr>
<tr>
<td>Individual Obs.</td>
<td>22,853</td>
<td>22,853</td>
<td>33,865</td>
</tr>
<tr>
<td>Group Obs.</td>
<td>10,311</td>
<td>10,311</td>
<td>424</td>
</tr>
<tr>
<td>R^2</td>
<td>0.131</td>
<td>0.082</td>
<td>0.158</td>
</tr>
</tbody>
</table>

Note. Column (1), (2), (5) and (6) are estimated using a family fixed effect model. Column (3) and (4) are estimated using a cross sectional OLS. EC is a dummy indicating early childbearing. Education is the length of the women’s total education measured in years. Further untabulated controls are: Log(Adult Earnings) is the natural logarithm of the adult earnings from 25 to 40, Birth Order is a dummy indicating whether the sister is the oldest, Diagnoses is the average number of diagnoses per year in adolescence. Father’s and Mother’s education is the education length of the women’s parents measured in years. Immigrant is a dummy indicating being a first or second-generation immigrant. Significant levels: 10% (*), 5% (**), 1% (**). Robust std. err. in the parenthesis, clustered at sister level.

### Table A5 – Effect of Early Childbearing on Adult Earnings Income and Educational Length at Age 40 – Restricting the Intra-Sister Difference in Age of First Birth

<table>
<thead>
<tr>
<th></th>
<th>Sample 1</th>
<th>Sample 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Log(Adult Earnings)</td>
<td>Education</td>
</tr>
<tr>
<td>Max age at first birth difference</td>
<td>&lt;10 years</td>
<td>&lt;5 years</td>
</tr>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Early Childbearing</td>
<td>-0.1483***</td>
<td>-0.5253***</td>
</tr>
<tr>
<td></td>
<td>(0.007)</td>
<td>(0.016)</td>
</tr>
<tr>
<td>Individual Obs.</td>
<td>53,925</td>
<td>53,925</td>
</tr>
<tr>
<td>Group Observations</td>
<td>24,421</td>
<td>24,421</td>
</tr>
<tr>
<td>R^2</td>
<td>0.024</td>
<td>0.050</td>
</tr>
</tbody>
</table>

Note. The coefficients are estimated using a family fixed effect model. EC is a dummy indicating early childbearing. Education is the length of the women’s total education measured in years. Further untabulated controls are: Log(Adult Earnings) is the natural logarithm of the adult earnings from 25 to 40, Birth Order is a dummy indicating whether the sister is the oldest, Diagnoses is the average number of diagnoses per year in adolescence. Significant levels: 10% (*), 5% (**), 1% (**). Robust std. err. in the parenthesis, clustered at sister level.
Table A6 – Effect of Early Childbearing on Adult Earnings Income and Educational Length at Age 40 – Restricting the Sisters to Share Fathers

<table>
<thead>
<tr>
<th></th>
<th>Sample 1</th>
<th>Sample 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Log(Adult Earnings)</td>
<td>Education</td>
</tr>
<tr>
<td>Early Childbearing (EC)</td>
<td>-0.1695***</td>
<td>-0.5866***</td>
</tr>
<tr>
<td></td>
<td>(0.007)</td>
<td>(0.015)</td>
</tr>
<tr>
<td>Individual Observations</td>
<td>62,355</td>
<td>62,355</td>
</tr>
<tr>
<td>Group Observations</td>
<td>28,604</td>
<td>28,604</td>
</tr>
<tr>
<td>R^2</td>
<td>0.027</td>
<td>0.056</td>
</tr>
</tbody>
</table>

Note. The coefficients are estimated using a family fixed effect model. EC is a dummy indicating early childbearing. Education is the length of the women’s total education measured in years. Further untabulated controls are: Log(Adult Earnings) is the natural logarithm of adult earnings from 25 to 40., Birth Order is a dummy indicating whether the sister is the oldest, Diagnoses is the average number of diagnoses per year in adolescence. Significant levels: 10% (*), 5% (**), 1% (**). Robust std. err. in the parenthesis, clustered at sister level.

Table A7 – Effect of Age at First Birth on Adult Earnings Income and Educational Length at Age 40

<table>
<thead>
<tr>
<th></th>
<th>Sample 1</th>
<th>Sample 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Log(Adult Earnings)</td>
<td>Education</td>
</tr>
<tr>
<td>Age at First Birth</td>
<td>0.0250***</td>
<td>0.0250***</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.001)</td>
</tr>
<tr>
<td>Individual Observations</td>
<td>73,135</td>
<td>73,135</td>
</tr>
<tr>
<td>Group Observations</td>
<td>32,588</td>
<td>32,588</td>
</tr>
<tr>
<td>R^2</td>
<td>0.033</td>
<td>0.033</td>
</tr>
</tbody>
</table>

Note. The coefficients are estimated using a family fixed effect model. Age at First Birth is the age of the women’s first child birth. Education is the length of the women’s total education measured in years. Further untabulated controls are: Log(Adult Earnings) is the natural logarithm of the adult earnings from 25 to 40., Birth Order is a dummy indicating whether the sister is the oldest, Diagnoses is the average number of diagnoses per year in adolescence. Significant levels: 10% (*), 5% (**), 1% (**). Robust std. err. in the parenthesis, clustered at sister level.
Chapter 2

The Family Earnings Gap Revisited: A Household or a Labor Market Problem?
The Family Earnings Gap Revisited: A Household or a Labor Market Problem?

Philip Rosenbaum*

February, 2019

Abstract

Using Danish administrative data from 1995-2014, I compare income and wage trajectories of women to those of their partner before and after becoming parents. I then compare within- and across-couple gaps for women in opposite and same-sex households. Since same-sex couples by definition do not experience sex-specific comparative advantages at work or at home, the changes in intra household earnings due to parenthood must be based on other factors than the intra household gender differences. Comparing the dynamics upon adopting a child in opposite and same-sex couples will identify to what extent the gender compared to non-gendered factors determine the observed gender inequality in the child penalty. Contrary to opposite-sex households and heterosexual mothers, for same-sex households, I find only a small child penalty for lesbians and no significant within household differences in earnings trajectories due to parenthood, no matter the mothers’ intra household bargaining power.

JEL Codes: J12, J16, J22, J71

Keywords: Gender earnings gap, gender inequality, household division of labor, child penalty, parenthood, same-sex partnerships

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1. Introduction

The gender gap is a continuous topic in the economics literature. Despite considerable convergence over the last century, gender inequality in incomes and wage rates continue to be significant across all countries. Looking at most western countries the convergence has slowed down or has even seemed to stop. USA and Denmark, each other’s polar with regard to social security and public welfare, have plateaued at a gender gap around 15-20%. So the riddle yet to be solved is; what causes this resilient and seemingly universal gap between men and women’s earnings?31

One thing that has not changed proportionally over time is the unequal impact parenthood has on men and women. Kleven et al. (2018) suggests that the gender gap is small pre-parenthood whereas women experience a significant child penalty, while men do not.31 Other studies have also stressed the significance of parenthood and claim that this is one of the last resistant and consistent biases leading to gender wage gaps.

In this paper, I take on a new approach to analyze this puzzle. I exploit the intra household difference in gender composition between heterosexual and lesbian couples.32 The empirical analysis is based on universal administrative Danish Registers, which allows me to track all pairs of parents and their income and salaries from 1995 to 2009. There are multiple advantages in evaluating the child penalty in same-sex couples compared to opposite-sex couples. First, the comparative advantages and division of labor within the households are non-gender specific. Second, the partners in same-sex relations will, by default, face the same kind of labor market treatment i.e., gender based advantages and disadvantages. Overall, there will be no difference in

31 Little or negligible effects are found for men’s earnings due to fatherhood (Wilde, Batchelder, and Ellwood, 2010; Wilner, 2016). If there is an effect, it is usually found to be small but in fact positive (Lundberg and Rose, 2000; Boeckmann & Budig, 2013; Killewald, 2013; Kunze, 2015)).
32 I will use the wording Lesbian for females in same-sex couples and Heterosexual for men and women in opposite-sex couples throughout the paper. These specific wordings are used to ease the reading and to specify which kind of same and opposite-sex constellation is referred to. Strictly speaking, it is only assumed that the females in the same-sex couples are lesbians and that the individuals in the opposite-sex couples are heterosexual, since I cannot observe their sexual preferences directly.
outcomes within the lesbian households due to gender. I exploit this to make three analyses that shed light on the nature of the existing gender inequality in the child penalty.

First, I compare the aggregate household child penalty in earnings between heterosexual and lesbian households. I find that the child penalty is lower in lesbian households relative to heterosexual households, even after controlling for education, timing of parenthood, and area of residence. This is so, in spite of the fact that women traditionally face higher child penalties. Second, I compare the individual parents’ child penalty between heterosexual women and the lesbian partner with less bargaining power (defined by factors usually associated with intra household decision power, such as age, income and education). Lesbians with low bargaining power experience relatively low child penalty compared to heterosexual mothers and do not experience higher child penalty than their high bargaining power partner. Third, I evaluate the dynamics in the intra household earnings gap due to parenthood. I find that the intra household earnings gap increases significantly due to parenthood in heterosexual households but not in lesbian households.

In this paper, I look at parenthood by adoption. Looking at adoptions makes it possible to identify same-sex parents, which is otherwise not quantitatively possible in Denmark. Although impossible, it would have been interesting to study non-adoption fertility as well, but comparing adopting lesbians with adopting heterosexuals has a clear-cut statistical advantage. By looking only at adoptions, gender comparative advantages in childrearing associated with pregnancies, nursing etc. are eliminated. Thus, the parents are freer to organize the childcare according to factors other than their physical and biological characters.

This is, to my knowledge, the first paper using panel data to estimate the effect of household gender composition on the child penalty and this novel sheds new light on the ongoing discussion on the gender inequality in child penalty and earnings. All together, the results indicate that the observed gender inequality in child penalty is not a universal gender entity, but
rather due to the gender of the partner and/or the partner’s involvement in childrearing and household production. If it is a universal gender penalty, penalties should be higher in lesbian households with two mothers compared to households with only one. I show that the bargaining power in lesbian households has little to do with the child penalty, where it seems that childrearing chores are shared rather evenly between partners of different ages, education and incomes. These results are also interesting from the more traditional economic perspective, where theories on gender differences in comparative advantages of childrearing and household production together with gains from division of labor and specialization are cornerstones in household economics theory. The positive effect on household earnings due to more egalitarian and non-specialized allocation of labor between partners within the household goes against the traditional view on how to optimize household outcomes post-parenthood.

The paper is organized as follows: section 2 reviews the vast literature. Section 3 outlines the theory behind using same-sex household for the identification strategy. Section 4 explains the institutional settings. Section 5 describes the data and shows some summary statistics. Section 5 shows some graphical evidences. Section 7 explains the empirical strategy and shows the results. Section 8 concludes.

2. Literature Review

2.1 Parenthood Gap

Looking at the historical development, big differences in the gender gap can be observed across countries with different public policies. Many equality measures have been implemented, as well as a cultural revolution where women entering the labor market demand equal pay. One thing that has not changed proportionally over time is the unequal impact parenthood has on men and women. Kleven et al. (2018) suggest that the gender gap is small pre-parenthood but increases in
parenthood since women have a significant child penalty, while men have not.\textsuperscript{33} Other studies applying different identification strategies on data from various countries, have also stressed the significance of parenthood and claims that this is one of the last resistant and consistent biases leading to gender wage gaps.

Much of the wage gap can be explained by fewer hours worked and weaker continuity in labor force participation by mothers leading to lower productivity (Mulligan & Rubinstein, 2008; Wilner, 2016; Adda et al., 2017; Azmat and Ferrer, 2017; Gallen, 2018) especially for middle-age workers where gender wage gaps are the biggest (Goldin & Katz, 2016; Blau & Kahn, 2017). Coudin et al. (2018), Goldin (2014) & Bertrand et al. (2010) suggest that work hours and disruptions in labor force participation dramatically lower wages due to a "job-flexibility penalty" or labor intensity where imperfect substitution between workers can lead to a convex hours-earnings relationship.\textsuperscript{34} Focusing on high-skilled Swedish workers, Albrecht et al. (2017) show that the career paths of men and women diverge at the time of the birth of their first child: mothers tend to work less, in a different type of firms, and becomes less mobile.

Mothers are often perceived to be discriminated against at the labor market, more than women are in general (Altonji & Blank, 1999; Wennerås et al., 2010; Blau & Kahn, 2017).\textsuperscript{35}

\textsuperscript{33} Card et al. (2015) suggest similar trends and show that the effect from pre-child human capital investments has fallen implying that in the past women used to pay the career penalty of children upfront, where they now seem to invest in education and career at similar level as men.

\textsuperscript{34} Some have argued that the gender difference in age at first birth can account for some of the gender gap. Men are usually older than women when having children. Many studies find that postponing is positively correlated with labor market outcomes (Card & Wise, 1978; Hofferth, 1984; Geronimus & Korenman, 1992; Hoffman et al., 1993; Rosenzweig & Wolpin, 1995; Holmlund, 2005; Leung et al., 2016). These two factors put together indicates that the gender difference in age at first birth may account for some of the general gender gap in child penalty. On the other hand, later studies trying to identify the causal effect of age at first birth on careers find no or little evidence that timing matters (Hotz et al., 2005; Rosenbaum, 2018). Looking at the high earning end, however, the picture seems to differ. Having the first baby at an early age improves the chances of promotions into CEO positions (Smith et al., 2013).

\textsuperscript{35} Discrimination can take on many forms, where some studies find it on the entry level through hiring biases (Goldin & Rouse, 2000; Bjerk, 2005) other document it in promotion processes, finding a significant glass ceiling for women hindering them from reaching top level jobs (Bertrand & Hallock, 2001; Albrecht et al., 2003; Matsa & Miller, 2011; Smith et al., 2013; Gobillon et al., 2015; Folke & Rickne, 2016). Searsons (2018) find asymmetric responses to the quality of male and female surgeons.
Employers are afraid of lower productivity or effort of mothers but not of fathers, which is primarily due to change in household division of labor when entering parenthood.

These results indicate that it is difficult for women to both have a family and excel in their career, which on the contrary men seems able to do. This raises the question whether a family can master two career-orientated spouses at once.\textsuperscript{36}

2.2 Households Organization

Households form an entity, where it is possible to increase the total household welfare with specialization and division of labor. This different time allocation within the household becomes even more pronounced when the couples enter parenthood, where time presumably becomes an even more scarce resource.

As proposed in the seminal work of Becker (1965) and (1985), partners’ allocation of time is determined by comparative advantages. His model of household division of labor has been the workhorse model in the literature. Assuming decreasing returns to scale and comparative advantage, both spouses may participate in the labor force, where their contributions to household income and to household production are determined by their relative productivity in those two activities.\textsuperscript{37} Such advantages result from previous investments in human capital, i.e., educational attainment, labor market experience and potential acquisition of any specific household skills. Hence, these differences in efficiencies should in principle not be determined by

\textsuperscript{36} In the light of these results, it is a puzzle why women would want children. Although economists tend to focus on pecuniary outcomes, it is indeed important to mention the non-pecuniary benefits of having children. Bertrand (2013) finds that the biggest premium to life satisfaction is associated with having a family and that it is much higher than the premium of having a career. Thus, one might ask why we evaluate the child penalty as a penalty and not as a life satisfaction premium. Is there a general glorification of the career way of living in the western world and do these societies obsess too much about the work-life? Keeping in mind that most jobs are not necessarily fulfilling and giving, but hard and non-enjoyable work. Maybe it is possible for women to have both career and family, as men have been able to. This raises the question whether a family can master two career-orientated spouses at once. Nonetheless, I believe that the key element to the gender gap question is non-normative. We economists should not dictate whether individuals should do either career or households, but we should give the opportunity for everyone to choose to pursue either or both. Liberating this choice is what gender equality is about in the 21\textsuperscript{st} century, rather than forcing everybody to spend less time at home and more time at work.

\textsuperscript{37} In the special case of increasing returns to labor, it is optimal for only one spouse to work, leading to full specification and division of market labor to housework.
the gender, which makes these types of household economic models gender neutral. Some will argue that a person’s later experiences are in part consequences of parents’ gender specific investment behavior, of intrinsic differences between the sexes (e.g. pregnancy and nursing), and the discounted value of future labor income, where women still face glass ceilings as foreshadowed.\textsuperscript{38} As a result, it is often perceived that women have the comparative advantage in household labor, while the man in income creating labor.\textsuperscript{39, 40}

These models predict bad news for women; even if women choose to continue their career while being main responsible for childcare and other housework, it will lead to significant wage penalties (Becker, 1985). Childcare and housework are effort demanding compared to leisure, and thus women lifting the burden of these would have less energy for the market job than their men.\textsuperscript{41} This can reduce the hourly earnings of mothers, affect their job type and occupation, and predictably lower their investment in human capital, even when they work the same number of market hours as fathers. Becker (1985) suggests that the housework responsibilities of mothers may account for much of the gender difference in earnings. These theories might lead to self-fulfilling prophecies. If households perceive that women would earn less in the long run, it would lead to a gender segregated division of time allocation when optimizing the household budget,

\textsuperscript{38} For career women trying to climb the ladder, but who have not reached top positions yet, the overall effect of children is that the more children, the lower probability of promotion (Smith et al., 2013).
\textsuperscript{39} Be aware that this assumption does not contradict that women may have the absolute advantage in either or both hemispheres.
\textsuperscript{40} These Beckerian household models, consider the household, as a whole, and therefore the decisions among the engaged becomes elementary unitary; in particular, this household is characterized by a unique utility function that is maximized under a budget constraint. Chiappori (1992) offers an alternative to this, called the “collective” household model that essentially consists in deepening the individualistic foundations of consumer theory by claiming that the members of the household should be considered independently rather than altogether as maximizing agents. This allows incorporating the notion that Agents are “egoistic” in the sense that their utility depends only on their own consumption and labor supply. This theoretical background offers insight to why, the household allocation is not always efficient, but rather Pareto efficient, since the equilibrium is now decided on the basis of two separate individuals optimizing separate utility functions. This is in fact sometimes present, where you see examples on household who does not pool income.
\textsuperscript{41} It is reasonable to question this simple categorization of time into job market and non-job market use. More precisely whether housework, such as cleaning and grocery shopping can be clustered together with time spend with your own children. Since the later can be assumed to be pleasurable - for the most part. However, the categorization somewhat makes sense when dividing non-job market time into bounded, inescapable and inflexible activities (including both cleaning and child caring) and unbounded independent and flexible egocentric activities (such as pure leisure).
which would lead to significant gender earnings gap. This is in fact the case, even though there has been a large convergence between men and women in time used at both the labor market and housework. Aguiar & Hurst (2007) find that women’s general non-market hours have decreased while men’s have increased over time. They find that both men and women are using more time with their children, but the women’s increase is significantly larger than the men’s.\footnote{Evidence from the American Time Use Survey indicates the same household behavior in USA. American mothers spend on average three times the amount of time at interacting with the children’s schools than American fathers, double the amount on taking physical care of the children, and spend an average 6.2 minutes a day doing homework with their children, while men spend less than four minutes on average.} This indicates a decreased specialization in non-child related housework, but an increased specialization in childrearing.

Women working equal market hours as their spouse still tend to do significantly more work at the household (Aguiar & Hurst, 2007), even in households with career orientated women (Folke & Rickne, 2016) and women endowed with high intelligence and unusually high IQs (Gensowski, 2018). Daly & Groes (2017) find that it is almost exclusively the mothers that take the children to medical services in Denmark. As these services are mainly performed during regular working hours this provides one mechanism, by which absenteeism increases as a consequence of motherhood.\footnote{On the other hand, the effect from pre-child human capital investments has fallen (Card et al., 2015), implying that in the past women used to pay the career penalty of parenthood upfront, where they now seem to invest in education and career at similar level as men (VIVE, 2018; Bettinger & Long, 2005; Brenoe, 2018). This preparenthood convergence between the genders has, among others, lead to un- or less-penalized salaries up until parenthood (Goldin, 2014; Kleven, et al. 2018).}

Although Scandinavian countries have more progressive views on women’s labor market participation than other western countries, the general gender views are still rather traditional. Data from the International Social Survey Program shows that having children is detrimental for the Danes’ view on women’s labor market participation. Whereas almost all survey participants believe that women should work full time pre-motherhood, only around 18% hold that view for
women having pre-school children. Interestingly this survey sample consists of both men and women, where there is little difference in the beliefs between the genders.\textsuperscript{44}

The fact that these observed attitudes are symmetric across genders indicates that it is a household decision to position the father on the labor market while easing the income burden of the mother. In consequence, women may choose less demanding jobs, leading to a lower lifetime income and promotion glass ceilings.

Bertrand et al. (2015) find a big discontinuity in incomes within the couples where few women exceed having 50\% of the household income. This inequality does not diminish over time, but rather seems to increase in marriage tenure.\textsuperscript{45} The discontinuity among the newlyweds implies that gender identity affects who marries whom, while the fact that the discontinuity grows with marriage tenure suggests that identity considerations also influence the evolution of relative income within a couple and/or the likelihood of divorce. This is in line with the theories of Goffman (1956) and Akerlof (2000) on gender identity formation where the behavioral prescription for one's gender affirms one's self image, or identity, as a "man" or as a "woman" and violating the prescriptions evokes anxiety and discomfort in oneself and in others. Gender identity, then, changes the "payoffs" from different actions. This can lead to either strong self-selection processes or outright discrimination.\textsuperscript{46} Angelov et al. (2016) find that the comparative advantages in terms of earnings potential determine how the monetary costs of parenthood are shared between the parents. Consistent with this effect they also find smaller lifetime gender gap in child penalty when the educational attainment of the women is closer to the husband, indicating that the match type is crucial for the magnitude of the gender gap in incomes and

\textsuperscript{44} Other surveys of household opinion on gender labor market participation find similar results. The Economist and YouGov, a pollster, conducted a large survey of America, Australia, Britain, France, Germany and Scandinavian countries in 2017, finding that most believe that the mother should make the change in her career in order for the household to work.

\textsuperscript{45} Similar results are found by Wilde et al. (2010) and Adda (2015).

\textsuperscript{46} Chiappori et al. (2002) also find, both theoretically and empirically, that changes in the sex ratio and in the divorce laws index have sizable impacts on gender time allocation and income transfers within the households. Both factors influencing the spouses outside option and hence changing the inside bargaining power between the spouses.
wages. Hence, one effect is being in a partnership and another effect comes from the choice of partner.

Even in the twenty-first century, men tend to avoid female partners who exhibit professional ambition, such as high levels of education or working in highly competitive markets (Brown & Lewis, 2004; Fishman et al., 2006; Greitemeyer, 2007; Hitsch et al., 2010). It is relatively unlikely that a woman will earn more than her husband, and when she does, she tend to lie about it (Murray-Close & Heggenes, 2018), maybe because it leads to lower marital satisfaction and higher divorce rates (Bertrand, 2013; Bertrand et al., 2015; Folke & Rickne, 2016). It increases the likelihood of divorce when women are promoted, but not so when men are promoted (Folke & Rickne, 2016). Moreover, the workplace is still the most common place to find a partner (Rosenfeld et al., 2015). Due to these factors, it is more understandable why single women might try to improve their marriage options by “acting wife” (Bursztyn et al., 2017). On the other hand, women value their partner’s intelligence and education, even when these exceed their own (Fishman et al., 2006; Lee, 2016).

3. Same-Sex Households

There seem to be no consensus whether the motherhood penalty stems from labor market or household decision mechanisms. One possible way of splitting these effects is by taking the gender out of the equation. In this study, this is done by looking at same-sex couples entering parenthood.

There are multiple advantages of evaluating the child penalty in same-sex couples. First, the comparative advantages and division of labor within the household are non-gender specific. In other words, it is not the gender or gender differences that determine the time allocation to

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47 Bursztyn et al. (2017) consider the self-selective identity process through studying the marriage market, finding that single women shy away from actions that could improve their careers to avoid signaling undesirable traits in the marriage market. They show that MBA single females perform worse when males are in the room, compared to an equal setting devoid of potential future spouses.
household and labor production, since there is no endowed gender bias in comparative advantages, bargaining abilities or willingness to compete or any of the other gender specific skills suggested in the literature. Second, the partners in same-sex relations will, by default, face the same kind of gender discrimination on the labor market. This gender normalization between the partners going into parenthood allows me to analyze; 1. whether there is any child penalty for parents in same-sex households, 2. if so, how it is divided among these parents, due to other factors than gender differences. It is possible to suggest a causal interpretation of the observed child penalty for women by conducting a careful comparison holding everything else equal but the gender composition of the couples. I can observe whether the child penalty is gender specific, specific for the opposite-sex stereotypical household organization or driven by meritocratic factors, such as abilities and earnings potential.

Put differently, same-sex couples offer an interesting comparison to opposite-sex couples in the household time allocation choices. Nobody has - to my knowledge - made an event study on micro level data comparing the child penalty across same- and opposite-sex parents before. In doing this, I can shed new light on why the child penalty is prevalent for mothers and not fathers.

My default assumption is that homosexuals do not differ systematically from heterosexuals in key elements such as labor market preferences and child rearing. Black et al. (2008) suggests that family formations in the gay and lesbian community differs only modestly from the general population as a whole.

The literature on same-sex household generally finds what they call a “lesbian premium” and a “gay penalty” (Sabia et al., 2017). This in fact, is bound to happen by default due to the

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48 The literature has suggested negative consequences of women's poor bargaining skills, unwillingness to compete and risk aversion. Papers on bargaining skills; Raiffa, 1982; Lax & Sebenius, 1986; Babcock & Laschever 2003; Small et al., 2007; Greig, 2008; Hall & Krueger, 2012; Leibbrandt & List, 2015; Card et al., 2015. Papers on unwillingness to compete; Bertrand et al., 2010, Croson and Gneezy, 2009; Flory et al., 2014; Buser et al., 2014; Markussen et al., 2014; and Reuben et al., 2015. Gneezy et al., 2003; Niederle & Vesterlund, 2007; Charness et al., 2011; Balafoutas & Sutter, 2012; Charness & Gneezy, 2012, Datta Gupta et al., 2013; Niederle et al., 2013, Dreber et al., 2014; Preece & Stodard, 2015; Flory et al., 2014. Papers on risk aversion; Eckel & Grossmann, 2008, Falk and Hermle, 2018; Censowski, 2018.
gender of the lesbian and gay’s spouses. According to the existing household literature, when
lesbians (gays) share the household burden with a woman (man) who in general takes greater
(less) household responsibilities, it liberates (occupies) time and effort to focus on the market job
and therefore increases (decreases) productivity and earnings. While there seems to be persistent
evidence for the “gay penalty”, lesbian partners and heterosexual couples have similar household
incomes, implying that the average female income must be higher in the lesbian couple. Empirical
studies find that cohabiting lesbians and gay men exhibit intra-household inequalities in earnings,
hours worked in paid labor, and the likelihood of working full-time suggesting that there is a
primary worker and secondary worker even in same-sex household (Giddings et al., 2014; Jepsen
& Jepsen, 2015; Antecol et al., 2008). Martell & Roncolato (2016) find evidence of different time-
use patterns for lesbians, but they conclude that these are driven by characteristics other than
sexual orientation. Same-sex couples may have gendered living arrangements (Biblarz & Savci,
2010), but a “natural” starting point and traditional social norms do not exist to guide the initial
household arrangement (Bauer, 2016).

Oreffice (2011) studied the impact of bargaining power on the labor supply in same-sex
households and find that the older and the wealthier partner has the most bargaining power. She
showed that partners in same-sex couples respond to shifts in bargaining power by changing their
respective labor supply. Antecol & Steinberger (2013) studied the labor supply gap of married
women in different-sex couples and women in partnered lesbian couples. They found that
primary earners in lesbian couples allocate more time to the labor market than secondary earners,
who still provide more labor than women in opposite-sex couples. Even though the literature is
expanding, most research still suffers from severe lack of power and causal interpretation due to
low number of observations and weak identification strategies.

There are good reasons to maintain that – at least along many important dimensions –
homosexuals are not fundamentally and inherently different from their heterosexual counterparts
(Black et al., 2007). It is furthermore reasonable to believe that same-sex households also exhibit division of labor, but do so on other metrics than the spouses’ gender.

4. Institutional settings

Denmark has a strong welfare state of the Scandinavian model, which combines considerable redistributions through high taxes and generous family policies intended to support female labor supply among other inequality depleting objectives. Together with relatively egalitarian gender views this means that Denmark has one of the highest female labor force participation rates in the world, currently around 80%, and almost no remaining gender gap in participation rates.\(^{49}\)

Public childcare is universal and heavily subsidized from around 6-12 months after birth. Until the child reaches the age where public childcare becomes available, there is job-protected and paid parental leave. Mothers are entitled to 4 weeks of pregnancy leave – taken before the birth, 2 weeks of mandatory post birth leave, and optional 12 weeks of fully compensated leave, which has to be taken somewhat in continuation of the above. Fathers have 2 weeks fully compensated leave, often taken from the day of the birth. Lastly, the parents are together entitled to 64 weeks of parental leave divided between the parents as wished. The long parental leave is well compensated by the government, usually together with the employer.\(^{50}\) In total mothers and fathers can take a maximum of about 19 and 16 months of parental leave respectively. Adopting parents are entitled to exactly the same amount of parental leave. The only practical difference is that none of the leave is earmarked to any gender, leaving a greater flexibility in the household organization.

Adopting children is not a trivial objective. It often takes some planning and information gathering to follow through an adoption process. Eligibility for adopting is dependent on several

\(^{49}\) Female labor force participation is around 70% in the United States, 73% in United Kingdom, 74% in Germany and 68% in France.

\(^{50}\) Most employees have generous agreements due to strong labor union traditions in Denmark. Those who are not in a union usually also have the same benefits, since the labor agreements often are universal for each field of work.
condition. In Denmark, the adopting parents must: Have lived with the adopting partner for at least 2.5 years, be in “reasonable” health, have a home which can accommodate a child, financial stability, no criminal record that compromises the caretaking of a child, and be under 43 years old at the adoption application date. This is to ensure a safe and stable environment for the adoptees. Although these restriction can be met by most Danish households, they exclude the poorest, who therefore will not be present in the final sample of this study.

5. Data and summary statistic

I use the Danish administrative register data, which is a panel dataset covering 100% of the population in the years 1994 to 2014. The data is provided by Statistics Denmark and includes many different registers. I use registers with annual information on demographic variables (e.g., age, gender, education etc.), income information (yearly income, earnings and a crude measure of wealth), employment status (e.g., employed, self-employed, unemployed), and family identifiers of the population. The parents in the sample are linked with their children through family links and personal identification numbers.51

The inclusion criteria are as follows: (i) I focus on parents who are married or cohabitating; (ii) I focus on parents ages 25 to 60. At this age, women have realized most of their pre-employment human capital investments. The reason to exclude single parents follows a comparability principle. That is, the predictive probabilities of having a child and the earnings of within married/cohabitating individuals substantially differ from those of singles. I focus on labor income because I only have a rough measure for hours worked in the register data, hence a wage variable will be a rough approximation at best. The labor income of the population is converted in real terms to the year 2015 price level using the Danish Consumer Price Index obtained from Danish National Accounts.

51 Anonymized for data privacy considerations by Statistics Denmark
In this paper, I look at parenthood by adoption. First, looking at adoptions makes it possible to identify same-sex parents, which is otherwise not quantitatively possible in Denmark. I can observe the gender of the adopting parents directly and define the household as same-sex if the adopting parents are of same gender. Compared to the otherwise mostly used survey measures where sexuality is self-reported, this measure is presumably unbiased. It has been possible to assemble a sufficient number of lesbian parents. Although it would serve as an interesting comparison, there are unfortunately not enough adoptions by male same-sex couples to conduct any meaningful statistical analysis. Furthermore, it was not possible to assemble enough same-sex couples where one mother gave birth. This may be for three reasons. First, there are few incidences of this kind. Second, they are difficult to observe since the non-childbearing mothers may not be registered as parents. Third, IVF-treatment is a fairly recently accepted fertility method for single and lesbian women. Thus, the same sex couples in this study consist of two women having children together and therefore the comparison of the child penalty will be between heterosexual and lesbian couples. To homogenize the treatment and control group, I restrict the households to consist of parents who do not have any children prior to adopting.

It would have been very interesting looking at both childbearing and adopting same-sex couples, where both situation can shed light over different aspects of the gender inequality in child penalties. The choice of which mother is chosen to be pregnant and afterwards the relative penalty between the childbearing and non-childbearing mothers within the household would

52 In general, it is very difficult to retrieve data of reasonable reliability and of significant power on homosexual individuals (Schönpflug et al., 2018).
53 It was only legalized in 2011 for gay couples to adopt in Denmark. Although legal today, it is de-facto very difficult for gay couples. E.g., many countries will not let their adoptees be adopted by gay men.
54 I find that more observations of these kinds in the more recent years, but there are still few. I also tried to look at mothers with a child who has no other parent identified. Of them, I tried to find those mothers who lived with another women, and therefore assuming a lesbian parenthood relation. Even by these metrics, it was not possible to assemble any significant amount of observations.
55 I am in the process to get data where I can take use of broader family and fertility types as comparison groups in order to both observe the particularity of adoptions and the increase my population.
both have been interesting to investigate. On the other hand, looking at adoptions has some clear-cut advantages. First, looking only at adoptions eliminates the potential gender bias coming from pregnancy and nursing. When adopting there are no biological changes to the mother that either consume effort which otherwise could be put into the job or prevents her from participating in the labor market. When there is no pregnancy, there is no obvious gender comparative advantage in childrearing. This factor is important in this setting, since without pregnancy there is no physical component that can separate the two mothers in the lesbian couple. The physical care of the infant is therefore not bound to any one of the women. Thus, they are freer to organize the childcare according to factors other than physical and biological characters. Second, adoption differs in many other ways from traditional childbirth. The timing for the decision of entering parenthood is different when adopting than in traditional pregnancy settings. Adopting parents have often been forced to postpone parenthood due to fertility problems, which is why adopting parents often are older when entering parenthood.56

Figure 1 shows the development in adoptions in Denmark over time. The figure shows how lesbian couples have gained a higher proportion of the overall adoptions in Denmark over the years from 1999 to 2009. The figure also shows substantial year-to-year variation in the overall number of adoptions, fluctuating between 300 and 600 adoptions a year. Not all adoptions are used in this study. I only use adoptions, where there is no prior relation between the adopting parents and the adoptees and when the adoptees are no older than 2 years old at the time of adoption. This ensures that the reason for adopting is not to help relatives and that adopting is somewhat relatable to having biological children.

The final panel for this study covers the parents three years prior to five year after their first adoption. This limited time-period is covered due to data limitations. 2009 is at present time

56 Adopting parents are often older since they have often have tried traditional fertility for a period without success before engaging in the adoption process. Some have argued that the child rearing is different for adoptees and traditional babies. On the one hand, it might be an advantage getting a child that has passed the first very demanding months. On the other hand, it can be troublesome getting a child who has have a relative unstable first period of life.
the last year where the gender of the adopting parents is observable from the ADOP-register and as figure 1 shows 2009 is also the year where most same-sex couples adopted. The last year of earnings information is 2014, which is 5 years of post-adopting observations when using the last cohort of adoptions from 2009.\textsuperscript{57} The final balanced panel covers 4,610 individual adopting parents, consisting of 1,761 different-sex households and 544 same-sex households.

Table 1 provides summary statistics for the adopting parents in heterosexual and lesbian households. The first column shows the men in opposite-sex couples, the second column the women in opposite-sex couples, the third column the women in same-sex couples, whereas the fourth and fifth column show the pre-adoption first income and second income women in the same-sex couples respectively. This is defined as having the highest labor income in the household in the year before the first adoption and is shown in order to see whether there are significant differences or division of labor within same-sex households. Different metrics on this is applied later in the paper. The statistics show that heterosexual men are the oldest at first adoption, followed by heterosexual women, the first income lesbian and lastly the second income lesbian. The overall difference in age at first adoption between heterosexual men at 37.95 and second income lesbians at 33.45 is 4.41 years. There are no noteworthy sample differences in ratio of immigrants (around 4 per cent) and number of adoptions (around 1.3-1.4 per couple).\textsuperscript{58}

The lesbian women are in general marginally better educated than the heterosexual women, who again are marginally better educated than the heterosexual men are. None of the differences in length of education is statistically significant.\textsuperscript{59} Lastly, a higher proportion of lesbian mothers live in the capital region (52 \%) than heterosexuals (42 \%) at the time of adoption. Lesbians tend to live in urban areas, often due to higher tolerance for non-traditional sexual orientations and due to larger marriage-markets. Both the lesbian and heterosexual adopting parents have a higher

\textsuperscript{57} In the process of being updated to 2016.
\textsuperscript{58} The demographic variables as well as the family links are pulled from the FABE and the BEF registers. The variables used to create educational length are HFPRIA and HFAUUD and are pulled from the UDDA registers. The adoption information are found in the ADOP register. All registers are from Statistics Denmark.
\textsuperscript{59} For type of education across the parents, see appendix figure A1.
tendency to live in the capital region than the general population of Danish parents where only 32% live in the capital region. This might be due to cultural and traditional differences across residents of urban and non-urban areas. Lastly is shown, the statistics for labor market experience. It shows quite a big difference across the groups. Where the men have the most experience and the lesbian women have the lowest experience and salary. In general, this shows that there are no large sample differences in the statistics, although controlling for age at first adoption, region of residence, experience, and year of adoptions could alleviate possible age and idiosyncratic time variation biases.

Figure 1 – Number of annual adoptions
Shows the number of adoption in Denmark from 1999 to 2009. The total adoptions (black curve), the adoptions by heterosexual couples (light grey) and by lesbian couples (dark grey).
Table 1 – Summary Statistics
Shows a number of summary statistic by household type gender and role. Where column (1) men from the adopting heterosexual households, (2) women from the adopting heterosexual households, (3) all women from the adopting lesbian households, (4) FI: First Income, partners with the highest pre-adoption intra household income from the adopting lesbian households, (5) SI: Second Income, partners with the lowest pre-adoption intra household income from the adopting lesbian households. Age at first adoption is the parents’ age when adopting their first child. Years of education is the mandatory time needed from elementary school to complete the highest taken education. Immigrant is a dummy indicating 1 if the person is either a first generation or second generation immigrant. Gender of first adopted child is a dummy indicating 1 if the gender of the first adopted child in the household is male and 0 if female. Number of adoptions is the number of total children adopted in 2009. Labor Experience is the number of years at the labor market one year prior to the first adoption. Salary is the labor income one year prior to the first adoption. The mean are shown with the standard deviation in the parenthesis for each variable and parent.

<table>
<thead>
<tr>
<th></th>
<th>Heterosexual</th>
<th>Lesbian</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men (1)</td>
<td>Women (2)</td>
<td>All (3)</td>
</tr>
<tr>
<td>Age at first adoption</td>
<td>37.95</td>
<td>36.92</td>
<td>34.07</td>
</tr>
<tr>
<td></td>
<td>(4.26)</td>
<td>(4.26)</td>
<td>(5.21)</td>
</tr>
<tr>
<td>Years of education</td>
<td>14.09</td>
<td>14.17</td>
<td>14.28</td>
</tr>
<tr>
<td></td>
<td>(2.30)</td>
<td>(2.12)</td>
<td>(2.26)</td>
</tr>
<tr>
<td>Immigrants</td>
<td>0.03</td>
<td>0.03</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>(0.18)</td>
<td>(0.17)</td>
<td>(0.20)</td>
</tr>
<tr>
<td>Sex of first adopted child</td>
<td>0.49 (boy=1)</td>
<td>0.52</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.50)</td>
<td>(0.50)</td>
<td></td>
</tr>
<tr>
<td>Number of adoptions</td>
<td>1.40</td>
<td>1.40</td>
<td>1.32</td>
</tr>
<tr>
<td></td>
<td>(0.54)</td>
<td>(0.54)</td>
<td>(0.54)</td>
</tr>
<tr>
<td>Labor Experience (t-1)</td>
<td>17.08</td>
<td>15.98</td>
<td>12.66</td>
</tr>
<tr>
<td></td>
<td>(6.41)</td>
<td>(6.25)</td>
<td>(6.07)</td>
</tr>
<tr>
<td>Observations</td>
<td>1761</td>
<td>1761</td>
<td>1088</td>
</tr>
</tbody>
</table>

Table 2 – Area of residence
Shows the area in Denmark of the households’ residence. The distribution is calculated on the basis of one observation per household per year.

<table>
<thead>
<tr>
<th></th>
<th>Heterosexual</th>
<th>Lesbians</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital</td>
<td>42.3</td>
<td>52.4</td>
</tr>
<tr>
<td>Zealand</td>
<td>10.4</td>
<td>7.4</td>
</tr>
<tr>
<td>Southern</td>
<td>14.0</td>
<td>10.9</td>
</tr>
<tr>
<td>Mid-Jutland</td>
<td>23.3</td>
<td>21.3</td>
</tr>
<tr>
<td>Northern Jutland</td>
<td>10.0</td>
<td>8.0</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>
6. Graphical Evidence

Before turning to the formal analysis, I provide some initial graphical evidence examining the raw salary and income trajectories across the different household and parental types over time. Figures 2 Panel A. and B. show the crude mean of yearly salary and income around the first adoption - salary being the labor earnings, income being the sum of labor earnings, public transfers and capital gains.\textsuperscript{60} First, the figures show a level difference between the different types of parent. Men are the highest earners across all the years, followed by the first income lesbian partner, the heterosexual women and lastly the second income lesbian partner. Second, the patterns reveal that before the first adoption the salary and income trajectory of the parents across type are the same, suggesting no gender or household type specific trend over time. Third, there are large gender differences immediately after the first adoption. Whereas men’s earnings seem to be only marginally or not affected by adoptions, the heterosexual and the first income lesbian women experience a large drop in salaries immediately after the first adoption and a stagnation of earnings afterwards. The second income lesbian women do not seem to be affected as much. The difference in the salary and income trajectories follows naturally from the organization of the Danish welfare state, where salary losses are highly compensated in general and almost entirely compensated when it is due to parental leave. The immediate drop in salaries indicates that there is a substantial short-term child penalty whereas the flatter salary and income trajectories post-parenthood indicate a persistent long-term child penalty. The level difference between the groups can be due to many reasons, but due to the event study design, the significant difference in age at first adoption is important. Lesbian women are in general younger in the event year, meaning they are earlier in their careers where the salaries are lower. This possible violation of common trend will be discussed and addressed in the next section. Panel C. shows

\textsuperscript{60} The yearly earnings are pulled from the IND (income) register from Statistics Denmark. The variable used to construct the salary variable is LOENMV, which consists of all labor income, fringe benefits, other tax-free income, employee bonuses, and realizations of stock options. The variable used to construct the income variable is PERINDKIALT, which consists of all income from labor, transfers, property and other unspecified contributions.
the labor market participation rate defined as having any salary in the given year, and Panel D. show the percentage of these who are only part time employees, defined as working less than 30 hours a week. Following the patterns of income and salary, there is a small decrease in participation across all women when entering parenthood, while men’s participation seem uninfluenced by parenthood. On the other hand, Panel D. shows that everybody decreases their working hours in the year of adoption and settles on working hour levels a little below that of the pre-parenthood level. Figure 2 Panel E. shows the number of days on parental leave for the parents across the different household types. It shows that heterosexual women spend the most time on parental leave with around 200 days in the year of adoption. This amount is shared evenly between the two mothers in same-sex relationships, where both the first and second income partner takes around 100 days each in the year of adoption. Lastly, the heterosexual men take only a minor part of the overall parental leave, with around 30 days in the year of adoption. This illustrates an important difference between men and women, but also between heterosexual and same-sex couples. The women are still the primary caretakers in heterosexual households, even in adoption situations, where sexual comparative advantage is less evident (no pregnancy or nursing). On the contrary, same-sex couples split the caretaking equally on average, no matter the pre-parenthood income power, education or age. This is on average across the households, meaning that there still can be specialization and variation in the parental leave taken within the household.

61 The working hours are not directly observable, but it is possible to construct an approximate measure of the individuals working hours based on their tax bills. There is a special lump-sum fee mandatory for all people with labor income. This lump-sum fee depends solely on the working hours and not the income. There are three levels of fees for three intervals of working hours for which an estimate of the individual working hours can be approximated. These variables are constructed on the basis of ATPXX from the IDA register.
62 The days on parental leave is based on the variable SAGSART from the SGDP register.
Figure 2 – Individual yearly salary pre and post adoption
Panel A. shows the crude mean individual yearly salary across households. Panel B. Shows the crude mean individual yearly income. Panel C. shows the labor market participation. Panel D. show the ratio of part-time to full-time positions. Panel E. shows the crude mean of parental leave taken. All variables are depicted across the different gender and income types in each year from Event-3 to Event+5. Event=0 in the year of the households first adoption. Hetero Men is the mean for the adopting men in heterosexual households, Hetero Women is the mean for the adopting women in heterosexual households, Lesbian FI is the mean of the adopting women in same-sex households with the highest intra-household pre-adoption income, Lesbian SI is the mean of the adopting women in same-sex households with the lowest intra-household pre-adoption income. All Lesbian is the mean of all adopting women in same-sex households.
7. Econometric Strategy and Results

The goal of this paper is to study the gender bias in child penalty - often denoted the family gap, motherhood penalty or mommy track. Thus, the idea is not to test the existence of the child penalty, but rather to investigate how the gender itself influences the observed differences in earnings between fathers and mothers. The gender’s influence on child penalty relies on multiple factors. Women may face hostile labor markets but may also suffer from their partner's lack of engagement in the household production. Having a male partner may lead to gender stereotypical household organization, which may force women to detract themselves from the labor market, to a higher degree than they desire.

Hence, the comparison I need is not childless women, but rather women facing different family situation. More specifically women in a gender invariant relationship entering parenthood, i.e., lesbian couples having children. If the mother does not differ from her partner in gender, then the observed effect of having a child cannot be due to the within household gender differences. Nor can it be due to gender heterogeneity in post parenthood discrimination in the labor market.

I apply a Difference-in-Difference (DiD) event study design using heterosexual couples as the treatment group and lesbian couples as the control group. The adoption of the household’s first child is the event in this setting. This design is suited to analyze the household, individual and intra household dynamics in economic outcomes when having children. Other studies have applied similar approaches looking only at heterosexual childbearing families mainly using men and women with delayed childbirth or couples who never had children as controls (Kleven et al., 2018; Angelov et al., 2016). This entails a strong assumption about common trend on observables between parents and non-parents, stating that fertility planning is somewhat exogenous. In this study, no such assumption is needed since I compare parents with same family situations on both sides, who also face the same economic and labor market situation.
The reason why the DiD approach comes in handy is that there is a pre-parental level difference in the total household earnings between the heterosexual and lesbian households. As long as the common trend assumption is not violated, the properties of DiD method ensures that the difference between the two family types observed over time is due to the difference in how they cope with having their first child. Figure 3 shows similar preparenthood trends for parents across gender and family type, which supports the common trend assumption. Since both heterosexual and lesbian parents face the same Danish labor market and institutional settings there is furthermore little reason to believe that the common trend assumption is violated.63

The heterosexual and lesbian women differ significantly at one central variable to the salary formation, namely the age at first adoption, shown in Table 1. The lesbian mothers are in general younger at the time of adoption, which also leads to the difference in labor market experiences. This might be the reason why there are level differences in the salaries in the event study graphs of Figure 2. Level differences are not violating any conditions needed for DiD to be unbiased as long as the trends between the groups are common. Furthermore, including controls for these two variables in the DiD-regressions should address the bias concerns, if the impact of age and experience at first adoption on child penalty is linear in time. However, the impact of work-interruptions - such as having children - on the earnings trajectories may vary depending on the career timing.64 I address the possible problem with non-linearity in the unbalanced variables between treatment and control group in the robustness check section 7.4.65

63 Furthermore, the two types of couple share the fertility situations. As seen in the summary statistics, all the parents are relatively old when entering parenthood. This is probably due to that adoptions are not parents’ first choice of method to have children, both for heterosexual and lesbian couples who most likely have tried other fertility processes before engaging in the adoption system.

64 There is a big literature on the birth timing effect on labor market outcomes. No real consensus is present. Some studies find no causal effect of birth timing, while others find significant positive effects of waiting. The results also varies between fathers and mothers. For further discussion on fertility timing and labor market outcomes see Rosenbaum (2019); Herr (2016); and Fitzenberger (2013).

65 If it is worse to have children earlier than later, a linear control for age and experience at first adoption will overestimate the child penalty for lesbian mothers, since they adopt earlier. The results show that lesbian mothers have lower child penalty than heterosexual mothers, thus this result will at must be a conservative one.
Now let $LE_s$ be a dummy for lesbian couples and $d_t$ be a time-dummy that switches on for observations obtained after entering parenthood (i.e., adopting). Then

$$Y_{jst} = \alpha + \gamma LE_s + \lambda d_t + \beta (LE_s \cdot d_t) + \epsilon_{jst},$$

where $Y$ is the total household earnings in family, $j$, at household sex composition, $s$. $\alpha$ is the intercept, and $\epsilon$ is the error term, assuming that $E(\epsilon_{jst}|s,t) = 0$. Each term represents an interesting conditional mean for interpretation:

- $\alpha = E(Y_{jst}|s = HE, t = Pre) - Y_{HE} + \lambda_{Pre}$
- $\gamma = E(Y_{jst}|s = LE, t = Pre) - E(Y_{jst}|s = HE, t = Pre) = Y_{LE} - Y_{HE}$
- $\lambda = E(Y_{jst}|s = HE, t = Post) - E(Y_{jst}|s = HE, t = Pre) = \lambda_{Post} - \lambda_{Pre}$
- $\beta = [E(Y_{jst}|s = LE, t = Post) - E(Y_{jst}|s = LE, t = Pre) - E(Y_{jst}|s = HE, t = Post) - E(Y_{jst}|s = HE, t = Pre)]$

Where $HE$ and $LE$ indicate heterosexual and lesbian households respectively and $Pre$ and $Post$ indicates if the measurement time is pre or post parenthood. $\alpha$ is the baseline heterosexual total household earnings before event i.e., pre parenthood. $\gamma$ is the pre-parenthood differences between the heterosexual and lesbian couples. $\lambda$ is the effect of entering parenthood for the heterosexual couples. $\beta$ is the causal effect of interest, which in this particular setting measures how much of the gender specific child penalty stems from intra-household gender composition.

Consider the following model:

$$Y_{jst} = \alpha + \gamma LE_s + \lambda d_t + \beta (LE_s \cdot d_t) + X'_{jst} \delta + \theta R_{jst} + \psi C_{jst} + \epsilon_{jst},$$

Where $X_{jst}$ is a vector of household type and time-invariant covariates, such as the households’ education level, age at first adoption and labor market experience. $R$ is regional dummies and $C$ is year dummies. These controls are included to address potential biases arising from either differences in observables or violation of the common trend assumption. These are important
controls due to significant differences between heterosexual and same-sex households in the age-at-first-adoption and pre-adopting labor market experiences.

The empirical analysis consists of three parts, each studying a different aspect of the child penalty across gender and household type. First, an investigation of the difference between lesbian and heterosexual child penalty in the aggregated household earnings. Second, the child penalty for the individual parents across gender and type is studied. Third, an analysis of the dynamics in the intra-household earnings gap pre and post the household’s first adoption.

7.1 Household Earnings

If the child penalty is gender specific to women due to gender comparative advantages in childrearing or labor market discrimination against mothers – as described in the introduction – then lesbian households must experience a higher accumulated child penalty. On the other hand, if the child penalty is due to other factors, such as gender stereotypic organization of the household time allocation, then it is not obvious that lesbian households will experience a bigger child penalty than the heterosexual households on aggregate. As shown in the data section, the accumulated days of parental leave taken around adoptions are somewhat similar for heterosexual and lesbian households. Despite this similarity in aggregated days of leave, the allocation between the partners is rather different where women take almost all the leave in heterosexual households the lesbian women share it equally. I therefore apply a DiD model on the household income pre and post the first adoption between heterosexual and lesbian households in the setup of equation (2). Now $Y$ is the logarithm of household earnings, $LE$ is a dummy equal one for the lesbian household, $d$ is a dummy indicating parenthood. I control for parental age at the time of adoption, household education level, region of residence and include time-dummies. The coefficient for the dummy, $LE$, captures the overall level difference in the earnings between the heterosexual and lesbian households. The coefficient for the parenthood dummy, $d$, is the overall
household child penalty across both types of households. The coefficient for the interaction term, $LE*d_j$, is the difference in the relative child penalty between heterosexual and lesbian households. $j$, is the household index and $t = 0, 1, \ldots, 5$ denotes the year relative to the couple’s first adoption. Figure 3 depicts the coefficients for the relative child penalty between heterosexual and lesbian households, while table 3 shows the full regression outputs on the yearly salary from Event+0 to Event+5. The regressions are run for both the aggregated household income and salary. It is shown that the child penalty in household earnings is higher for heterosexual couples than for lesbian couples. Lesbian households experience a 12-18% salary premium in the child penalty compared to heterosexual households, meaning that lesbian households have a substantially lower child penalty than heterosexual households. This indicates that the child penalty is not bound to the gender of the parents but is rather due to the gender heterogeneity within the households, where lesbian couples’ way of organizing households post parenthood seems more efficient for the income formation.\textsuperscript{66} This is also interesting for the discrimination argument and questions the earlier results indicating that the labor market discriminates against mothers per se.\textsuperscript{67} In general, this result goes against that mothers should experience higher child penalty due their gender one way or the other. If higher child penalty is idiosyncratic to being a mother, then lesbian households, which have two mothers, should experience a higher overall child penalty than heterosexual one-mother households. These results are also interesting seen through traditional economic perspective, where theories on gender differences in comparative advantages of childrearing and household production together with gains from division of labor and specialization are cornerstones in household economics theory. The positive effect on household earnings due to non-specialization of partners within the household goes against the traditional view on how to optimize household outcomes post-parenthood. While this is still only

\textsuperscript{66} It would be interesting to show whether this income premium come on expense to child development and performance. Unfortunately, this is beyond the scope of this study, since I am not able to follow the households for sufficient number of years at this stage. However, this question will be of interest in future follow up studies.

\textsuperscript{67} Surely, labor market discrimination can still exist even through these results. Although, the size is questionable due to these outcomes.
indicative, it is certain that a large part of women’s child penalty is decided in the household and not at the labor market.68

The other coefficients in the regressions show that lesbian households experience lower income levels in general and both household type’s earnings is lowered in the first 2-3 years of parenthood, whereafter it is restored and afterwards increased. Having a higher household level of education and living in the capital region of Denmark are - not surprisingly - correlated with higher earnings. This study is only able to present the short-term effect – following parents five years after getting their first child. It would be interesting to do a follow up study in the future, and follow the parents for a longer period, to observe whether these preliminary results also reflect the long-term outcomes and to measure how the difference in the household organization affect the children’s development and wellbeing.

The income variable captures everything from labor earnings, public transfers and capital gains. Although income primarily consists of labor earnings, it is not a clean measure of productivity or labor market outcomes, which is why the yearly salary is used as well. Again, I take the logarithm of the earnings measures to get a percentage approximation of the relative size of child penalty. Whereas there are no households with zero income, some households have single years without labor earnings, for which they are excluded from the sample.69 The results on log yearly salaries are similar to the ones on the log incomes, which underlines that the lesbian households are able to lower the labor earnings penalty due to parenthood. This indicates that it is possible for women to maintain careers even in the wake of having children, especially in the absence of a patriarch.

68 The other leg of the specialization gains is how the children fares. Unfortunately, I cannot follow the households for more than five years after adoptions and none useable variables on wellbeing and skills are available for children less than five years. However, there is little reason to believe that the child wellbeing should differ significantly in the lesbian and heterosexual households. Browne (2007) and Golombok (2015) finds evidence for greater child wellbeing raised in lesbian households.

69 In practice, less than 1 % of the total sample of the households have zero labor earnings within a year. It is almost impossible to have a zero income for a household in Denmark, where almost everybody is compensated by the social security if not able to generate income themselves. Furthermore, the presence of labor earnings is even more unlikely in this sample, who all have been through adoption procedures demanding economic stability.
Figure 3 – Difference-in-Difference coefficient for child penalty in earnings between Lesbian Household to Heterosexual Households

The figures show the Difference-in-Difference regression estimates of relative child penalty for lesbian household to heterosexual households. The dependent variables are the natural logarithm of yearly income, shown in Panel A, and the natural logarithm of yearly salary, shown in Panel B. The main explanatory variable in both regressions is $L_E^d$, which is the relative child penalty for lesbian households to heterosexual households due to parenthood. Additional and non-depicted independent variables used in both regressions are as described in Table 1. An indicator variable of having adopted, an indicator of household type of parental gender composition. Additional controls are used for household educational attainment (measured as the collective years of education), age at first adoption, labor market experience (measured as the collective years of labor market experience in the year before adopting), dummy indicating if the mother is adopting in the measurement year, a categorical variable of area of residence, and year dummies. The estimates are shown for Event+0 to Event+5. Robust standard errors are shown in the parenthesis. The dots are the point estimates, whereas the lines indicates the confidence intervals on 99% level.

**Panel A. Income**

**Panel B. Salary**

![Graphs showing the Difference-in-Difference regression estimates of relative child penalty for lesbian household to heterosexual households.](image-url)
Table 3 – Difference-in-Difference coefficient for child penalty in earnings between Lesbian Household to Heterosexual Households

The table shows the Difference-in-Difference regression estimates of relative child penalty for lesbian household to heterosexual households. The dependent variable is the natural logarithm of yearly salary. The main explanatory variable in both regressions is Parenthood*LE, which is the relative child penalty for lesbian households to heterosexual households due to parenthood. Additional independent variables used in the regressions are an indicator variable of Parenthood estimating the general salary effect of becoming parents on household level and an indicator of household type, Lesbian, estimating the general salary differences between same-sex and different-sex households. Additional controls are used for household educational attainment (Household Education, measured as the collective years of education), age at first adoption, Adoption Year is a dummy indicating if the household is adopting in the measurement year, Experience is the household aggregated year of labor market experience in the year before adopting, and non-depicted dummies for area of residence and years. The estimates are shown for Event+0 to Event+5. Robust standard errors are shown in the parenthesis. ***,**,* correspond to statistical significance at 1%, 5% and 10% level respectively. Variating observation numbers are due to few zero salaries that are dropped due to the log-transformation.

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7.2 Individual Parent Earnings

Having shown that lesbian households’ earnings do not suffer as much due to parenthood as heterosexuals’, it is interesting to decompose the effect between the parents within the household. In this section, I compare the heterosexual mothers to the lesbian mothers. It is not evident how heterosexual women should be compared to the lesbian mothers. In the absence of a man, the lesbian couples may form household roles based on factors other than the gender. The lack of women’s bargaining power within the household is described repeatedly in the bargaining literature (as described in the introduction), but other factors than gender have also
been proposed to influence the bargaining power, such as relative age, education and income.\textsuperscript{70} I therefore make several comparison groups based on these bargaining factors. First, I make a straightforward comparison of all heterosexual women to all lesbian women, expecting greater penalty for the heterosexual women almost by default. Second, I account for bargaining power through selection of five different comparison groups. I compare heterosexual women to the lesbian partner (i) with the lowest pre parenthood earnings, (ii) with the lowest education, (iii) who is youngest, (iv) with the least pre parenthood labor market experience, and (v) who is taking the majority of the parental leave. Comparison group (v) is highly endogenous, since deciding who to take the majority of the parental leave is negatively correlated with the relative earnings potential within the household. Keeping this in mind, the comparison group still offers some insights in the cost of being the primary caretaker within the household. I apply the same DiD design over the same years as the one used on household levels described above.

I find that heterosexual mothers experience higher child penalties in salaries than lesbian mothers in general. I furthermore find that heterosexual mothers experience higher child penalties even when compared to the lesbian mothers with the weaker bargaining position. This is true when comparing heterosexual mothers to the lesbian mothers who in their relationship either are the second income bearer pre-adoption, holds the least education, is the youngest, has the least labor experience or is taking the majority of the parental leave. The results holds for both total income (untabulated) and salary penalties, shown in figure 4.\textsuperscript{71} The results are not surprising since the heterosexual male does not suffer significantly from fatherhood together with the fact that the heterosexual households do worse than lesbian households on aggregate. This

\textsuperscript{70} Unfortunately, I do not have any wealth measure, which otherwise are widely used as an explanation for bargaining power.

\textsuperscript{71} The full regression output is reported in table A2 in the Appendix. In further untabulated figures, I restrict the comparisons further by only including the heterosexual mothers with the least bargaining power within the household (i.e., lowest pre-parenthood income, lowest education, youngest and taking the most parental leave). As most heterosexual mothers have the lower bargaining power measured by these metrics within their households, the results are similar to the ones shown in figure 4. The results are also robust to excluding any parent who is undertaking an education within the measurement years.
mean that the heterosexual mothers must account for the large child penalty observed in heterosexual households.

Figure 4 – Difference-in-Difference coefficients for child penalty in earnings between Heterosexual Women to Lesbian Women

The figures show the Difference-in-Difference regression estimates of relative child penalty for heterosexual women to lesbian women. The dependent variable is the natural logarithm of yearly salary. The main explanatory variable is \( LE*d \), which is the relative child penalty for lesbian households to heterosexual households due to parenthood. Additional and untabulated independent variables used in the regressions are: an indicator variable of motherhood. An indicator variable of household gender composition type. Controls for educational attainment, age at first adoption, labor experience, a dummy indicating adoption within the year, a categorical variable of area of residence, and year dummies. The categories All compares all heterosexual women to all lesbian women. Low Earning compares heterosexual to lesbian women who holds the second income within the household. Youngest compares heterosexual to lesbian women who are the youngest within the household. Low Educated compares heterosexual to lesbian women who have the lowest educational attainment within the household. Most Leave compares heterosexual to lesbian women who takes the most maternity leave within the household. Least Experience compares the heterosexual to lesbian women who have the least labor market experience within the household at the time of adoption. The estimates are shown for Event+0 to Event+5. The dots are the point estimates, whereas the lines indicate the confidence intervals on 99 % level.

These differences in child penalty across heterosexual and lesbian women can come from three margins: labor participation, hours worked and wage rates. It is thus interesting to decompose effects and observe what is causing this division in child penalty for women in heterosexual- and lesbian households. Figure 5 shows two DiD outcomes between mothers in heterosexual households compared to mothers in lesbian households.\(^\text{72}\) The same DiD regression model is applied, but now the outcome variables are a dummy for labor market participation within the year (1, indicating participation, 0, indicating no participation) depicted in Panel A., and a dummy for having a part-time position (1, indicating part-time, 0, indicating full-time) depicted in Panel B. Only women having labor market participation within the year are included in the results shown in Panel B. Panel A. shows that the difference in earning between the lesbian

\(^{72}\) The full regression output is reported in table A3 in the Appendix
and the heterosexual mothers found above does not come from changes in labor market participation. Except some indication of differences in the first year after adopting, there are no differences between heterosexual and lesbian mothers. This is true when comparing all heterosexual mothers both to all lesbian mothers and to lesbian mothers with low intra household bargaining power. On the other hand, Panel B. show that among the women participating, more heterosexual women moves from a full-time to a part-time position than lesbian women do when entering motherhood. This is true when comparing heterosexual mothers to both all lesbian mothers and the lesbian mothers with low intra household bargaining power. Overall, this indicates that motherhood does not affect the heterosexual and the lesbian mothers’ labor market participation differently, but more heterosexual mothers lower their working hours compared to lesbian mothers after entering motherhood.

Figure 5 – DiD coefficients for the child penalty in labor market participation and working hours between Heterosexual Women to Lesbian Women

The figures show the Difference-in-Difference regression estimates of relative child penalty in labor participation and full-time positions for heterosexual women to lesbian women. In Panel A, the dependent variable is a dummy indicating one for an individual participating in the labor market within a year. In Panel B, the dependent variable is a dummy indicating one for labor market participants holding a part-time position. Both panels show the results across the different samples of mothers based on bargaining power (explained in section 6.2 and Figure 4). The main explanatory variable in is $LE^*d$, which is the relative child penalty for lesbian households to heterosexual households due to parenthood. Additional and untabulated independent variables used in the regressions are; an indicator variable of motherhood, an indicator variable of household gender composition type, controls for educational attainment, age at first adoption, labor experience, a dummy indicating adoption within the year, a categorical variable of area of residence, and year dummies. The estimates are shown for Event+0 to Event+5. The dots are the point estimates, whereas the lines indicate the confidence intervals on 99% level.
7.3 Intra Household Earnings Gap

The obvious follow up question then is how becoming parents influences the intra household earnings gap. To estimate the intra household earnings gap due to parenthood, I apply the following DiD specification:

\[
Y_{jct} = \alpha + \sum_{m=0}^{5} \alpha_m 1[t = m] + \sum_{k=1994}^{2014} \varphi_k 1[c = k] + \theta \bar{Y}_{(t-1)j} + X_{(t-1)j}^\delta + \varepsilon_{jct}
\]

where \( t = -1, 0, \ldots, 5 \) denotes the year relative to adoption, the calendar year is indexed by \( c = 1994, \ldots, 2014 \), \( Y_{jct} \) is the within-couple difference in income or salary, \( j \) is the couple index, \( \bar{Y}_{(t-1)j} \) is the within-couple difference in income or salary one year prior to adoption, \( X_{(t-1)j} \) is vector containing within-couple differences in age and pre-child years of education for couple \( j \) one year prior to adoption. \( 1[ \ldots ] = 1 \) if the expression within parentheses is true and 0 otherwise. \( \varphi_k \) is the calendar year control for idiosyncratic time trends or shocks, which is important since there is variation in the calendar year of first adoption. \( \varepsilon_{jct} \) is the error term.

The parameters of interest \( \alpha_m \) for \( m = 0, 1, \ldots, 5 \), identify the effects of parenthood on the intra household earnings gap at the year of adoption and up to 5 years after, relative to the pre-adoption gap. Thus, the parameters identify the approximate change in the intra household percentage earnings gap compared to the pre-adoption gap for each year after the adoption year.

The dependent variables are the absolute salary and the log(salary) differences between the partners. For the heterosexual households it is the man’s salary subtracted by the woman’s. For the lesbian households it is the salary of the woman with the highest pre-parenthood income subtracted by the salary of the woman with the lowest pre-parenthood income. Figure 6 shows that the intra-household salary difference increases relatively more in heterosexual households.
compared to lesbian households when entering parenthood.\textsuperscript{73} Meaning that parenthood affects the partners more unequally in heterosexual households than in lesbian households.

**Figure 6** – *Difference-in-Difference coefficient for intra-household earnings gap entering parenthood between Heterosexual and Lesbian households*

The figure shows the Difference-in-Difference regression estimate of relative development in the intra-household salary gap in parenthood for different-sex and same-sex households. The dependent variable is the intra household difference in absolute salary (Panel A.) and log salary (Panel B) between the partners. For the different-sex households it is the man’s salary subtracted by the woman’s. For the same-sex households it is the salary of the women with the highest pre-parenthood income subtracted by the women with the lowest pre-parenthood income. The main explanatory variable in the regressions is $LE*\delta$, which is the relative effect of parenthood for the lesbian households to the heterosexual households. Additional (untabulated) independent variables used in regressions are an indicator variable of parenthood estimating the general effect of becoming a parent, and an indicator of household type estimating the general intra-household differences in salary between different-sex and same-sex households. Controls for the intra household differences one year prior to the first adoption in the parents’ educational attainment (measured as the collective years of education), age at first adoption (i.e., becoming parent) and salary as well as a categorical variable of area of residence are used. Lastly, the regressions include year dummies. The absolute estimates are in DKK (1DKK is approximately 0.157 USD). The estimates are shown for Event+0 to Event+5. The dots are the point estimates, whereas the lines indicates the confidence intervals on 99 % level.

Panel A.  
Panel B.

\section*{7.4 Robustness tests}

The common trend assumption is central in obtaining unbiased estimates when applying a DiD model. One major concern that may violate this assumption is the significant differences in age and labor experiences at first adoption between the opposite and same-sex households. The impact of having children may vary significantly across ages and career stages.\textsuperscript{74} The estimated effect of the child penalty for lesbians might be overestimated if postponing parenthood is good for labor market outcomes, since they adopt earlier in life compared heterosexual women on average.

\textsuperscript{73} The full regression output is reported in table A4 in the Appendix

\textsuperscript{74} There is a big literature on this which have not reach any consensus. For further discussion on fertility timing and labor market outcomes see Rosenbaum (2019), Herr (2016), Fitzenberger (2012).
So far, I have addressed the potential bias in sample differences by including linear controls for age and experience at the time of adoption in the regressions. The question is whether these are linear in time and thus whether a linear control for these is sufficient. The common support, i.e., the overlap, between the treatment and control group is large, even though the sample means are unequal. This allows me to apply Inverse Probability Weights, IWP, which addresses the concern of biases due to systematic difference in timing of first adoption. I do this for the mothers estimating the individual level child penalty. First, I estimate the propensity score, \( \hat{p} \), of being a lesbian women, \( LE=1 \), on observables covariates, \( X \), using a logit model. Lesbian women, \( LE=1 \), get the weights \( w = 1/\hat{p} \), while heterosexual women, \( LE=0 \) get the weights \( w = 1/(1 - \hat{p}) \). Notice that \( \hat{p} \) depend on \( X \), so \( w \) depends on \( X \) and \( LE \). Weighting the sample serves as a method to compare the most relevant of the control observations to the treated in order to elicit the true effect of being treated. In this case, the causal difference in child penalty between lesbian and heterosexual women.

I test different specifications of the matching function. In the most specified model, the propensity score is derived from the age, labor market experience, and educational level in the year at first adoption. After obtaining the IPW on the basis of propensity scores, I apply them together with the DiD model from the main analysis. I do not include the controls used to derive the propensity scores in the DiD models, since it would lead to over-control problems.

These tests are only more precise than the unweighted normal DiD with linear controls, if we assume that age and experience at first adoptions are not linear to the child penalty and that there are sufficient amount of control observations without common support in the treatment group. The results show that the point estimates are robust to these new specifications, but the standard errors increased pushing some of the new estimates to be only borderline significant.

\[ ^{75} \text{For further details on Propensity Scores for Matching methods using observables to account for systematic differences between treatment and control see Rosenbaum & Rubin (1985). For further details on the Inverse Probability Weighting method see (Robin et al., 1994).} \]
even though the point estimates do not change significantly. The results can be seen in Figure A6 in the appendix.

Who is taking the parental leave is highly endogenous, since it is negatively correlated with the relative earnings potential within the household. Although endogenous, Hald (2018) suggests that the intra household variation affects the division of labor and therefore is a strong determiner for the intra household gender wage gap.\footnote{Olafsson & Steingimsdottir (2019) find that parents who are entitled to paternity leave are less likely to separate using a reform in Iceland that offered one month of parental leave earmarked to fathers with a child born on or after January 2001.} Earlier I tested the child penalty between the mothers of opposite and same-sex households with the restriction of them taking the most leave within the household. I found that child penalty for the caretaking lesbian mothers are lower than for the caretaking heterosexual mothers. I now expand on this model and insert a continuous variable counting the days of parental leave around the first adoption to evaluate the relative intra household caretaking as well as the absolute effect of parental leave days on the child penalty. As seen in Figure 2 – Panel E, the number of days it takes to be the parent with the most leave is on average lower in same-sex than in opposite-sex household. The coefficient for days of leave is negative and statistically significant throughout the full period, but the child penalty remains lower for the lesbian women. This indicate that parental leave has both a direct and an indirect effect. The direct being that the negative effect increases in number of days away from the labor market, while the indirect comes from being the one taking most of the parental leave within the household and thus indicating that the individual is the primary caretaker in other aspects as well.

Following the hypothesis that whom you have children with and how much they participate in the household production is important for your own labor market outcomes, I conduct an additional test which includes the number of days of parental leave (or share of the household total parental leave) the partner takes in the regressions estimating the primary
caretaker’s earning trajectories. The result that the child penalty is lower for the lesbian women is robust to including these controls. The outputs also show that the higher share taken by the partner the lower the penalty for the primary caretaker no matter household gender composition. The results can be seen in Figure and Table A5 and A6 in the appendix.

8. Conclusion

The gender gap in earnings is an intensely debated topic in most western countries. Even though the western world has experienced a significant convergence in earnings between the genders, a significant and persistent gap still exists. In this paper, I take on a new approach to analyze this puzzle. I exploit the intra household difference in gender composition between heterosexual and lesbian couples. There are multiple advantages in evaluating the child penalty in same-sex couples compared to heterosexual couples. First, the comparative advantages and division of labor within the households are non-gender specific. Second, the partners in same-sex relations will, by default, face the same kind of labor market treatment i.e., gender based advantages and disadvantages.

The first and relatively non-central result from this study is that the pattern of gender inequality in child penalty persists in heterosexual couples that adopt. Even though adopting eliminates the potential gender bias that results from pregnancy and nursing and thus lowers the gender comparative advantage in childrearing, there remains a large child penalty for mothers. As in traditional childbirth households, there is no child penalty for fathers.

I then turn to present three main results on the household organizations impact on the child penalty. First, I show that the child penalty on aggregate is lower in lesbian households relative to heterosexual households, even after controlling for education, timing of parenthood, and area of residence. Second, looking at the individual parents’ child penalty and comparing heterosexual women to the lesbian partner with less bargaining power shows that the child
penalty is lower for lesbian women independently of the intra household bargaining position.
The analysis also reveals that this difference in child penalty does not come from changes in labor market participation, but primarily from wage rates and the higher tendency for heterosexual women to take on part-time rather than full-time positions. I also test whether these results depends on the heterogeneous organization of parental leave between the two types of household. After controlling for days of parental leave taken and the share of parental leave taken by the partner, I still find that lesbian women have lower child penalties than heterosexual women. Third, I show that the intra household earnings gap increases significantly due to parenthood in heterosexual households while it does not in lesbians households.

All together, these results indicate that the observed gender inequality in child penalty is not a universal gender entity. I show that the bargaining power in lesbian households has little to do with the child penalty, where it seems that childrearing chores are shared rather evenly across partners of different ages, education and incomes. These results are also interesting from the more traditional economic perspective, where theories on gender differences in comparative advantages of childrearing and household production together with gains from division of labor and specialization are cornerstones in household economics theory. The positive effect on household earnings due to more egalitarian and non-specialized allocation of labor between partners within the household goes against the traditional view on how to optimize household outcomes post parenthood.

The presented results are all short-term effects, since I am not able to follow the households for longer than five years after their first adoption. This prohibits investigations of the children’s development and performance across the household types either, since few measures are made for children younger than 5. One follow up question of interest is whether the lower child penalties compromise the children’s outcomes.
Whether equally shared household production is overall better or not is not for this study to decide. These results show that the child penalty for mothers is much dependent on the partner and household organization and less dependent on labor market attitudes against mothers per se – although discrimination cannot be rejected and is still most certainly a significant problem. The results show that the child penalty can be lowered by sharing the household production with a partner that is more engaged in childrearing and that this household organization most likely does not lower the overall household earnings, but rather the opposite.
References:


Appendix

Figure A1 – Educational attainments
Show distribution of highest obtained educational level across household type, gender and income type. School is elementary school of 10 years from the age 5 to 15. High School is additional 3 years of schooling which is also qualifying for further academic studies. Vocational is all vocational education of 2-4 years often taken instead of high school. Short Further is all short post high school training of 1-1.5 years in a specific trait. Undergrad consist of all academic bachelors and professional bachelors. Grad consist of all master and PhD educations.
Table A2 – Difference-in-Difference coefficients for child penalty in earnings between Heterosexual Women to Lesbian Women

The tables show the Difference-in-Difference regression estimates of relative child penalty for heterosexual women to lesbian women. The dependent variable is the natural logarithm of yearly salary. The main explanatory variable in the regressions is Parenthood*Lesbian, which is the relative child penalty for heterosexual mothers to lesbian mothers due to parenthood. Additional independent variables used in the regressions are an indicator variable of motherhood estimating the general effect of becoming a mother on the salary, and an indicator of household type estimating the general earnings difference between heterosexual and lesbian women. Controls for educational attainment (measured as the collective years of education), age at first adoption (becoming parents) and a categorical variable of area of residence are used. Lastly, the regressions include year dummies. Panel A. compares heterosexual women to all lesbian women. Panel B. compares all heterosexual women to the lesbian with the second income within the household. Panel C. compares all heterosexual women to the lesbian who is the youngest within the household. Panel D. compares all heterosexual women to the lesbian with the lowest educational attainment within the household. Panel E. compares all heterosexual women to the lesbian who takes the most maternity leave within the household. The estimates are shown for Event+0 to Event+5. ***, **, * correspond to statistical significance at 1%, 5% and 10% level respectively. Variating observation numbers are due to few zero salaries that are dropped due to the log-transformation.

Panel A. Heterosexual mothers and all lesbian mothers

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Region Control       | Yes       | Yes        | Yes       | Yes       | Yes       |
Year Dummy            | Yes       | Yes        | Yes       | Yes       | Yes       |
Observations          | 4,795     | 4,729      | 4,664     | 4,579     | 4,503     |
R-squared             | 0.089     | 0.097      | 0.095     | 0.110     | 0.104     |
Panel B. Within household second income heterosexual mothers and lesbian mothers

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### Panel C. Within household youngest heterosexual mothers and lesbian mothers

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Panel D. Within household lowest educated heterosexual mothers and lesbian mothers

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Panel E. Most parental leave taking heterosexual mothers and lesbian mothers

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Panel F. Within household least labor market experienced heterosexual mothers and lesbian mothers

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Table A4 – Difference-in-Difference coefficient for intra-household earnings gap entering parenthood between Heterosexual and Lesbian households:
The tables show the Difference-in-Difference regression estimate of relative development in the intra-household salary gap in parenthood for different-sex and same-sex households. The dependent variable is the intra household difference in absolute salary (Panel A) and log salary (Panel B) between the partners. For the different-sex households it is the man’s salary subtracted by the woman’s. For the same-sex households it is the salary of the women with the highest pre-parenthood income subtracted by the women with the lowest pre-parenthood income. The main explanatory variable in the regressions is LE*δd, which is the relative effect of parenthood for the lesbian households to the heterosexual households. Additional independent variables used in the regressions are an indicator variable of parenthesis estimating the general effect of becoming a parent, and an indicator of household type estimating the general intra-household differences in salary between different-sex and same-sex households. Controls for the intra household differences one year prior to the first adoption in the parents’ educational attainment (measured as the collective years of education), age at first adoption (i.e., becoming parent) and salary as well as a categorical variable of area of residence are used. Lastly, the regressions include year dummies. The absolute estimates are in DKK (1DKK is approximately 0.157 USD). The estimates are shown for Event+0 to Event+5. ***, **, * correspond to statistical significance at 1%, 5% and 10% level respectively. Variating observation numbers in Panel B. are due to few zero salaries that are dropped due to the log-transformation.

Panel A. Intra-household difference in yearly absolute salary

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<td>39,727.5905***</td>
<td>61,052.8528***</td>
<td>79,474.1386***</td>
<td>66,540.3914***</td>
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<td>(7,425.828)</td>
<td>(8,938.134)</td>
<td>(10,071.012)</td>
<td>(11,910.679)</td>
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<td>(13,075.805)</td>
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<td>(16,052.701)</td>
<td>(18,478.470)</td>
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<td>(20,956.220)</td>
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<td>27,925.1991**</td>
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<td>∆ Intra Household Salary</td>
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<td>(770,250)</td>
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<td>6,477.2845***</td>
<td>6,508.1437***</td>
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<td>(852,386)</td>
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Region Control: Yes Yes Yes Yes Yes Yes
Year Dummy: Yes Yes Yes Yes Yes Yes
Observations: 3,650 3,650 3,650 3,650 3,650 3,650
R-squared: 0.843 0.757 0.698 0.649 0.639 0.613
### Panel B. Intra-household difference in yearly log salary

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<td>0.471</td>
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The tables show the Difference-in-Difference regression estimates of relative child penalty for heterosexual women to lesbian women. The dependent variable is the natural logarithm of yearly salary. The main explanatory variable in the regressions is \(\text{Parenthood} \times \text{Lesbian}\), which is the relative child penalty for heterosexual mothers to lesbian mothers due to parenthood. Additional and untabulated independent variables used in the regressions are; an indicator variable of motherhood. An indicator variable of household gender composition type. Days of parental leave taken around first adoption. Controls for educational attainment, age at first adoption, labor experience, a dummy indicating adoption within the year, a categorical variable of area of residence, and year dummies. Lastly, the regressions include year dummies. Panel A. compares heterosexual women to all lesbian women with at least one day of parental leave taken around first adoption. Panel B. compares heterosexual women to all lesbian women that takes the most parental leave within the household. The estimates are shown for Event+0 to Event+5. ***, **, * correspond to statistical significance at 1%, 5% and 10% level respectively. Variating observation numbers are due to few zero salaries that are dropped due to the log-transformation.

**Panel A.** All women

**Panel B.** Women with the most intra household leave
### Regression output for Figure A5, Panel A

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<tr>
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### Regression output for Figure A5, Panel B

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</table>
Figure and Table A6 – DiD coefficients for child penalty in earnings between Heterosexual Women to Lesbian Women – Controlling for the partners share of parental leave around first childbirth

The tables show the Difference-in-Difference regression estimates of relative child penalty for heterosexual women to lesbian women. The dependent variable is the natural logarithm of yearly salary. The main explanatory variable in the regressions is Parenthood*Lesbian, which is the relative child penalty for heterosexual mothers to lesbian mothers due to parenthood. Additional and untabulated independent variables used in the regressions are; an indicator variable of motherhood. An indicator variable of household gender composition type. The partners share of parental leave taken around first adoption. Controls for educational attainment, age at first adoption, labor experience, a dummy indicating adoption within the year, a categorical variable of area of residence, and year dummies. Lastly, the regressions include year dummies. The figure and table compares heterosexual women to all lesbian women that takes the most parental leave within the household. The estimates are shown for Event+0 to Event+5. ***, **, * correspond to statistical significance at 1%, 5% and 10% level respectively. Varying observation numbers are due to few zero salaries that are dropped due to the log-transformation.
Regression output for Figure A6

<table>
<thead>
<tr>
<th>Model</th>
<th>Event+1</th>
<th>Event+2</th>
<th>Event+3</th>
<th>Event+4</th>
<th>Event+5</th>
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<tr>
<td>Parenthood</td>
<td>-0.2378***</td>
<td>-0.0652**</td>
<td>-0.1662***</td>
<td>-0.1577***</td>
<td>-0.1687***</td>
</tr>
<tr>
<td></td>
<td>(0.026)</td>
<td>(0.026)</td>
<td>(0.032)</td>
<td>(0.033)</td>
<td>(0.039)</td>
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<td>Lesbian</td>
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<td>-0.1486***</td>
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<td>-0.1277***</td>
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<tr>
<td></td>
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<td>(0.042)</td>
<td>(0.045)</td>
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<td>(0.045)</td>
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<tr>
<td>Parenthood*Lesbian</td>
<td>0.2118***</td>
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<tr>
<td></td>
<td>(0.054)</td>
<td>(0.051)</td>
<td>(0.056)</td>
<td>(0.052)</td>
<td>(0.057)</td>
</tr>
<tr>
<td>Partner's share of leave</td>
<td>0.2903***</td>
<td>0.2286***</td>
<td>0.2431***</td>
<td>0.1501***</td>
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</tr>
<tr>
<td></td>
<td>(0.050)</td>
<td>(0.047)</td>
<td>(0.052)</td>
<td>(0.049)</td>
<td>(0.052)</td>
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<tr>
<td>Adoption year</td>
<td>-0.1114</td>
<td>-0.1357***</td>
<td>-0.0513</td>
<td>-0.1027*</td>
<td>-0.0885</td>
</tr>
<tr>
<td></td>
<td>(0.095)</td>
<td>(0.041)</td>
<td>(0.048)</td>
<td>(0.062)</td>
<td>(0.111)</td>
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<tr>
<td>Age at adoption</td>
<td>-0.0025</td>
<td>0.0005</td>
<td>-0.0020</td>
<td>-0.0032</td>
<td>-0.0043</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.003)</td>
</tr>
<tr>
<td>Household Education</td>
<td>0.0691***</td>
<td>0.0758***</td>
<td>0.0757***</td>
<td>0.0778***</td>
<td>0.0763***</td>
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<tr>
<td></td>
<td>(0.005)</td>
<td>(0.005)</td>
<td>(0.005)</td>
<td>(0.005)</td>
<td>(0.005)</td>
</tr>
<tr>
<td>Labor Experience (t-1)</td>
<td>0.0159***</td>
<td>0.0160***</td>
<td>0.0190***</td>
<td>0.0207***</td>
<td>0.0209***</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.002)</td>
<td>(0.002)</td>
<td>(0.002)</td>
<td>(0.002)</td>
</tr>
<tr>
<td>Region Control</td>
<td>-0.0646*</td>
<td>-0.0418</td>
<td>-0.0612*</td>
<td>-0.0736**</td>
<td>-0.1125***</td>
</tr>
<tr>
<td>Year Dummy</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Observations</td>
<td>4,070</td>
<td>4,019</td>
<td>3,957</td>
<td>3,886</td>
<td>3,829</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.103</td>
<td>0.116</td>
<td>0.107</td>
<td>0.121</td>
<td>0.106</td>
</tr>
</tbody>
</table>
Figure A7 – DiD coefficients for child penalty in earnings between Heterosexual Women to Lesbian Women – Using nearest neighbor matching or inverse probability weights (IPW) to align treatment and control group

The tables show the Difference-in-Difference regression estimates of relative child penalty for heterosexual women to lesbian women. The dependent variable is the natural logarithm of yearly salary. The main explanatory variable in the regressions is Parenthood*Lesbian, which is the relative child penalty for heterosexual mothers to lesbian mothers due to parenthood. Additional and untabulated independent variables used in the regressions are; an indicator variable of motherhood. An indicator variable of household gender composition type. Days of parental leave taken around first adoption. Controls for educational attainment, age at first adoption, labor experience, a dummy indicating adoption within the year, a categorical variable of area of residence, and year dummies. Lastly, the regressions include year dummies. Panel A. compares lesbian women to heterosexual women weighted with IWP based on the age at first adoption. Panel B. compares lesbian women to heterosexual women weighted with IWP based on the age at first adoption and restricting both groups of women to have taken the most parental leave within the household. The estimates are shown for Event+0 to Event+5. ***, **, * correspond to statistical significance at 1%, 5% and 10% level respectively. Variating observation numbers are due to few zero salaries that are dropped due to the log-transformation.

Panel A. IPW: Age at first adoption  
Panel B. IPW: Age at first adoption on most parental leave mothers 
Panel C. IPW: Age at first adoption, education and pre-adoption labor market experience
Chapter 3

CEO Education and Corporate Environmental Footprint
CEO Education and Corporate Environmental Footprint

January 30, 2019

Abstract

We analyze the effect of CEO education on environmental decision-making. Using a unique sample of Danish firms from 1996 to 2012, we find that CEO education significantly improves firms’ energy efficiency. We seek to derive causality using health shocks: the hospitalization of highly educated CEOs induces a drop in energy efficiency, whereas the hospitalization of less educated CEOs does not have any significant effect. Exploring the mechanisms at play, we show that our results are largely driven by advanced education in business degrees. Moreover, we show that CEO education is associated with greater environmental awareness: highly educated CEOs exhibit greater concerns for climate change, as measured by a survey of social preferences, and drive more environmentally efficient cars. Taken together, our findings suggest that education shapes managerial styles giving rise to greater sustainability in corporate actions.

Keywords: CEOs; Education; Climate Change; Energy Efficiency

JEL Codes: G34; I20; J24; Q50
1. Introduction

This paper analyzes the effect of CEO education on environmental decision-making. Several works in the literature have been devoted to quantifying the impact of human capital on economic outcomes such as labor market returns (e.g. Card 2001), financial decision-making (e.g. Cole et al. 2014; Black et al. 2018) and lifetime wealth (e.g. Oreopoulos 2007). Moreover, the literature has suggested that education is not only beneficial for individuals but may breed benefits to the entire society. This argument can be traced back to at least Friedman (1955: pg. 2), who noted that “A stable and democratic society is impossible without a minimum degree of literacy and knowledge on the part of most citizens and without widespread acceptance of some common set of values. Education can contribute to both. In consequence, the gain from education of a child accrues not only to the child or to his parents but also to other members of the society”. More recently, Putnam (1995: pg. 672) argued that “education is by far the strongest correlate that I have discovered of civic engagement in all its forms.” Empirical studies provide support for this view by showing that education increases voter participation, support for free speech, public awareness and political involvement (Dee 2004; Milligan et al. 2004). Along this line, Meyer (2015) shows that educated individuals are more concerned about social welfare and environmental issues, while Volland (2017) documents that social trust is negatively correlated with energy demand at the household level.

We contribute to this literature by studying the impact of education on a CEO’s environmental stance. We find that better educated CEOs reduce their environmental footprint by spurring corporate energy efficiency and making greener private decisions. CEOs provide a context of utmost importance for our study. First, CEOs have ultimate influence on corporate decisions. Second, CEOs are seen as the face of the company, and their environmental actions can influence stakeholder perceptions. Third, CEOs have access to resources and influence that can be used to drive environmental initiatives. Through these channels, education can impact corporate environmental decisions. This paper contributes to the literature by providing empirical evidence on the effect of CEO education on environmental decision-making.

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77 See also Krueger and Lindahl (2001) for a discussion.
78 Huang et al. (2009) provide evidence that education increases social trust and public participation. Brand (2010) shows that these effects are stronger for individuals who are otherwise less likely to obtain higher education.
79 More generally, there is evidence suggesting that cultural views affect the way in which individuals handle collective action problems (Cherry et al. 2017).
policies, which may amplify the consequences of their personal environmental commitment (or lack thereof). Second, CEO decisions may significantly affect the environmental sustainability of other firms in the value chain (Dai et al. 2018) via e.g. stakeholder engagement, imitation and knowledge transfer. Despite such relevance, the effect of CEO traits on firms’ environmental policies remains, to our knowledge, largely unexplored.

We collect data from the Danish Environmental Protection Agency data covering the energy consumption of 428 Danish manufacturing companies from 1996 to 2012. For each of these companies, we gather register data on CEO education and several other demographic characteristics. Our results indicate that firms led by highly educated CEOs use significantly less energy per output. In economic terms, an additional year of CEO education is associated with 7% lower electricity and 17% lower gas (all scaled by employees), as well as a 20% higher efficiency in a composite index based on the use of energy inputs within a given industry.

While this result holds controlling for several variables related to the industry, firm and CEO level, we acknowledge that the endogenous matching between companies and CEOs poses an empirical challenge to interpret our results causally. We try to overcome this challenge by exploiting CEO hospitalization events. As argued in Bennedsen et al. (2018), this approach helps to tease out the causal effect of CEOs on corporate policies given that hospitalization events exogenously change CEO exposure without altering the CEO-firm match. The hospitalization of highly educated CEOs may lower current energy use through at least two channels. First, environmental projects typically rest on cognitively demanding tasks that require changes in existing routines and novel recombination of existing approaches. When highly educated CEOs are hospitalized, there is a sudden lack of leadership inputs which impairs energy-related projects, in particular if other top managers have to cover up for the absent CEO on the part of the CEO job that is not related to energy projects. Second, hospitalization induces an increase in CEO’s personal risk. Hospitalized CEOs may be spending effort and time on personal well-being, and
may even start to consider leaving the helm of the company. This process takes focus away from such complex activities as energy-preserving projects. Moreover, hospitalization may reduce a CEO’s ability and incentives to monitor the activities of the company, and thus weakens employees’ incentive to work hard on energy-saving tasks. Customers and suppliers may also face weaker incentives to invest in complex relationship with firms led by hospitalized CEOs, thus reducing the resources available to energy-related projects. Our results indicate that, as compared to CEOs without college education, the hospitalization of highly educated CEOs has a significant and negative effect on firms’ electricity efficiency: for an additional day that highly educated CEOs spend in the hospital, the electricity efficiency of their firms declines by 7% to 9% depending on the specification.

There are two interpretations for our findings so far. The first builds on the notion that education spurs managerial efficiency: accordingly, more educated managers may be better able to identify and pursue energy-saving approaches leading to a lower utilization of energy inputs. This evidence is related to Bloom et al. (2010), who find that good managerial practices improve energy efficiency. The second argument builds on the association between education and civic engagement (Dee 2004; Milligan et al. 2004), which suggests that highly educated CEOs may embrace a universalistic managerial style characterized by greater awareness of environmental priorities and better alignment between corporate and societal goals. Both of these arguments propose that more educated CEOs achieve superior environmental performance; however, the first argument implies that the effect arises from managerial skills (and is thus largely specific to some fields of study) whereas according to the second the effect stems from the level of cumulated education. Separating out these explanations empirically is difficult. We address this challenge by comparing CEOs’ educational attainment across different fields of study. Our results indicate that energy efficiency mainly arises by holding advanced degrees in business–related disciplines.
We move to study the individual actions behind our results so far. Recent evidence suggests that CEOs tend to bring their own personal beliefs into corporate decision-making (Cronqvist et al. 2012). Accordingly, we posit that CEO education may be positively associated with personal awareness of climate change. Our results indicate that highly educated CEOs are significantly more concerned about climate change, as proxied by a survey-based measure of environmental concerns covering more than 5,000 CEOs. This result holds controlling for confounding factors such as gender, age and income, while also tackling endogeneity concerns by using parents’ education as instrumental variables while controlling for parents’ political and religious values (which may have had a direct effect on offspring’s preferences toward the environment). Next, we establish the material implications of education on CEOs’ personal choices by focusing on car purchase decisions, a topic currently under scrutiny (e.g. Yan and Eskeland 2018) given that cars are an important driver of pollution with significant implications for health conditions (Knittel et al. 2016). Our results suggest that CEO education has a positive and significant effect on the decision to purchase fuel-efficient cars, as measured by: (1) greater kilometer per liter of fuel, and (2) greater likelihood of owning an electric car. These findings too hold controlling for CEO income and other personal characteristics including age, gender and area of residence.

Our paper offers novel insights to the underexplored relationship between the educational level of top executives and the environmental footprint of the organizations they lead. The seminal study by Bertrand and Schoar (2003) provided early evidence on the presence of managerial styles. Recent works show that the impact of managerial styles on firm performance is stronger for highly educated CEOs (Bennedsen et al. 2018). Companies led by CEOs with better educational credentials achieve greater financial performance (Falato et al.

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Building on this notion, many works have explored the origins of managerial styles by focusing on CEOs’ individual and family characteristics (e.g. Adams and Ferreira 2009; Cronqvist and Yu 2017; Yim 2013), professional background and experience (e.g. Custodio and Metzger 2013; Dittmar and Duchin 2016).
2015; King et al. 2016; Miller et al. 2015), while companies led by CEOs with science-related degrees engage in more R&D spending. By bridging the literature on managerial traits (e.g. Bertrand and Schoar 2003; Malmendier and Tate 2005, 2008) with that on the determinants of firms’ environmental efficiency (e.g. Bloom et al. 2010; Popp 2002; Martin et al. 2012), our study provides important contributions to the debate on why some firms pollute more than others (Shapira and Zingales 2017). Corporate environmental actions are shaped by a complex set of firm-level and external determinants including a country’s legal framework (Liang and Renneboog 2017), industry competition (Fernandez-Kranz and Santaló 2010), energy price and policies (e.g. Popp 2002; Nesta et al. 2014), organization and management practices (Bloom et al. 2010; Boyd and Curtis 2014; Martin et al. 2012) and corporate governance (Amore and Bennedsen 2016; Ferrell et al. 2016; Kock et al. 2012). This web of determinants induces a substantial heterogeneity in energy efficiency, which may even exceed the heterogeneity found in traditional productivity measures (Lyubich et al. 2018). Our contribution to this debate is to empirically show that the environmentally-conscious management style of educated CEOs has a positive effect on a firm’s energy efficiency.

Our research has relevant implications along three directions. First, from the business perspective, energy consumption can represent a significant production cost, and our study suggests that CEO education is a managerial trait that provides relevant variations of such costs. Second, a growing research documents that socially-responsible actions may have significant implications for shareholder value (e.g. Deng et al. 2013; Kruger 2015; Flammer 2015; Servaes and Tamayo 2013), for instance because investment in corporate social responsibility facilitates the access to debt financing (Amiraslani et al. 2017) or because investors are sin averse due to social norms (Hong and Kacperczyk 2009). We argue that education shapes managerial styles in a way that may be beneficial not just for shareholders, as the previous literature has suggested, but also for the environment. Third, understanding what drives firms to produce more efficiently can
help policy-makers design effective environmental policies which take into account not only traditional factors such as production inputs or industry specialization but also the demographic traits and human capital of top executives.

The rest of the paper is organized as follows. Section 2 describes the data and shows the main summary statistics. Section 3 illustrates the relationship between CEO education and corporate energy efficiency and discusses our econometric strategies. Section 4 is concerned with the CEOs personal values and private choices. Section 5 concludes.

2. Data and summary statistics

Our data come from various registers managed by Statistics Denmark and other sources, which provide us with comprehensive information at the firm and CEO level. In this section, we illustrate each data source and discuss the match between individual-level information and company data containing environmental and accounting items.

2.1. Firm-level data

We employ data from two separate sources, which are merged to form a longitudinal dataset of Danish firms from 1996 through 2012.\(^81\) The first source is represented by the annual reports submitted by companies to the Danish Environmental Protection Agency as part of the Green Accounting program, introduced in 1995 and aimed at increasing the public awareness of Danish firms’ environmental activities. The quality of these reports is ensured by central supervisory authorities of the Danish Ministry of Environment and Food. Every firm is assigned a supervisor, who goes through the green report and evaluates its completeness, consistency and reliability. Disclosing environmental data has been mandatory for firms in such sectors as manufacturing, infrastructure, transportation, power plants, mining and quarrying, and waste

\(^81\) Our dataset does not include the year 2008 due to a change in how the data were recorded by the Danish Environmental Agency.
disposal. Although the green reports have been filed in different formats and to different institutions, it is possible to observe each firm over time. We have therefore accessed all the environmental reports and extracted the environment-related variables from 1996 to 2012.

Our second source is Experian, an annual register containing detailed accounting and management information for all limited-liability and privately-held Danish firms. These companies are obliged to deliver a comprehensive set of financial items to the Danish Ministry of Business and Growth every year. According to the Danish corporate law, firms’ financial reports have to be approved by external accountants, a procedure which raises the credibility of the data. Unfortunately, firms are not obliged to report all accounting items, and this explains a greater number of missing values in some items such as revenues. The management section of this data source includes the identifier of each CEO, which Danish firms are required to report annually.

2.2. Education and other CEO-level data

The Danish educational system is primarily public and no tuition fees are demanded. We categorize the different educational levels in three groups. The first, Non-college degrees, consists of primary and lower-secondary school (9-10 years of schooling mandatory for all Danes), high school (upper secondary school, which is optional and takes 3 years), vocational education (an alternative to high school with a typical duration of 3 years) and short academy professional programs (with a duration of maximum 2 years). The second, Undergraduate degrees, consists of 3 to 3.5 years long post high school professional bachelor and undergraduate programs (academic bachelor’s program). The third, Master or PhDs, consists of university graduate programs, where a

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The specific sectors are: iron, steel, other metals, plastic coatings, cement, glass, glass fibers, mineral wool, pottery, ceramics, electro graphite, carbon, asbestos, chalk, calcium, tar, minerals, organic and inorganic chemicals, fertilizers, medicine, dyes, food additives, plant protection substances, biocides, polyurethane foam, paper, cellulose, textiles, alcohol, yeast, sugar, industry bakeries, potato flour, slaughterhouses, fish meal, meat meal, leather, diary, sea food, shell fish and proteins. A minor legislative change implemented in 2010 lowered by around 35% the number of firms obliged to report their Green Accounts.
master degree takes 2 years (on top of the 3 years for the undergraduate), and 3 additional years to get a PhD. Figure A1 provides an illustration of the Danish educational system.

To study how CEO education affects green behavior, we access the Educational Register (UDDA), which contains data on the educational attainment of all graduates from any Danish educational institution. From this register, we gather the years of education, type of degree, year of graduation and institution for each CEO in our sample. We use other registers to collect other demographic variables such as CEOs’ age, gender, area of residence, marital status and income.

2.3. Sample and summary statistics

Common to the literature (e.g. Bloom et al. 2010; Brunnermeier and Cohen 2003; Jaffe and Palmer 1997), we focus on firms that operate in the manufacturing sector. The key advantage of this choice is that in manufacturing industries energy usage is a significant input of the production process. After cleaning and merging the data, we obtain 428 unique manufacturing firms for a total of 2,491 firm-year observations.83

Our main variable of interest is the logarithm of a firm’s electricity consumption scaled by the number of employees. Electricity consumption is a reliable measure of a firm’s overall energy consumption and it is often easy to monitor. Employees are typically less volatile than profits and thus provide a better scaling factor than, say, operating profits. Nevertheless, we check that our results are robust to scaling electricity consumption by fixed assets or profit measures. Different firms use different energy sources, which can be close substitutes. To account for this issue, we employ alternative energy-related items in the numerator, such as gas and water consumption, or composite indexes that capture energy efficiency more broadly (see Section 3.3 for details).

83 Specifically, we start from a sample of 1,013 firms in the green accounting program. We drop 285 firms with missing information on the key energy variables, 209 firms that do not operate in manufacturing industries, 16 firms without information on the number of employees (our scaling factor for the measure of electricity efficiency), and 75 firms with missing information on the individual characteristics of the CEO. As a result, we obtain 428 unique firms for a total of 2,491 observations.
Summary statistics are presented in Table 1. Panel A shows that the average firm has 168 employees and DKK 342 million (i.e. approximately 53.6 million $) in total assets, whereas Panel B shows that the average firm uses 4.2 billion kWh annually. The two panels also show that energy consumption, capital and employees vary considerably, indicating a wide variation across firm sizes. This underpins the importance of scaling energy consumption variables by the firm’s number of employees. Panel C shows the distribution of firms across the manufacturing sub-industries.
Panels A and B of this table provide firm characteristics for our sample firms for the period 1996-2012. Fixed assets, total assets, gross profits and pretax earnings are expressed in 1,000,000 DKK = 150,800 $ = 134,500 €. Capital Intensity is the ratio of a firm’s fixed assets (in DKK 1,000) over its number of employees. Employees are the number of employees in the firm. Energy variables are expressed in thousands. Panel C shows the distribution of observations across manufacturing sub-industries classified according to the 3-digit NACE (the European statistical classification of economic activities).

### Panel A. Firm characteristics

<table>
<thead>
<tr>
<th></th>
<th>Observations</th>
<th>Mean</th>
<th>Std. dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total assets</td>
<td>2,491</td>
<td>341,894</td>
<td>1,729,515</td>
</tr>
<tr>
<td>Fixed assets</td>
<td>2,491</td>
<td>209,791</td>
<td>1,265,396</td>
</tr>
<tr>
<td>Gross profit</td>
<td>2,444</td>
<td>92,075</td>
<td>317,985</td>
</tr>
<tr>
<td>Pretax earnings</td>
<td>2,491</td>
<td>30,721</td>
<td>182,417</td>
</tr>
<tr>
<td>Capital intensity</td>
<td>2,491</td>
<td>1,346</td>
<td>1,721</td>
</tr>
<tr>
<td>Employees</td>
<td>2,491</td>
<td>168</td>
<td>351</td>
</tr>
</tbody>
</table>

### Panel B. Energy-related measures

<table>
<thead>
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<th>Observations</th>
<th>Mean</th>
<th>Std. dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity, kWh</td>
<td>2,491</td>
<td>4,235.80</td>
<td>6,733.94</td>
</tr>
<tr>
<td>Log(kWh/Employees)</td>
<td>2,491</td>
<td>10.02</td>
<td>1.22</td>
</tr>
<tr>
<td>Log(kWh/Fixed assets)</td>
<td>2,491</td>
<td>4.00</td>
<td>1.41</td>
</tr>
<tr>
<td>Log(kWh/Gross profit)</td>
<td>2,409</td>
<td>4.06</td>
<td>1.37</td>
</tr>
<tr>
<td>Log(kWh/Pretax earnings)</td>
<td>1,900</td>
<td>5.78</td>
<td>1.83</td>
</tr>
<tr>
<td>Gas, M³</td>
<td>1,527</td>
<td>1,817.58</td>
<td>10,200</td>
</tr>
<tr>
<td>Log(Gas/Employees)</td>
<td>1,527</td>
<td>7.18</td>
<td>2.80</td>
</tr>
<tr>
<td>Log(Gas/Fixed assets)</td>
<td>1,527</td>
<td>1.03</td>
<td>2.70</td>
</tr>
<tr>
<td>Log(Gas/Gross profit)</td>
<td>1,476</td>
<td>1.23</td>
<td>2.84</td>
</tr>
<tr>
<td>Log(Gas/Pretax earnings)</td>
<td>1,159</td>
<td>3.00</td>
<td>3.00</td>
</tr>
<tr>
<td>Water, M³</td>
<td>2,737</td>
<td>180.65</td>
<td>883.16</td>
</tr>
<tr>
<td>Log(Water/Employees)</td>
<td>2,737</td>
<td>4.45</td>
<td>2.19</td>
</tr>
<tr>
<td>Log(Water/Fixed assets)</td>
<td>2,737</td>
<td>-1.67</td>
<td>2.16</td>
</tr>
<tr>
<td>Log(Water/Gross profit)</td>
<td>2,654</td>
<td>-1.54</td>
<td>2.19</td>
</tr>
<tr>
<td>Log(Water/Pretax earnings)</td>
<td>2,155</td>
<td>0.14</td>
<td>2.41</td>
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</table>

### Panel C. Industry distribution

<table>
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<th>Percent</th>
</tr>
</thead>
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<td>Food</td>
<td>16</td>
<td>0.64</td>
</tr>
<tr>
<td>Leather and related</td>
<td>445</td>
<td>17.86</td>
</tr>
<tr>
<td>Paper products</td>
<td>71</td>
<td>2.85</td>
</tr>
<tr>
<td>Chemicals</td>
<td>147</td>
<td>5.90</td>
</tr>
<tr>
<td>Other non-metal</td>
<td>787</td>
<td>31.59</td>
</tr>
<tr>
<td>Computer and electronics</td>
<td>92</td>
<td>3.69</td>
</tr>
<tr>
<td>Electrical equipment</td>
<td>933</td>
<td>37.45</td>
</tr>
<tr>
<td>Total</td>
<td>2,491</td>
<td>100</td>
</tr>
</tbody>
</table>
In Table 2, we provide summary statistics for CEO characteristics. As shown, the CEOs in our sample are almost exclusively men, they are on average 53 years old and have undergone 15 years of education. 53% of the CEOs hold an undergraduate or higher degree. Of these, 49% hold “Technical advanced degrees”, consisting of engineering or natural sciences, 38% hold degrees in “Business advanced degrees”, consisting of degrees in business or economics, and 13% hold some “Other advanced degree” mostly consisting of degrees in humanities.

Table 3 reports the average firm characteristics by different levels of CEO education. Panel A shows that firm size, measured in total assets, fixed assets and employees, is increasing in CEO education. Panel B presents the average firm characteristics by CEOs’ educational level, while Table A1 offers a detailed description of each variable used in the empirical analysis.
Table 3. Average firm characteristics by CEO educational level

This table reports the average values of Table 1, Panels A and B, separately for different levels of CEO education.

<table>
<thead>
<tr>
<th>Panel A. Firm characteristics</th>
<th>Non-college degree</th>
<th>Undergraduate degree</th>
<th>Master or PhD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed assets</td>
<td>52,448.73</td>
<td>106,576.50</td>
<td>836,562.60</td>
</tr>
<tr>
<td>Total assets</td>
<td>103,767.00</td>
<td>190,991.20</td>
<td>1,279,616.00</td>
</tr>
<tr>
<td>Gross profit</td>
<td>38,352.56</td>
<td>74,145.09</td>
<td>270,324.30</td>
</tr>
<tr>
<td>Pretax earnings</td>
<td>6,661.97</td>
<td>14,289.49</td>
<td>127,889.10</td>
</tr>
<tr>
<td>Capital intensity</td>
<td>1,175.43</td>
<td>1,157.27</td>
<td>2,185.23</td>
</tr>
<tr>
<td>Employees</td>
<td>93.40</td>
<td>165.93</td>
<td>370.89</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel B. Energy-related measures</th>
<th>Non-college degree</th>
<th>Undergraduate degree</th>
<th>Master or PhD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity, kWh</td>
<td>2,904.57</td>
<td>4,620.42</td>
<td>6,965.50</td>
</tr>
<tr>
<td>Log(kWh/Employees)</td>
<td>10.16</td>
<td>9.89</td>
<td>9.90</td>
</tr>
<tr>
<td>Log(kWh/Fixed assets)</td>
<td>4.24</td>
<td>3.98</td>
<td>3.39</td>
</tr>
<tr>
<td>Log(kWh/Gross profit)</td>
<td>4.26</td>
<td>3.98</td>
<td>3.66</td>
</tr>
<tr>
<td>Log(kWh/Pretax earnings)</td>
<td>6.16</td>
<td>5.69</td>
<td>5.02</td>
</tr>
<tr>
<td>Gas, M³</td>
<td>1,166.07</td>
<td>805.26</td>
<td>1,302.53</td>
</tr>
<tr>
<td>Log(Gas/Employees)</td>
<td>7.73</td>
<td>7.24</td>
<td>7.60</td>
</tr>
<tr>
<td>Log(Gas/Fixed assets)</td>
<td>1.66</td>
<td>1.22</td>
<td>1.07</td>
</tr>
<tr>
<td>Log(Gas/Gross profit)</td>
<td>1.78</td>
<td>1.37</td>
<td>1.42</td>
</tr>
<tr>
<td>Log(Gas/Pretax earnings)</td>
<td>3.80</td>
<td>3.18</td>
<td>3.04</td>
</tr>
<tr>
<td>Water, M³</td>
<td>38.64</td>
<td>98.63</td>
<td>236.41</td>
</tr>
<tr>
<td>Log(Water/Employees)</td>
<td>4.58</td>
<td>4.10</td>
<td>4.78</td>
</tr>
<tr>
<td>Log(Water/Fixed assets)</td>
<td>-1.35</td>
<td>-1.78</td>
<td>-1.74</td>
</tr>
<tr>
<td>Log(Water/Gross profit)</td>
<td>-1.34</td>
<td>-1.80</td>
<td>-1.46</td>
</tr>
<tr>
<td>Log(Water/Pretax earnings)</td>
<td>0.56</td>
<td>-0.16</td>
<td>-0.06</td>
</tr>
</tbody>
</table>
3. CEO education and corporate energy efficiency

In this section, we estimate the association between the length of CEO education and electricity usage. Seeking to establish causality, we adopt an empirical identification based on hospitalization shocks. Then, we go beyond the focus on electricity and show the effect of CEO education on several dependent variables capturing energy efficiency more broadly. Finally, we explore the effect of specific fields of study.

3.1. Baseline results

We begin by estimating the following regression:

\[ y_{it} = \beta_1 \text{Education}_{it} + \mathbf{M}_{it}\beta_2 + \mathbf{F}_{it}\beta_3 + \delta \text{Industry}_i + \gamma \text{Year}_t + u_{it} \]

where \( y_{it} \) is the logarithm of electricity over employees for the firm \( i \) at time \( t \). \( \text{Education} \) is the CEO’s educational level, measured in years. \( \mathbf{M}_{it} \) is a vector containing individual characteristics such as age and gender, which may correlate with environmental attitudes and thus confound the education effect. \( \mathbf{F}_{it} \) is a vector containing a firm’s financial variables such as capital intensity (computed as the ratio of total assets to employees) and asset growth (measured as the annual growth in total assets), which are commonly employed as controls in the environmental economics literature (e.g. Bloom et al. 2010). \( \text{Industry} \) is a set of industry dummies that capture the time-invariant sectoral heterogeneity within the manufacturing sector. \( \text{Year} \) is a set of year dummies included to absorb time effects common to all firms. We estimate this regression with pooled OLS and compute robust standard errors clustered at the firm level to account for both heteroscedasticity and serial correlation in the structure of residuals.

84 In untabulated checks, we further validate our findings using a broader set of controls including e.g. the ratio of intangibles to total assets, and profitability (computed as the ratio of operating profits to total assets).

85 The main approach to account for industry effects is based on a classification including 23 different industries. As we will show, our results hold using finer industry classifications based on 53 or 111 different industries.

86 Notice that since CEO education does not change over time we do not include firm fixed effects in our baseline analysis. Indeed, in our sample, there are 428 firms and very few of them changes CEO. Firms that change CEO (1) hire from outside the pool of 428 CEOs, which raises concerns of endogenous matching; (2) hire a CEO who is...
In Column (1) of Panel A, Table 4, we regress electricity efficiency on the CEO’s educational level and only control for year and industry dummies. As shown, CEO education is negatively and significantly associated with electricity per employee. In economic terms, the coefficient indicates that an additional year of CEO education is associated with a 7% higher electricity efficiency. Column (2) shows that this effect remains significant when controlling for CEOs’ age and gender. In Columns (3)-(4), we further control for a firm’s capital intensity, asset growth, and the logarithm of total assets. Looking at the coefficient of these variables, we find that firm growth and firm size are both associated with lower electricity efficiency, either because fast-growing firms sacrifice environmental goals during their expansion process or because higher energy intensity supports the firms in growing. Moreover, we find that capital per worker is positively associated with electricity efficiency. Despite the inclusion of these controls, our main result on CEO educational level remains significant at the 1% level.

In Panel B of Table 4, we estimate the regression using a set of education dummies instead of our baseline variable measuring years of schooling. We use three categories: non-college education (baseline), undergraduate degree, and Master or PhD degree. As compared to CEOs with non-college degree, holding an undergraduate degree has a positive and significant (at the 10% level) effect on electricity efficiency. This effect becomes much stronger, both economically and statistically, for CEOs holding a Master of PhD degree: the coefficient indicates a 38% increase in electricity efficiency relative to firms with CEOs holding a non-college degree. These findings suggest that the effect of CEO education on a firm’s environmental stance is stronger for CEOs with the highest educational attainment, possibly owing to the fact that environmental activities typically rest on cognitively demanding tasks that require changes in existing routines and novel recombination of existing approaches (see Amore and Bennedsen 2016 for related arguments).

likely to have education similar to that of the outgoing CEO, which does not yield enough variation for our estimation. However, we address concerns of omitted factor bias at the CEO level in Sections 3.2 and 3.3.
Table 4. CEO education and firms’ electricity efficiency

The dependent variable is the natural logarithm of electricity consumption over the number of employees. The main explanatory variable in Columns (1)-(4), years of education, measures a CEO’s years of schooling, whereas the main explanatory variable in Column (5) is a set of dummies measuring the CEO’s highest degree, where “No college degree” is the baseline. Male CEO is a dummy equal to one for male CEOs and zero for female CEOs. CEO age measures the years of CEO age. Log(Capital intensity) is the natural logarithm of the ratio of a firm’s fixed assets over its number of employees. Asset growth is the growth rate in the firm’s total assets, Employees are the number of employees in the firm. Total assets is the logarithm of a firm’s total assets. Furthermore, our regressions include 3-digit industry and year dummies. Clustered (firm) standard error are shown in the parentheses. **p<0.01, *p<0.05, *p<0.1.

<table>
<thead>
<tr>
<th>Panel A.</th>
<th>Panel B.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent variable: Log(kWh/Employees)</td>
<td>Dependent variable: Log(kWh/Employees)</td>
</tr>
<tr>
<td></td>
<td>(1)</td>
</tr>
<tr>
<td><strong>Years of education</strong></td>
<td>-0.0738***</td>
</tr>
<tr>
<td></td>
<td>(0.022)</td>
</tr>
<tr>
<td>Male CEO</td>
<td>0.0620</td>
</tr>
<tr>
<td></td>
<td>(0.193)</td>
</tr>
<tr>
<td>CEO age</td>
<td>-0.0032</td>
</tr>
<tr>
<td></td>
<td>(0.006)</td>
</tr>
<tr>
<td>Log(Capital intensity)</td>
<td>0.2711***</td>
</tr>
<tr>
<td></td>
<td>(0.057)</td>
</tr>
<tr>
<td>Asset growth</td>
<td>-0.0637**</td>
</tr>
<tr>
<td></td>
<td>(0.028)</td>
</tr>
<tr>
<td>Total assets</td>
<td>-0.0118***</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
</tr>
<tr>
<td>Industry dummies</td>
<td>Yes</td>
</tr>
<tr>
<td>Year dummies</td>
<td>Yes</td>
</tr>
<tr>
<td>Observations</td>
<td>2,491</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.110</td>
</tr>
<tr>
<td></td>
<td>Undergraduate degree</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Master or PhD</td>
<td>-0.3824**</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Male CEO</td>
<td>-0.1415</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>CEO age</td>
<td>-0.0030</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Log(Capital intensity)</td>
<td>0.3324***</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Asset growth</td>
<td>-0.0527*</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Total assets</td>
<td>-0.0119***</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Industry dummies</td>
<td>Yes</td>
</tr>
<tr>
<td>Year dummies</td>
<td>Yes</td>
</tr>
<tr>
<td>Observations</td>
<td>2,491</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.180</td>
</tr>
</tbody>
</table>
3.2. Evidence from CEO hospitalization events

Our findings so far offer strong indication that CEO education is positively associated with firms’ electricity efficiency. Our baseline estimates included a host of confounding factors to rule out concerns of omitted factors. Nevertheless, interpreting our results causally remains problematic due to well-known concerns of endogenous matching between CEOs and firms (e.g. Custodio and Metzger 2014). As Fee et al. (2013) pointed out, endogeneity in the formation and termination of CEO-firm matches hinders the interpretation of existing studies that have used CEO turnover to understand the effect of managerial styles on corporate outcomes.

To alleviate this concern, we use an identification strategy based on CEO hospitalization events. While we acknowledge that the rarity of hospitalization events restricts the analysis to a small sample, this approach has some advantages. First, they occur more frequently than most of the other CEO shocks (e.g. sudden death) used in the previous literature while being largely exogenous to firm outcomes. Bennedsen et al. (2018) provide evidence that reduces the concern of reverse causality, according to which past firm performance may affect the likelihood of hospitalization. By altering CEO exposure while keeping constant the match between a CEO and its company, hospitalizations enable us to add to our baseline model in Table 4 both firm and CEO fixed effects, which reduce omitted factor biases coming from unobserved individual heterogeneity. Second, while CEO shocks such as sudden death have only a binary variation, hospitalization events have different duration that varies across CEOs; this heterogeneity can be exploited to estimate the impact of CEO presence at the firms. Third, even though most hospitalization spells are short, the absence from the office is typically much longer: Bennedsen et al. (2018) find that, on average, when an employee is hospitalized from 1 to 3 days the days of absence are 23, and when an employee is hospitalized from 4 to 5 days the days of absence are

87 To confirm this result in our sample, we estimate a logit regression where the hospitalization is the dependent variable and the main explanatory variable is the change in operating profits to assets between two years and one year prior to the hospitalization event. Results do not show any significant effect of declining performance on the likelihood of hospitalization, and thus mitigate the reverse causality concern that CEOs tend to be hospitalized as a result of worse business conditions.
39. For senior managers the respective figures are 13 and 27 days. Collectively, these findings indicate that even short spells of CEO hospitalization can lead to a significant decrease in the effective work hours.

The hospitalization of highly educated CEOs may lower current energy use through at least two channels. The first relates hospitalization events to managerial capacity. Environmental projects typically rest on cognitively demanding tasks that require changes in existing routines and novel recombination of existing approaches. Thus, these projects require top-management inputs in formulation, implementation and monitoring. When highly-educated CEOs are hospitalized there is a sudden lack of leadership resources which impairs energy-related projects, in particular if other top managers have to cover up for the absent CEO on the part of the CEO job that is not related to energy projects. Furthermore, there may be delays in restoring environmental initiatives for at least two reasons: (1) the hospitalized CEO may need a personal recovery that extends beyond the actual hospitalization period; (2) when the CEO is back to work, his/her priorities will be on catching up with the day-to-day management while the environmental projects may be put aside for some time.

The second channel relates to the fact that health shocks increase key personal risk in the firm, which in turn affects the behavior of the CEO and the stakeholders of the firm. The CEO may be spending effort and time on his/her current and future well-being and may start considering retiring or changing job. This process likely takes focus away from the most complicated activities, which include energy-preserving projects. It also may reduce a CEO’s ability and incentives to monitor the activities of the company, and thus weakens employees’ incentive to work hard on energy-saving initiatives. External stakeholders might perceive that the CEO may not be around forever or that he/she may not be able to exercise leadership. Customers and suppliers may have reduced incentives to invest in relationship-specific activities with the firm, which will temporarily reduce the resources available to energy-related projects.
Generally, we expect the effect of hospitalization to be different from that of a vacation because vacations are planned (and often in periods where most other employees take vacation) whereas the length and timing of hospitalization and recovery periods are less planned and often come without warning. Bennedsen et al. (2018) document that CEO hospitalization events induce a substantial drop in a firm’s operating efficiency: 10 days of hospitalization reduces firm operating profitability with 5.8 pct. from its mean.88

Our data source for this analysis is the National Patient Register, which contains all public and private secondary health care interactions in Denmark.89 Using this data, we count the days that the CEOs were hospitalized in the year up to and in the current year. As Table 5 shows, out of the total 2,491 firm-year observations there are 250 firm-years (amounting to 10 % of the total number of firm-year observations) in which a CEO has been hospitalized for at least one day within the current and past years. The table also shows that CEO hospitalization events vary in both the intensive and the extensive margins, i.e., the occurrence and duration of hospitalizations. Moreover, as further validation of our approach, the table highlights that hospitalizations do not vary significantly across the CEOs’ educational levels.90

88 Comparing the size of this coefficient with ours is not straightforward due to the fact that a CEO may not optimize energy consumption in the same way as profits. Indeed, we expect that during periods of CEO hospitalization profitability becomes a major concern since the firm seeks to reduce any drop in profit that may harm its competitive ability. During these turbulent periods, environmental projects may be neglected or put aside, and this may explain the larger drop on energy efficiency.

89 The vast majority of hospitalizations are managed by the public healthcare system. Approximately 95% of the hospital spending in Denmark is financed through public expenditures.

90 While our data sources contain information on the primary medical condition, we are unable to exploit this information due to a small sample size.
Table 5. CEO hospitalization events

Each column reports firm-year observations by CEOs' highest degree and by the level of hospitalization days in the current year and the year before. Hospital data are constructed based on records from Statistics Denmark, which reports the number of days that an individual was hospitalized.

<table>
<thead>
<tr>
<th></th>
<th>Non-college degree</th>
<th>Undergraduate degree</th>
<th>Master or PhD</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>1,026</td>
<td>814</td>
<td>401</td>
</tr>
<tr>
<td>1 day</td>
<td>50</td>
<td>19</td>
<td>11</td>
</tr>
<tr>
<td>2 days</td>
<td>20</td>
<td>16</td>
<td>6</td>
</tr>
<tr>
<td>3 days</td>
<td>14</td>
<td>14</td>
<td>5</td>
</tr>
<tr>
<td>4 days</td>
<td>&lt;5</td>
<td>5</td>
<td>&lt;5</td>
</tr>
<tr>
<td>5 days</td>
<td>&lt;5</td>
<td>6</td>
<td>&lt;5</td>
</tr>
<tr>
<td>6 days</td>
<td>9</td>
<td>&lt;5</td>
<td>&lt;5</td>
</tr>
<tr>
<td>7 days</td>
<td>&lt;5</td>
<td>&lt;5</td>
<td>&lt;5</td>
</tr>
<tr>
<td>≥8 days</td>
<td>39</td>
<td>15</td>
<td>&lt;5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,162</strong></td>
<td><strong>894</strong></td>
<td><strong>435</strong></td>
</tr>
</tbody>
</table>

We regress the main dependent variable of Table 4 on the interaction term between hospitalization length and CEO’s educational attainment keeping the firm- and CEO-level controls of our previous specification. As shown in Table 6, Column (1), the interaction between CEO hospitalization and holding an undergraduate degree is not significantly different from the baseline (i.e. CEOs with non-college education). By contrast, the interaction between CEO hospitalization and holding an advanced degree is positive and statistically significant.

To validate our result, in Column (2) to (4) we show the findings obtained scaling electricity by fixed assets, gross profits and total assets, respectively. Moreover, in Table 7 we estimate the effect of hospitalization on three different subsamples depending on the level of CEO education. Again, we employ four alternative dependent variables to verify the robustness of our findings. Consistent with our previous findings, CEO hospitalization does not have any significant effect on electricity efficiency when the CEO has low to medium education. However, when the CEO holds an advanced degree, the coefficient of CEO hospitalization becomes significant. Economically, the coefficients indicate that for an additional day a highly educated
CEO spends in the hospital, the electricity efficiency of his/her firm drops by 7% to 9%. While this magnitude may seem large, it is worth keeping in mind that hospitalization events have broader consequences for a CEO’s effort provision: each day of hospitalization is surrounded by a period of significantly reduced workload implying that the count of hospital days corresponds to much longer absence spells. Furthermore, there may be urgent day-to-day management to catch up with once the CEO returns, which reduces the time available for energy-saving projects.91

91 The distribution of hospitalization days in Table 5 suggests that we are mostly capturing the effect of changes in the low end of the distribution. Thus, we cannot speak of very long hospitalization periods – even if we expect them to command large effects since long hospitalizations will likely trigger CEO replacement, retirement or death.
Table 6. CEO hospitalization and electricity efficiency: Interaction

The dependent variable is the natural logarithm of electricity consumption over the number of employees (Column 1), fixed assets (Column 2), gross profits (Column 3) or total assets (Column 4). Days at hospital \([t-1, t]\) measures the hospitalization days of the CEO in the current year and the year before. Undergraduate degree is a dummy equal to one if the CEOs hold an undergraduate degree, and zero otherwise. Master or PhD is a dummy equal to one if the CEOs hold a Master or PhD degree, and zero otherwise. The baseline group is formed by CEOs holding non-college degrees. CEO age measures the years of CEO age. Log(Capital intensity) is the natural logarithm of the ratio of a firm’s fixed assets over its number of employees. Asset growth is the growth rate in the firm’s total assets. Employees are the number of employees in the firm. Total assets is the logarithm of a firm’s total assets. Furthermore, our regressions include 3-digit industry and year dummies. Clustered (firm) standard errors are shown in the parenthesis. *** p<0.01, ** p<0.05, * p<0.1.

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>Ln(kWh/ Employees)</th>
<th>Ln(kWh/ Fixed assets)</th>
<th>Ln(kWh/ Gross profits)</th>
<th>Ln(kWh/ Total assets)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days at hospital ([t-1, t])</td>
<td>-0.0044</td>
<td>-0.0044</td>
<td>-0.0092</td>
<td>-0.0067</td>
</tr>
<tr>
<td></td>
<td>(0.010)</td>
<td>(0.010)</td>
<td>(0.009)</td>
<td>(0.011)</td>
</tr>
<tr>
<td>Days at hospital ([t-1, t]) × Undergraduate Degree</td>
<td>0.0077</td>
<td>0.0076</td>
<td>0.0129</td>
<td>0.0105</td>
</tr>
<tr>
<td></td>
<td>(0.012)</td>
<td>(0.012)</td>
<td>(0.011)</td>
<td>(0.013)</td>
</tr>
<tr>
<td>Days at hospital ([t-1, t]) × Master or PhD</td>
<td>0.0887***</td>
<td>0.0889***</td>
<td>0.0856**</td>
<td>0.0922***</td>
</tr>
<tr>
<td></td>
<td>(0.033)</td>
<td>(0.033)</td>
<td>(0.043)</td>
<td>(0.034)</td>
</tr>
<tr>
<td>CEO age</td>
<td>-0.0039</td>
<td>-0.0027</td>
<td>0.0138</td>
<td>-0.0113</td>
</tr>
<tr>
<td></td>
<td>(0.014)</td>
<td>(0.014)</td>
<td>(0.017)</td>
<td>(0.014)</td>
</tr>
<tr>
<td>Log(Capital intensity)</td>
<td>0.2382***</td>
<td>-0.7606***</td>
<td>0.1208**</td>
<td>-0.2708***</td>
</tr>
<tr>
<td></td>
<td>(0.070)</td>
<td>(0.070)</td>
<td>(0.054)</td>
<td>(0.050)</td>
</tr>
<tr>
<td>Asset growth</td>
<td>0.0254</td>
<td>0.0251</td>
<td>-0.0416</td>
<td>0.1459**</td>
</tr>
<tr>
<td></td>
<td>(0.025)</td>
<td>(0.025)</td>
<td>(0.042)</td>
<td>(0.059)</td>
</tr>
<tr>
<td>Total assets</td>
<td>0.0035</td>
<td>0.0034</td>
<td>-0.0002</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.008)</td>
<td>(0.008)</td>
<td>(0.009)</td>
<td></td>
</tr>
<tr>
<td>Firm fixed effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>CEO fixed effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year dummies</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Observations</td>
<td>2,491</td>
<td>2,491</td>
<td>2,401</td>
<td>2,491</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.913</td>
<td>0.935</td>
<td>0.898</td>
<td>0.925</td>
</tr>
</tbody>
</table>
Table 7. CEO hospitalization and electricity efficiency: Subsample analysis

The dependent variable is the natural logarithm of electricity consumption over employees in Columns (1), (5) and (9), fixed assets in Columns (2), (6) and (10), gross profits in Columns (3), (7) and (11), and total assets in Columns (4), (8) and (12). In Columns (1)-(4), the analysis is conducted on the subsample of CEOs holding a non-college degree. In Columns (5)-(8), the analysis is conducted on the subsample of CEOs holding an undergraduate degree. In Columns (9)-(12), the analysis is conducted on the subsample of CEOs holding a master or PhD degree. Days at hospital [t-1, j] measures the hospitalization days of the CEO in the current year and the year before. Male CEO is a dummy equal to one for male CEOs and zero for female CEOs. CEO age measures the years of CEO age. Log(Capital intensity) is the natural logarithm of the ratio of a firm’s fixed assets over its number of employees. Asset growth is the growth rate in the firm’s total assets. Employees are the number of employees in the firm. Total assets is the logarithm of a firm’s total assets. Clustered (firm) standard errors are shown in the parenthesis. *** p<0.01, ** p<0.05, * p<0.1.

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>Ln(kWh/ Employees)</th>
<th>Ln(kWh/ Fixed assets)</th>
<th>Ln(kWh/ Gross profits)</th>
<th>Ln(kWh/ Total assets)</th>
<th>Ln(kWh/ Fixed assets)</th>
<th>Ln(kWh/ Gross profits)</th>
<th>Ln(kWh/ Total assets)</th>
<th>Ln(kWh/ Employees)</th>
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<tr>
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<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
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<td>(6)</td>
<td>(7)</td>
<td>(8)</td>
<td>(9)</td>
<td>(10)</td>
<td>(11)</td>
</tr>
<tr>
<td>Days at hospital [t-1, j]</td>
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<td>-0.005</td>
<td>-0.008</td>
<td>-0.0071</td>
<td>0.0021</td>
<td>0.0021</td>
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<td>0.0823***</td>
<td>0.0724*</td>
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<td>(0.009)</td>
<td>(0.009)</td>
<td>(0.011)</td>
<td>(0.008)</td>
<td>(0.008)</td>
<td>(0.007)</td>
<td>(0.007)</td>
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<td>(0.029)</td>
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<td>0.0377</td>
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<td>(0.015)</td>
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<td>(0.026)</td>
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<td>(0.025)</td>
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<td>(0.041)</td>
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<td>-0.3855***</td>
<td>0.3956***</td>
<td>-0.6044***</td>
<td>0.1118</td>
<td>-0.2027**</td>
<td>0.1219</td>
<td>-0.8781***</td>
<td>0.0788</td>
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<td>(0.049)</td>
<td>(0.065)</td>
<td>(0.050)</td>
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<td>(0.132)</td>
<td>(0.085)</td>
<td>(0.082)</td>
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<td>0.0012</td>
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<td>0.1065**</td>
<td>0.1028</td>
<td>0.1028</td>
<td>0.0213</td>
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<td>(0.017)</td>
<td>(0.017)</td>
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<td>(0.053)</td>
<td>(0.098)</td>
<td>(0.098)</td>
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<td>(0.083)</td>
<td>(0.152)</td>
<td>(0.152)</td>
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<td>-0.0632</td>
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<td>0.0058</td>
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<td>(0.050)</td>
<td>(0.032)</td>
<td>(0.007)</td>
<td>(0.007)</td>
<td>(0.008)</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>CEO fixed effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year dummies</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>1,162</td>
<td>1,122</td>
<td>1,162</td>
<td>894</td>
<td>894</td>
<td>861</td>
<td>894</td>
<td>435</td>
<td>435</td>
<td>418</td>
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<tr>
<td>Adjusted R²</td>
<td>0.926</td>
<td>0.943</td>
<td>0.888</td>
<td>0.929</td>
<td>0.91</td>
<td>0.936</td>
<td>0.912</td>
<td>0.927</td>
<td>0.922</td>
<td>0.931</td>
<td>0.892</td>
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</table>
Table 8. Placebo tests: Effect of future hospitalization on current electricity efficiency

The dependent variable is the natural logarithm of electricity consumption over the number of employees. Days at hospital 1 year ahead (Column 1) and 2 years ahead (Column 2) measure, respectively, the hospitalization days dated one year or two years after the time when the dependent variable is measured. Undergraduate degree is a dummy equal to one of the CEOs hold an undergraduate degree, and zero otherwise. Master or PhD is a dummy equal to one if the CEOs hold a Master or PhD degree, and zero otherwise. The baseline group is formed by CEOs holding non-college degrees. CEO age measures the years of CEO age. Log(Capital intensity) is the natural logarithm of the ratio of a firm’s fixed assets over its number of employees. Asset growth is the growth rate in the firm’s total assets. Employees are the number of employees in the firm. Total assets is the logarithm of a firm’s total assets. Furthermore, our regressions include 3-digit industry and year dummies. Clustered (firm) standard errors are shown in the parenthesis. *** p<0.01, ** p<0.05, * p<0.1.

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days at hospital 1 year ahead</td>
<td>0.0033</td>
<td>(0.005)</td>
</tr>
<tr>
<td>Days at hospital 1 year ahead × Undergraduate degree</td>
<td>-0.0173</td>
<td>(0.017)</td>
</tr>
<tr>
<td>Days at hospital 1 year ahead × Master or PhD</td>
<td>0.0409</td>
<td>(0.030)</td>
</tr>
<tr>
<td>Days at hospital 2 years ahead</td>
<td>0.0017</td>
<td>(0.004)</td>
</tr>
<tr>
<td>Days at hospital 2 years ahead × Undergraduate degree</td>
<td>-0.0147</td>
<td>(0.020)</td>
</tr>
<tr>
<td>Days at hospital 2 years ahead × Master or PhD</td>
<td>0.0464</td>
<td>(0.043)</td>
</tr>
<tr>
<td>CEO age</td>
<td>0.0067</td>
<td>0.0061</td>
</tr>
<tr>
<td>Log(Capital intensity)</td>
<td>0.2357***</td>
<td>0.2329***</td>
</tr>
<tr>
<td>Asset growth</td>
<td>0.0150</td>
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<td>Total assets</td>
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<td>0.0026</td>
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<td>Firm fixed effects</td>
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<td>Yes</td>
</tr>
<tr>
<td>CEO fixed effects</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year dummies</td>
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<td>Observations</td>
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<td>1,708</td>
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<tr>
<td>Adjusted R²</td>
<td>0.924</td>
<td>0.934</td>
</tr>
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</table>
Trying to improve the causal interpretation of our finding, we conduct a placebo test where we estimate the effect of future CEO hospitalization on current electricity consumption. In Table 8 we replace the baseline hospitalization variable with a measure of hospitalization events, which take place either one year or two years after the date of the dependent variable. As shown, none of the interactions between future hospitalization and CEO education has a significant effect on current electricity efficiency.

3.3. Robustness analysis

In this section, we start by addressing the concern that CEO education is correlated with other factors associated with CEO skills, which may in turn be correlated with electricity efficiency. CEO compensation tends to be higher for CEOs that have more skills and experience. Additionally, there is a positive association between CEO pay and education (see e.g. Custodio et al. 2013 on the MBA premium for US CEOs), which makes executive pay a relevant omitted factor potentially biasing our analysis. To account for this challenge, we add a control measuring the logarithm of CEO total compensation. Results in Columns (1) of Table 9 show that CEO compensation is positively associated with firms’ electricity efficiency, perhaps consistent with the view that better-paid CEOs have a broader skill set. Nevertheless, we find that the coefficient of CEO education remains economically and statistically significant.
Table 9. Controlling for CEO pay and ownership

The dependent variable is the natural logarithm of electricity consumption over number of employees. The main explanatory variable in Columns (1)-(4), years of education, measures a CEO’s years of schooling. Log(CEO Income) is the natural logarithm of the CEO yearly income. CEO ownership is a dummy equal to one if the CEO holds more than 5% of the firm’s equity shares. CEO age measures the years of CEO age. Log(Capital intensity) is the natural logarithm of the ratio of a firm’s fixed assets over its number of employees. Asset growth is the growth rate in the firm’s total assets. Employees are the number of employees in the firm. Total assets is the logarithm of a firm’s total assets. Furthermore, our regressions include 3-digit industry and year dummies. Clustered (firm) standard errors are shown in the parenthesis. *** p<0.01, ** p<0.05, * p<0.1.

<table>
<thead>
<tr>
<th>Dependent variable: Log(kWh/Employees)</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Years of education</td>
<td>-0.0525***</td>
<td>-0.0609***</td>
<td>-0.0557***</td>
</tr>
<tr>
<td></td>
<td>(0.020)</td>
<td>(0.020)</td>
<td>(0.020)</td>
</tr>
<tr>
<td>Log(CEO income)</td>
<td>-0.1378**</td>
<td>-0.1391**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.062)</td>
<td>(0.061)</td>
<td></td>
</tr>
<tr>
<td>CEO ownership</td>
<td>-0.3733*</td>
<td>-0.3345*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.198)</td>
<td>(0.179)</td>
<td></td>
</tr>
<tr>
<td>Male CEO</td>
<td>-0.0064</td>
<td>-0.0981</td>
<td>0.0003</td>
</tr>
<tr>
<td></td>
<td>(0.161)</td>
<td>(0.166)</td>
<td>(0.159)</td>
</tr>
<tr>
<td>CEO age</td>
<td>-0.0030</td>
<td>-0.0044</td>
<td>-0.0023</td>
</tr>
<tr>
<td></td>
<td>(0.005)</td>
<td>(0.005)</td>
<td>(0.005)</td>
</tr>
<tr>
<td>Log(Capital intensity)</td>
<td>0.2776***</td>
<td>0.3062***</td>
<td>-0.3345*</td>
</tr>
<tr>
<td></td>
<td>(0.059)</td>
<td>(0.057)</td>
<td>(0.179)</td>
</tr>
<tr>
<td>Asset growth</td>
<td>-0.0534*</td>
<td>-0.0568**</td>
<td>-0.0464*</td>
</tr>
<tr>
<td></td>
<td>(0.027)</td>
<td>(0.028)</td>
<td>(0.027)</td>
</tr>
<tr>
<td>Total assets</td>
<td>-0.0113***</td>
<td>-0.0122***</td>
<td>-0.0112***</td>
</tr>
<tr>
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<td>(0.002)</td>
<td>(0.003)</td>
<td>(0.002)</td>
</tr>
<tr>
<td>Industry dummies</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Year dummies</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Observations</td>
<td>2,483</td>
<td>2,556</td>
<td>2,483</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.183</td>
<td>0.183</td>
<td>0.188</td>
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</table>

CEO ownership may affect the incentives to manage the company efficiently for the long run. In this case, greater CEO equity holdings will extend the time-horizon in managerial decision-making making the firm more focused on long-term sustainable goals rather than short-term financial results. Due to data limitations, we are unable to estimate separately the effects of long-term equity-based and short term pay items in the CEO’s pay package. However, we can control for equity alignment by including a dummy equal to one if the CEO is also a significant shareholder of the firm (i.e. he/she owns at least 5% of the equity capital). Results reported in Column (2) of Table 9 confirm that CEO education is positively associated with energy efficiency.
even after controlling for CEO ownership. Lastly, in Column (3) we show that the positive association between CEO education and electricity efficiency is robust to the joint inclusion of CEO pay and CEO equity ownership as controls.  

So far, we have employed electricity as main energy input. To generalize our findings, we operationalize the dependent variable using other relevant energy sources such as water and gas consumption. These items are again normalized using employees. Columns (1)-(2) of Table 10, which provide the estimates obtained using these ratios as dependent variables, confirm that CEOs with longer education manage more energy-efficient firms.

Next, we use alternative standardization methods. Columns (3)-(5) of Table 10 show the results obtained using as dependent variable: (1) the logarithm of electricity over profits; (2) the logarithm of electricity over fixed assets; (3) the logarithm of electricity over pre-tax earnings. As shown, the coefficient of CEO education is significant across all columns. We also follow an alternative computation of the dependent variable by converting kWh and natural gas to British Thermal Units (BTU) to obtain a common measure for both energy inputs. The BTU is defined as the amount of heat required to raise the temperature of one pound of water by one degree of Fahrenheit. We apply the standard conversion rate of 1 kWh = 3,412.14 BTU and 1 m$^3$ Natural Gas = 36,020.98 BTU. Finally, we aggregate the BTU stemming from the two different energy inputs at the firm level, divide it by the number of employees and take the logarithm of the resulting values. Results in Column (6) show that an additional year of CEO education lowers energy efficiency by 6%.

Alternatively, following existing work (Jaggi and Freedman 1992; Telle 2006) we construct a ratio that evaluates each firm’s energy consumption relative to its peers within a given sub-industry. First, each type of energy consumption is normalized by the firm’s number of employees, and then the resulting values are averaged across the different energy sources. This ratio is then compared to the average consumption of a peer group within the same industry, and the difference is used as the dependent variable in our regression analysis. As shown in Column (7), we find that an additional year of CEO education reduces energy efficiency by 4.5%.

A related question would be about the difference of CEO education for publicly traded and private companies. Unfortunately, we do not have publicly traded firms in our sample to make this comparison.
employees: $\epsilon_{ijst} = \frac{\text{Energy}_{ijst}}{\text{Employees}_{ij}}$, where $i$ is the firm, $j$ is the sub-industry, $s$ is the energy source and $t$ is the year. The lower $\epsilon_{ijst}$, the more energy efficient the firm is. To make this ratio comparable, we find the most energy efficient firm in each sub-industry: $\epsilon_{\text{min},js} = \min_{i=1, \ldots, N} \min_{t=1, \ldots, T} (\epsilon_{ijst})$.

This baseline value is the minimum value of the energy per employee ratio found within each sub-industry over the time and for, respectively, electricity, and gas. The sub-industry minimum is now divided by each firm’s energy efficiency ratio, to obtain a relative measure of energy efficiency: $E_{ijst} = \frac{\epsilon_{\text{min},sj}}{\epsilon_{ijst}}$. $E_{ijst}$ ranges from zero to one. The closer to one, the more energy efficient the firm is relative to its peers. As argued, different firms may use different energy sources that can be close substitutes. To ensure that the firms are not just substituting away from one energy source to another, we find the ratios for each energy input and collect them in a common index: $\text{Energy index}_{ijt} = \frac{1}{S} \sum_{s=1}^{S} E_{ijts}$. Using this ratio, instead of the absolute values, has the advantage that it ranks the firm’s energy efficiency within the sub-industry unambiguously. The downside is that it makes it more complex to interpret the regression coefficients. In our computation, both energy sources (electricity and gas) have equal weights. Unfortunately, the observation number falls significantly, since only firms with information on both the energy variables can be used to compute the index. Results in Column (7) show that CEO education raises a firm’s energy efficiency relative to the industry benchmark.

In the next step of our robustness analysis, we account for sectoral heterogeneity in a more fine-grained way. First, we replace the industry classification of our baseline specification (based on 23 industries and effectively partitioning our manufacturing firms in 7 sub-industries) with a classification based on 53 industries (partitioning our manufacturing firms in 17 sub-industries). Second, we use an even more detailed classification based on 111 different industries (partitioning our manufacturing firms in 34 sub-industries). Results in Columns (8)-(9) show the

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93 The results are robust to excluding water consumption from the index.
results obtained using these more detailed sets of industry dummies. As shown, our findings remain economically and statistically significant.

Finally, in Column (10) we estimate our regression separately for the subsample of the most energy-intensive industries (i.e. the two industries with the highest average of the dependent variable computed across all firms). Our results indicate that the effect of CEO education on energy efficiency is economically stronger than the one estimated using the full sample.
Table 10. Robustness checks

The dependent variable in Column (1) is the natural logarithm of water consumption over gross profits, in Column (2) is the natural logarithm of gas consumption over gross profit, in Column (3) is the natural logarithm of electricity over firm fixed assets, in Column (4) is the natural logarithm of electricity over the number of employees, in Column (5) is the natural logarithm of electricity over pretax earnings, in Column (6) is the natural logarithm of electricity over revenues, in Column (7) is the logarithm of energy efficiency computed using gas, water and kWh (see Section 3.3 for details). In Column (8) we convert kWh and Gas consumption into the British Thermal Unit in order to aggregate the firms' total energy consumption. In Columns (9)-(10), we show the baseline electricity regression using industry classifications based on 53 or 111 different industries respectively. In Column (11), we restrict the analysis to the two most energy-intensive industries, namely electrical equipment and chemicals. Male CEO is a dummy equal to one for male CEOs and zero for female CEOs. CEO age measures the years of CEO age. Log(Capital intensity) is the natural logarithm of the ratio of a firm's fixed assets over its number of employees. Asset growth is the growth rate in the firm's total assets. Employees are the number of employees in the firm. Total assets is the logarithm of a firm's total assets. Furthermore, our regressions include 3-digit industry and year dummies. Clustered (firm) standard errors are shown in the parentheses. *** p<0.01, ** p<0.05, * p<0.01.

<table>
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<th>Dependent variable</th>
<th>Log(Water/ Employees)</th>
<th>Log(Gas/ Employees)</th>
<th>Log(kWh/ Gross profits)</th>
<th>Log(kWh/ Fixed assets)</th>
<th>Log(kWh/ Pretax earnings)</th>
<th>BTU-based index</th>
<th>Efficiency (Gas &amp; kWh)</th>
<th>Log(kWh/ Employees) 3-digit</th>
<th>Log(kWh/ Employees) 4-digit</th>
<th>Energy-intensive subsample</th>
</tr>
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<td>-0.0629</td>
<td>-0.166***</td>
<td>-0.071***</td>
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<td>-0.0931***</td>
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<td>(0.020)</td>
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<td>(0.301)</td>
<td>(0.413)</td>
<td>(1.462)</td>
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<td>(0.170)</td>
<td>(0.379)</td>
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<td>CEO age</td>
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<td>-0.0016</td>
<td>-0.0012</td>
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<tr>
<td>(0.010)</td>
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<td>(0.005)</td>
<td>(0.008)</td>
<td>(0.008)</td>
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<td>(0.005)</td>
<td>(0.005)</td>
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</tr>
<tr>
<td>Log(Capital intensity)</td>
<td>0.3708***</td>
<td>0.7103***</td>
<td>0.0838</td>
<td>-0.6858***</td>
<td>-0.1247</td>
<td>0.5108***</td>
<td>-0.5459***</td>
<td>0.3253***</td>
<td>0.2974***</td>
<td>0.2959***</td>
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<td>(0.095)</td>
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<td>(0.061)</td>
<td>(0.057)</td>
<td>(0.082)</td>
<td>(0.099)</td>
<td>(0.191)</td>
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<td>(0.060)</td>
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<tr>
<td></td>
<td>-0.0219</td>
<td>-0.1098</td>
<td>-0.2384***</td>
<td>-0.0568***</td>
<td>-0.3287*</td>
<td>0.0158</td>
<td>0.1687</td>
<td>-0.0521*</td>
<td>-0.0548*</td>
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<td>(0.062)</td>
<td>(0.028)</td>
<td>(0.179)</td>
<td>(0.075)</td>
<td>(0.142)</td>
<td>(0.025)</td>
<td>(0.023)</td>
<td>(0.099)</td>
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<td></td>
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<td>-0.0124***</td>
<td>-0.0123***</td>
<td>-0.0180***</td>
<td>-0.0881***</td>
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<td>-0.0113***</td>
<td>-0.0113***</td>
<td>-0.1676***</td>
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<td>(0.008)</td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.004)</td>
<td>(0.028)</td>
<td>(0.020)</td>
<td>(0.002)</td>
<td>(0.002)</td>
<td>(0.002)</td>
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</tr>
<tr>
<td>Industry dummies</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year dummies</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Observations</td>
<td>2,737</td>
<td>1,527</td>
<td>2,474</td>
<td>2,556</td>
<td>1,942</td>
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<td>1,508</td>
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<td>2,491</td>
<td>1,080</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.26</td>
<td>0.164</td>
<td>0.129</td>
<td>0.388</td>
<td>0.141</td>
<td>0.281</td>
<td>0.634</td>
<td>0.26</td>
<td>0.293</td>
<td>0.228</td>
</tr>
</tbody>
</table>
3.4. CEOs’ field of study

So far, we have shown that CEO education is associated with energy efficiency. Bloom et al (2010) show a positive association between managerial practices and firms’ energy efficiency. This perspective suggests that our findings can be driven by holding degrees in specific fields, such as business studies, which endow CEOs with skills and training in managing firms with fewer energy inputs. Relatedly, CEOs with technical background may have a deeper understanding of products and production units, and may therefore be able to increase a firm's production efficiency.

To delve into the effect of the fields of study, we divide CEOs’ educational achievements into four different categories. The first is “short education”, which contains all educational degrees lower than college, whereas we divide all “long education” degrees (i.e. undergraduate or higher) into three groups: (1) business (including economics and management); (2) technical (including engineering and natural sciences degrees); and (3) other fields (including humanities, legal studies and so on). As mentioned in Section 2.3, the majority of CEOs with long education did their studies in business (38%) or technical-oriented fields (49%), while about 13% of them hold a degree in other disciplines.

We estimate the model in Table 4 replacing the continuous measure of a CEO’s years of education with this categorical variable for the fields of study taking four values (short education is used as baseline group). Table 11 indicates that relative to CEOs with short education, only CEOs with long education in business-related degrees experience a greater electricity efficiency (from 45% to 51% depending on the specification, and significant at the 1% level) while the coefficients for CEOs holding long education in technical fields or other fields are not statistically different from zero. These results provide some support for the managerial practice view, which suggests that CEOs with advanced education in management-related disciplines should leave a larger imprint on firms’ energy efficiency.
Table 11. Fields of study

The dependent variable is the natural logarithm of electricity consumption over number of employees. Technical advanced degree is a dummy for undergraduate or higher education in engineering or natural sciences. Business advanced degree is a dummy for undergraduate or higher education in management or economics. Other advanced degree is all undergraduate or higher educations in fields outside either technical or business. The baseline educational category is formed by all non-college educational attainments. Male CEO is a dummy equal to one for male CEOs and zero for female CEOs. CEO age measures the years of CEO age. Log(Capital intensity) is the natural logarithm of the ratio of a firm’s fixed assets over its number of employees. Asset growth is the growth rate in the firm’s total assets. Employees are the number of employees in the firm. Total assets is the logarithm of a firm’s total assets. Furthermore, our regressions include 3-digit industry and year dummies. Clustered (firm) standard errors are shown in the parenthesis. *** p<0.01, ** p<0.05, * p<0.1.

<table>
<thead>
<tr>
<th>Dependent variable: Log(kWh/Employees)</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business advanced degree</td>
<td>-0.4578***</td>
<td>-0.4694***</td>
<td>-0.5163***</td>
<td>-0.5020***</td>
</tr>
<tr>
<td>Technical advanced degree</td>
<td>-0.1433</td>
<td>-0.1470</td>
<td>-0.1890</td>
<td>-0.0988</td>
</tr>
<tr>
<td>Other advanced degree</td>
<td>-0.1272</td>
<td>-0.1322</td>
<td>-0.2413</td>
<td>-0.2309</td>
</tr>
<tr>
<td>Male CEO</td>
<td>0.1436</td>
<td>-0.0568</td>
<td>-0.0905</td>
<td></td>
</tr>
<tr>
<td>CEO age</td>
<td>-0.0033</td>
<td>-0.0054</td>
<td>-0.0042</td>
<td></td>
</tr>
<tr>
<td>Log(Capital intensity)</td>
<td>0.2772***</td>
<td>0.3336***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asset growth</td>
<td>-0.0611**</td>
<td>-0.0521*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total assets</td>
<td>-0.0133***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industry dummies</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year dummies</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Observations</td>
<td>2,491</td>
<td>2,491</td>
<td>2,491</td>
<td>2,491</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.108</td>
<td>0.109</td>
<td>0.158</td>
<td>0.189</td>
</tr>
</tbody>
</table>
4. CEO education, environmental attitude and personal choices

Our analysis so far shows a positive association between CEO education and firms’ energy efficiency. As we have argued, this result can be attributable to the fact that more educated managers embrace managerial styles that blend corporate efficiency and respect for the environment. In this section, we test whether CEO education is associated with a greater awareness of climate changes and, in turn, with a greener attitude in personal decisions.

4.1. CEO education and the perception of climate change

We start by studying the relationship between CEO education and individual perception of climate change threats. Measuring preferences toward the environment is challenging. Leveraging on the growing popularity of survey methods in economics (e.g. Bloom and Van Reenen 2007), recent studies have adopted questionnaires to elicit pro-environment preferences (e.g. Videras et al. 2012). To address our research question, in collaboration with Statistic Denmark in 2015 we sent a questionnaire to approximately 55,000 Danish CEOs. We received answers from 13,590 CEOs, yielding a response rate of a little over 25%. The survey questions were about values regarding political preferences and cultural values. Importantly, the survey also contained a question asking “Following the current trend, are we going to experience a climate catastrophe in the near future?” Possible responses are: 1=Agree a lot; 2=Agree; 3=Neither nor; 4=Disagree, 5=Disagree a lot. We use the response to this question as a measure of CEOs’ environmental awareness (greater values correspond to weaker environmental concerns). The 11,901 CEOs that answered this question are, on average, close to climate neutral (with an average response of 2.9).

While the survey data is available for a larger sample, in the next empirical analyses we employ the subsample of approximately 5,000 CEOs with available information on the CEO and the education of their parents (which we will later use as an instrument for CEO education). We
apply this restriction also when we use OLS, in order to estimate OLS and 2SLS on the same sample.

We start by estimating a regression in which the dependent variable is the measure of climate change concerns ranging from 1 to 5. Given the ordered nature of such variable, we employ ordered logit regressions. The key explanatory variable measures a CEO’s years of education. Results, reported in the first column of Panel A, Table 12, show that CEO education has a negative effect on the likelihood of stating weaker climate change concerns; in other words, longer education makes CEOs more concerned about climate change. To reduce omitted factor problems, we control for the CEO age, gender, and the logarithm of income. Results, reported in the second column of Panel A, are largely consistent with our previous estimates.

To establish causality, we use a two-stage least square regression. To this end, we follow the educational literature and employ the education of a CEO’s father and mother as instrumental variables (see Hoogerheide et al. 2012 for a review). The validity condition maintains that these instruments are significantly associated with CEO education. We validate this condition in the first-stage regression reported in the left part of Panel B, Table 12: the education of both a CEO’s mother and father has a positive and 1% significant effect on CEO education. The exclusion restriction maintains that parents’ education does not have a direct effect on CEO’s climate change concerns other than via the direct effect of CEO education. The primary factor that may invalidate this condition is CEO income: CEOs coming from more educated (and arguably wealthier) parents may also be less financially constrained (due e.g. to intergenerational transfer or resources) and this may influence a CEO’s environmental preferences. To mitigate this concern, our specification controls for CEO income.94 Another relevant source of variation comes from the family environment in which the CEO grew up:

94 In untabulated checks, we also verify that our results are robust to the inclusion of a dummy equal to one if any of the parents have or have had a managerial position in the same firm of the son or daughter (the focal CEO of our analysis). This check is useful to mitigate the concern that parents’ education can be correlated with offspring’s education (needed for our analysis) but also have a direct effect on offspring’s green attitude due to learning or imitation of parents’ green managerial style.
growing up with better educated parents may influence the CEOs’ environmental preferences not necessarily via their education but directly via parents’ environmental preferences. To alleviate this concern, we should ideally control for parents’ environmental preferences. While we do not have direct questions about parents’ green attitude, we can use our survey data to control for a host of cultural factors related to the family environment in which the CEOs grew up. In particular, we control for two variables measuring how religious the CEOs’ upbringing was, and the political orientation in the CEOs’ childhood household. These two variables can be used as proxies for climate change views, since religious and political views have been shown to correlate with climate change concerns (e.g. Biel and Nilsson 2014; Stanley et al. 2017; Hoffarth and Hodson 2016). Hence, controlling for these variables partly alleviates concerns about the endogenous transmission of parental education to CEO environmental preferences.

The lower panel of Panel B presents the second stage regression, in which the key explanatory variable is the instrumented value of CEO education together with the controls of our baseline specification. As shown, the results are consistent with our previous insights: CEO education has a positive and 1% significant effect on climate change concerns.96

95 It is important to notice that the average age of our CEOs is 53 years, so the majority of them were children in the 60 and early 70s. Before the oil crisis in 1974, there was, in general, little environmental awareness in Denmark. This supports in itself the claim that CEOs’ green awareness is not directly correlated with parents’ green awareness after we control for parents’ education.

96 The table also shows that age and being a male significantly decrease climate concerns, which is in line with previous studies (e.g. Eisler et al. 2003).
Table 12. Relationship between CEO education and environmental concerns

Panel A of Table 3 presents the results from an ordered logit model in which the dependent variable is the CEO’s response to the survey question “Following the current trend, are we then going to experience a climate catastrophe in the near future?” Possible responses are: 1=Agree a lot; 2=Agree; 3=Neither nor; 4=Disagree, 5=Disagree a lot. Greater values correspond to weaker environmental concerns. The main explanatory variable is a CEO’s years of education, CEO age, a dummy for male CEOs, and the logarithm of CEO income. Religious upbringing is measured using answers to the survey question “My childhood home was religious and religion was a big part of my adolescence” possible answers: 1= Disagree a lot, 2=Disagree, 3=Neither nor, 4=Agree, 5=Agree a lot. Family’s political view is measured using answers to the survey question “How would you characterize the political view in your childhood home on a scale from one to ten, where one is left wing and 10 is right wing. Panel B presents results from a 2-stage least square model. In the first stage regression, reported in the left panel of the table, the dependent variable is CEO education and the key explanatory variables are the controls included in Panel A, together with the two instrumental variables: the education of a CEO’s mother and father. The right panel of Panel B presents the second stage regression, in which the key explanatory variable is the instrumented value of CEO education from the first stage together with the controls of our baseline specification. Robust standard errors are shown in the parenthesis. *** p<0.01, ** p<0.05, * p<0.1

Panel A. Ordered logit

<table>
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<tr>
<th>Dependent variable: Climate concern</th>
<th>(1)</th>
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<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Years of education</td>
<td>-0.0217*</td>
<td>-0.0217*</td>
<td>-0.0220*</td>
<td>-0.0294**</td>
</tr>
<tr>
<td></td>
<td>(0.012)</td>
<td>(0.012)</td>
<td>(0.012)</td>
<td>(0.012)</td>
</tr>
<tr>
<td>CEO age</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.0101***</td>
<td>0.0100***</td>
<td>0.0083**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td></td>
</tr>
<tr>
<td>Male CEO</td>
<td>0.1179*</td>
<td>0.1135</td>
<td>0.1321*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.069)</td>
<td>(0.069)</td>
<td>(0.069)</td>
<td></td>
</tr>
<tr>
<td>Log(CEO income)</td>
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<td>0.0018</td>
<td>-0.0013</td>
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<tr>
<td></td>
<td>(0.031)</td>
<td>(0.031)</td>
<td>(0.030)</td>
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<tr>
<td>Religious upbringing</td>
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<td></td>
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<td></td>
<td></td>
<td>0.1051***</td>
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<td></td>
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<td>5,473</td>
<td>5,463</td>
<td>5,439</td>
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</tbody>
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Panel B. 2SLS analysis

First stage. Dependent variable: Years of education

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<th>(1)</th>
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</thead>
<tbody>
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<td>(0.004)</td>
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<td>Male CEO</td>
<td>-0.1555*</td>
<td>-0.1582*</td>
<td>-0.1417</td>
</tr>
<tr>
<td></td>
<td>(0.0867)</td>
<td>(0.0867)</td>
<td>(0.0872)</td>
</tr>
<tr>
<td>Log(CEO income)</td>
<td>0.2318***</td>
<td>0.2312***</td>
<td>0.2305***</td>
</tr>
<tr>
<td></td>
<td>(0.030)</td>
<td>(0.030)</td>
<td>(0.030)</td>
</tr>
<tr>
<td>Father's years of education</td>
<td>0.1049***</td>
<td>0.1049***</td>
<td>0.1029***</td>
</tr>
<tr>
<td></td>
<td>(0.010)</td>
<td>(0.009)</td>
<td>(0.010)</td>
</tr>
<tr>
<td>Mother's years of education</td>
<td>0.1103***</td>
<td>0.1103***</td>
<td>0.1103***</td>
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<tr>
<td></td>
<td>(0.010)</td>
<td>(0.010)</td>
<td>(0.010)</td>
</tr>
<tr>
<td>Religious upbringing</td>
<td>0.1035***</td>
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<td></td>
<td>(0.027)</td>
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<td>0.0424***</td>
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<td>(0.013)</td>
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</tr>
<tr>
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<td>5,463</td>
<td>5,439</td>
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<tr>
<td>R²</td>
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<td>0.092</td>
<td>0.092</td>
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<td>F-statistics</td>
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<td>92.36</td>
<td>91.74</td>
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</table>

Second stage. Dependent variable: Climate concern

<table>
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<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
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</thead>
<tbody>
<tr>
<td>Years of education</td>
<td>-0.1324***</td>
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<td>-0.1502***</td>
</tr>
<tr>
<td></td>
<td>(0.025)</td>
<td>(0.025)</td>
<td>(0.025)</td>
</tr>
<tr>
<td>CEO age</td>
<td>0.0063***</td>
<td>0.0062***</td>
<td>0.0053***</td>
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<tr>
<td></td>
<td>(0.002)</td>
<td>(0.002)</td>
<td>(0.002)</td>
</tr>
<tr>
<td>Male CEO</td>
<td>0.0615</td>
<td>0.0586</td>
<td>0.0641</td>
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<tr>
<td></td>
<td>(0.043)</td>
<td>(0.043)</td>
<td>(0.043)</td>
</tr>
<tr>
<td>Log(CEO income)</td>
<td>0.0268</td>
<td>0.0265</td>
<td>0.0302*</td>
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<tr>
<td></td>
<td>(0.018)</td>
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<td>(0.018)</td>
</tr>
<tr>
<td>Religious upbringing</td>
<td>0.0217</td>
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<tr>
<td></td>
<td>(0.014)</td>
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<td></td>
</tr>
<tr>
<td>Family's political view</td>
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<td>0.0671***</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.007)</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>5,463</td>
<td>5,463</td>
<td>5,439</td>
</tr>
</tbody>
</table>

4.2. CEO education and environmental choices: Evidence from cars
The previous section shows that CEO education is positively associated with awareness of climate change issues. But does education make CEOs greener when it comes to allocation of personal resources and decision-making over real outcomes? We address this question using data on CEOs’ cars. The Motor Vehicle Register (DMRB) contains extensive information on every motor vehicle registered in a Danish household or company. The register is updated whenever a vehicle undergoes a transaction (e.g. new purchase, change of ownership, scrapping etc.). Given our focus on personal lifestyle, we only focus on passenger cars (excluding commercial vehicles). The cars are all associated with the owner’s individual identification number. If the car is owned by a company but used by the CEO, then the company identification number is registered as the owner, but the CEO identification number is registered as the user. We are therefore able to construct a complete map of the cars owned and used by Danish CEOs. Our data contain information on cars’ fuel type, fuel efficiency (kilometers per liter of fuel), weight and classification (e.g. 2 or 4-wheel drive). We focus on the universe of Danish CEOs in 2013, and on the subsample of CEOs included in our survey. Summary statistics for both samples are reported in Table 13.

Table 13. Summary statistics on CEO cars
This table shows the summary statistics for the CEOs employed in our analysis in Table 13. Panel A refers to the population of Danish CEOs, while Panel B refers to the CEOs covered in our survey about CEO values. Urban dummy is equal to one if the CEO residence is in one of the five largest municipalities in Denmark and zero otherwise. Log(Km/Liter gas) is the logarithm of a CEO car’s energy efficiency measured as the ratio of kilometers per liter of gasoline. Electric car is a dummy equal to one for electric cars and zero otherwise. A complete description of each variable is provided in Table A1.

<table>
<thead>
<tr>
<th>Panel A. Population of Danish CEOs</th>
<th>Observations</th>
<th>Mean</th>
<th>Std. dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban dummy</td>
<td>74,858</td>
<td>0.20</td>
<td>0.40</td>
</tr>
<tr>
<td>Electric car</td>
<td>74,858</td>
<td>0.0010</td>
<td>0.03</td>
</tr>
<tr>
<td>Diesel car</td>
<td>74,858</td>
<td>0.46</td>
<td>0.50</td>
</tr>
<tr>
<td>Log(Km/Liter gas)</td>
<td>74,858</td>
<td>2.80</td>
<td>0.29</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel B. CEOs in the value survey</th>
<th>Observations</th>
<th>Mean</th>
<th>Std. dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban dummy</td>
<td>4,504</td>
<td>0.17</td>
<td>0.38</td>
</tr>
<tr>
<td>Electric car</td>
<td>4,504</td>
<td>0.0011</td>
<td>0.03</td>
</tr>
<tr>
<td>Diesel car</td>
<td>4,504</td>
<td>0.48</td>
<td>0.50</td>
</tr>
<tr>
<td>Log(Km/Liter gas)</td>
<td>4,504</td>
<td>2.78</td>
<td>0.29</td>
</tr>
</tbody>
</table>

In our regression analysis, the first dependent variable is the logarithm of kilometers per liter of fuel (greater values correspond to more environment-friendly cars). One potential violation of this argument is represented by diesel engines, which are normally considered worse for the environment but at the same time makes a car run longer per liter. To avoid this confounding effect, we control for a dummy equal to one for diesel cars, and zero otherwise. We also control for the weight of the cars and therefore estimate the environmental margin of car choices within a given class of car size. Additionally, we control for the CEO-level characteristics employed in the previous section (namely gender and age, but also CEO income that may affect car choice via budget constraints). To account for the confounding effect of a CEO’s area of residence (in urban vs. rural areas) we also control for a dummy equal to one if the CEO lives in one of the five largest Danish municipalities, and zero otherwise.

We employ both OLS and 2SLS using parents’ education as instrumental variables. Results in Columns (1)-(2) of Table 14, Panel A, indicate that CEO education has a significant

---

97 Even though diesel cars drive longer per liter of fuel, they pollute more than gasoline cars (Anenberg et al. 2017).
and positive effect on the green efficiency of his/her car. We validate this finding using an alternative dependent variable, i.e. a dummy equal to one for electric cars and zero otherwise. Driving an electric car is often perceived as a strong environmental commitment. Column (3) shows that more educated CEOs are significantly more likely to own electric cars. The remaining part of the table validates this result using different subsamples. In Columns (4)-(5), we use the subsample of non-married CEOs to evaluate whether their car choice depends on their family situation. Higher education is positively associated with car efficiency in the OLS specification. The coefficient remains positive and large in the 2SLS specification, though the coefficient is less precise.

In Panel B of Table 14, we employ the CEOs covered in the survey discussed in Section 4.1. Again, the results are consistent with our main finding: highly educated CEOs choose more environmental-friendly cars. Using this latter sample makes us able to control for how religious the CEOs’ upbringing was, and the political orientation in the CEOs’ childhood household (similar to what we did in Section 4.1). As the table shows, our results are robust to the inclusion of these additional variables as well as to the use of a 2SLS regression.

### Table 14. CEO education and car choices

This table presents results of OLS and the second-stage of 2SLS regressions. In the 2SLS regressions, we use as instruments for CEO education the education of a CEO’s father and mother measured in years. Depending on the specification, the dependent variable is Log(Km/Liter gas), i.e. the logarithm of the ratio of kilometers per...
liter of gas, or Electric car, i.e. a dummy equal to one for electric cars and zero otherwise. In Columns (1)-(3) of Panel A, we use the population of Danish CEOs. In Columns (4)-(5) we use the subsample of single (unmarried) CEOs. Years of education measures a CEO's years of schooling. Male CEO is a dummy equal to one for male CEOs and zero for female CEOs. CEO age measures the years of CEO age. Urban dummy is equal to one if the CEO lives in one of the five largest municipalities and zero otherwise. Log(CEO income) is the logarithm of CEO income. Log(Car weight) is the logarithm of a CEO's car. Diesel car is equal to one for diesel cars and zero otherwise.

In Panel B we use the CEOs covered in our value survey of 2009. These regressions include as further controls also religious upbringing measured using answers to the survey question “My childhood home was religious and religion was a big part of my adolescence” possible answers: 1= Disagree a lot, 2=Disagree, 3=Neither nor, 4=Agree, 5=Agree a lot, and family’s political view measured using answers to the survey question “How would you characterize the political view in your childhood home on a scale from one to ten, where one is left wing and 10 is right wing. Robust standard errors are shown in the parenthesis. *** p<0.01, ** p<0.05, * p<0.1

<table>
<thead>
<tr>
<th>Panel A.</th>
<th>All CEOs</th>
<th>Single CEOs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent variable: log(Km/Liter gas) log(Km/Liter gas) Electric car</td>
<td>Years of education</td>
<td>0.0043*** 0.0080*** 0.0005**</td>
</tr>
<tr>
<td>Log(CEO income)</td>
<td>-0.0074*** -0.0066*** 0.0003</td>
<td>0.0044*** 0.0052</td>
</tr>
<tr>
<td>Male CEO</td>
<td>-0.0002* -0.0002** -0.0000</td>
<td>0.0007 (0.007)</td>
</tr>
<tr>
<td>CEO age</td>
<td>-0.0088*** -0.0111*** -0.0003</td>
<td>0.0006 (0.007)</td>
</tr>
<tr>
<td>Urban dummy</td>
<td>-0.9565*** -0.9576*** 0.0037***</td>
<td>-1.0809*** -1.0804***</td>
</tr>
<tr>
<td>Log(Car weight)</td>
<td>0.4023*** 0.4026***</td>
<td>0.4446*** 0.4445***</td>
</tr>
<tr>
<td>Diesel car</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.550 0.549 0.650 0.650</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>74,858 74,858 4,180 4,180</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel B.</th>
<th>CEOs covered in the survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent variable: log(Km/Liter gas) log(Km/Liter gas)</td>
<td>log(Km/Liter gas) log(Km/Liter gas) log(Km/Liter gas) log(Km/Liter gas)</td>
</tr>
</tbody>
</table>
5. Conclusion

Understanding the drivers of environmental decisions is central to designing effective policies that mitigate the impact of firm actions on natural resources. We contribute to the growing literature on the implications of top executives’ human capital by studying how CEO education shapes environmental attitudes in corporate decision-making.

Estimating a wide array of regressions on a panel dataset of Danish firms from 1996 to 2012, we deliver the following findings. First, we find a positive association between CEO education and firms’ energy efficiency: better educated CEOs use significantly less energy inputs (electricity and gas) per employee. Second, we seek to establish the causal direction of our findings by using CEO hospitalization events, which generate temporary and arguably exogenous separations between CEOs and firms without changing the matching between the two. Third, we estimate the effects of long education in different fields showing a positive association between

<table>
<thead>
<tr>
<th></th>
<th>OLS (1)</th>
<th>OLS (2)</th>
<th>OLS (3)</th>
<th>2SLS (4)</th>
<th>2SLS (5)</th>
<th>2SLS (6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Years of education</td>
<td>0.0035**</td>
<td>0.0036**</td>
<td>0.0034**</td>
<td>0.0104**</td>
<td>0.0104**</td>
<td>0.0103**</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.005)</td>
<td>(0.005)</td>
<td>(0.001)</td>
</tr>
<tr>
<td>Log(CEO income)</td>
<td>0.0104***</td>
<td>0.0104***</td>
<td>0.0106***</td>
<td>0.0086**</td>
<td>0.0086**</td>
<td>0.0087**</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
</tr>
<tr>
<td>Male CEO</td>
<td>-0.0075</td>
<td>-0.0074</td>
<td>-0.0066</td>
<td>-0.0068</td>
<td>-0.0068</td>
<td>-0.0058</td>
</tr>
<tr>
<td></td>
<td>(0.009)</td>
<td>(0.009)</td>
<td>(0.009)</td>
<td>(0.009)</td>
<td>(0.009)</td>
<td>(0.009)</td>
</tr>
<tr>
<td>CEO age</td>
<td>-0.0010**</td>
<td>-0.0010**</td>
<td>-0.0010**</td>
<td>-0.0010**</td>
<td>-0.0010**</td>
<td>-0.0010**</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>Urban dummy</td>
<td>-0.0028</td>
<td>-0.0031</td>
<td>-0.0025</td>
<td>-0.0072</td>
<td>-0.0074</td>
<td>-0.0072</td>
</tr>
<tr>
<td></td>
<td>(0.008)</td>
<td>(0.008)</td>
<td>(0.008)</td>
<td>(0.008)</td>
<td>(0.008)</td>
<td>(0.008)</td>
</tr>
<tr>
<td>Log(Car weight)</td>
<td>-0.9777***</td>
<td>-0.9774***</td>
<td>-0.9768***</td>
<td>-0.9787***</td>
<td>-0.9783***</td>
<td>-0.9778***</td>
</tr>
<tr>
<td></td>
<td>(0.021)</td>
<td>(0.021)</td>
<td>(0.021)</td>
<td>(0.021)</td>
<td>(0.021)</td>
<td>(0.021)</td>
</tr>
<tr>
<td>Diesel car</td>
<td>0.3984***</td>
<td>0.3982***</td>
<td>0.3982***</td>
<td>0.3989***</td>
<td>0.3987***</td>
<td>0.3985***</td>
</tr>
<tr>
<td></td>
<td>(0.007)</td>
<td>(0.007)</td>
<td>(0.007)</td>
<td>(0.007)</td>
<td>(0.007)</td>
<td>(0.007)</td>
</tr>
<tr>
<td>Religious upbringing</td>
<td>0.0002</td>
<td>-0.0005</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0003)</td>
<td>(0.0003)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Family's political view</td>
<td>0.0006</td>
<td>0.0003</td>
<td>0.0006</td>
<td>0.0003</td>
<td>0.0003</td>
<td>0.0001</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.0001)</td>
<td>(0.001)</td>
<td>(0.0001)</td>
<td>(0.0001)</td>
<td>(0.0001)</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.533</td>
<td>0.532</td>
<td>0.532</td>
<td>0.530</td>
<td>0.530</td>
<td>0.529</td>
</tr>
<tr>
<td>Observations</td>
<td>4,504</td>
<td>4,497</td>
<td>4,777</td>
<td>4,504</td>
<td>4,497</td>
<td>4,777</td>
</tr>
</tbody>
</table>
electricity efficiency and CEO advanced education in business-related fields. Fourth, using a comprehensive survey on individual values and preferences, we show that highly educated CEOs exhibit stronger personal concerns for climate change. They are also significantly more likely to own environment-friendly vehicles, such as fuel-efficient cars and electric cars.

Taken together, our results suggest that CEO education brings about a management style that can reconcile financial performance with environmental preservation.
References


Appendix

Figure A1. The Danish educational system
### Table A1. List of variables

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Financial variables</strong></td>
<td></td>
</tr>
<tr>
<td>Total assets</td>
<td>The value of the firm's total assets</td>
</tr>
<tr>
<td>Gross profits</td>
<td>Yearly gross profit</td>
</tr>
<tr>
<td>Capital intensity</td>
<td>The ratio of capital (total assets) to labor (employees)</td>
</tr>
<tr>
<td>Asset growth</td>
<td>The percentage yearly change in total assets</td>
</tr>
<tr>
<td>Employees</td>
<td>The total number of the firm’s employees</td>
</tr>
<tr>
<td>Fixed assets</td>
<td>Tangible assets such as property, plant, equipment etc.</td>
</tr>
<tr>
<td>Pretax earnings</td>
<td>Earnings after operating expenses and before tax</td>
</tr>
<tr>
<td><strong>CEO characteristics</strong></td>
<td></td>
</tr>
<tr>
<td>CEO age</td>
<td>The age of the CEO</td>
</tr>
<tr>
<td>CEO male</td>
<td>Dummy = 1 if the CEO is a male</td>
</tr>
<tr>
<td>Years of education</td>
<td>The duration of the CEO’s highest educational degree in years</td>
</tr>
<tr>
<td>Non college degree</td>
<td>Consists of lower and upper secondary, vocational, and short academy</td>
</tr>
<tr>
<td>Undergraduate degree</td>
<td>Consists of 3-3.54 years long post high school professional bachelor and</td>
</tr>
<tr>
<td>Master or PhD degree</td>
<td>Consists of university graduate programs</td>
</tr>
<tr>
<td>Short education</td>
<td>Dummy = 1 if the CEO's highest education is shorter than a college degree</td>
</tr>
<tr>
<td>Long technical education</td>
<td>Dummy = 1 if the CEO’s has a master or PhD degree in engineering or natural</td>
</tr>
<tr>
<td>Long business educations</td>
<td>Dummy = 1 if the CEO’s has a master or PhD degree in business or economics</td>
</tr>
<tr>
<td>Long other education</td>
<td>Dummy = 1 if the CEO’s has a master or PhD degree in any other field</td>
</tr>
<tr>
<td>Log(CEO income)</td>
<td>The CEO’s yearly cash payments, excluding benefits, stock option or other</td>
</tr>
<tr>
<td>CEO ownership</td>
<td>Dummy = 1 if the CEO own more than 5 per cent of the firm</td>
</tr>
<tr>
<td>Urban dummy</td>
<td>Dummy = 1 if the CEO lives in one of the five most populated municipalities</td>
</tr>
<tr>
<td>Fathers' years of education</td>
<td>Years of education obtained by the father of the CEO</td>
</tr>
<tr>
<td>Mothers' years of education</td>
<td>Years of education obtained by the mother of the CEO</td>
</tr>
<tr>
<td>Days at hospitalization [t, t-1]</td>
<td>Days during which the CEOs has been hospitalized in the year up to and</td>
</tr>
<tr>
<td><strong>Firm’s energy efficiency</strong></td>
<td></td>
</tr>
<tr>
<td>Electricity</td>
<td>Yearly electricity consumption measured in 1,000 kWh</td>
</tr>
<tr>
<td>Log(kWh/Employees)</td>
<td>The logarithm of the firm's electricity consumption over its employees</td>
</tr>
<tr>
<td>Log(kWh/Gross profits)</td>
<td>The logarithm of the firm's electricity consumption over its gross profits</td>
</tr>
<tr>
<td>Log(kWh/Pre-tax earnings)</td>
<td>The logarithm of the firm's electricity consumption over its pre-tax</td>
</tr>
<tr>
<td>Log(kWh/Fixed assets)</td>
<td>The logarithm of the firm's electricity consumption over its fixed assets</td>
</tr>
<tr>
<td>Water, M³</td>
<td>Yearly water consumption measured in 1,000 cubic meters</td>
</tr>
<tr>
<td>Log(Water/Gross profits)</td>
<td>The logarithm of the firm’s water consumption over its gross profits</td>
</tr>
<tr>
<td>Gas M³</td>
<td>Yearly gas consumption measured in 1,000 cubic meters</td>
</tr>
<tr>
<td>Log(Gas/Gross profits)</td>
<td>The logarithm of the firm’s gas consumption over its gross profits</td>
</tr>
<tr>
<td>Environmental variables at the CEO level</td>
<td></td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>Climate concern</td>
<td>Survey question: Following the current trend, are we then going to experience a climate catastrophe in the near future? Categories: 1. Agree a lot, 2. Agree, 3. Neither nor, 4. Disagree, 5. Disagree a lot</td>
</tr>
<tr>
<td>Religious upbringing</td>
<td>Survey question: CEOs’ perception of how religious his/her upbringing was on a scale from 1 to 5 (1: not religious - 5: very religious) Survey question: CEOs’ perception of his family's political view in his/her upbringing on a scale from 1 to 10 (1: Left wing - 10: Right wing)</td>
</tr>
<tr>
<td>Family's political view</td>
<td></td>
</tr>
<tr>
<td>Log(Km/Liter gas)</td>
<td>The logarithm of the most fuel-efficient car at the CEO's household, measured by distance (in kilometers) the car runs per liter gas (number provided by producer)</td>
</tr>
<tr>
<td>Log(car weight)</td>
<td>The logarithm of the weight of the heaviest car in the CEO's household</td>
</tr>
<tr>
<td>Diesel car</td>
<td>Dummy=1 if the CEO’s household owns a diesel car</td>
</tr>
<tr>
<td>Electric car</td>
<td>Dummy=1 if the CEO’s household owns an electric car</td>
</tr>
</tbody>
</table>
Conclusion

This Ph.D. thesis analyzes the determinants and implication of age at first childbearing for women, the gender inequality in child penalty, and CEOs’ environmental decision-making.

Overall, the three chapters of this thesis use highly detailed register and survey data on different labor market outcomes. Each chapter contributes to our understanding of economic questions highly relevant in the public debate. The first chapter addresses the issue of when to have children. Women in modern society are pressured by constant demands from the society. For financial reasons, they are told that they are supposed to finish their studies and be well established in the labor market before having children. For biological considerations, they are told not to wait until they are too old, since fertility drops significantly with age. These “kind” suggestions provide a narrow window for when the women are supposed to feel confident in having children. My study finds that women should not necessarily wait with childbearing for financial reasons, since the observed income premium of postponing childbearing is most likely based on reverse causality. The second chapter addresses the issue of gender equality in the labor market. I identify one of the reasons behind the inequality in earnings and argue that most of the earnings differential has its roots within the households. How we organize the household around childbirth is still gender dependent and the current organization has a strong impact on mothers’ earnings. The third chapter finds that education increases climate change awareness and better educated CEOs are better at saving energy for manufacturing firms. A big part of the world’s energy consumption comes from manufacturing firms. Identifying what can lower energy consumption can be important in the ongoing struggle against overexploiting our planet’s resources.
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