

Essays in Applied Econometrics and Causal Machine Learning

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Prologue

Social scientists have generally been skeptical about the use of machine learning to answer important policy questions, but some have begun to acknowledge the potential of the new methodology. My dissertation is composed of three self-contained chapters that aim to show how economists may adopt machine learning to analyze complex relationships in situations where standard techniques may fail. In this review, I will highlight two of these studies, where the findings have immense implications for policy-makers, and hopefully, this also demonstrates why machine learning should become an integrated part of economists' toolbox.

Retirement reform forces vulnerable people into public benefits

Demographic change has become a major challenge for many countries. Several pension systems face the pressure of ever-increasing life expectancy and falling labor force participation rates for the elderly. To release pressure from the social security systems, the overall working life must be extended. Many governments have already implemented policies that encourage older individuals to work longer by either cutting retirement benefits or increasing the eligibility age for pension benefits. In Denmark, the most recent retirement reform delayed access to early retirement benefits by increasing the eligibility age in incremental steps of six months for cohorts born from 1954 and forth.

These policies, however, may have adverse effects on those who cannot afford to lose any of the early retirement benefits. Particularly, an unintended consequence may be if those who rely on early retirement benefits are already vulnerable and under-resourced individuals who will then be forced to continue working or, in the worst case, into government benefits.

The study *Between Work, Public Programs, and Retirement: Heterogeneous Responses to a Retirement Reform* presents new evidence on these pressing issues by estimating the causal effects of eligibility to retire early on both employment and take-up rates of government benefits program.

The main finding suggests that shifting the early retirement age increases employment as expected but also increases the take-up of government benefits, which has been swept under the carpet by policy-makers to some extent. Specifically, delaying the eligibility age by six months increases employment by 4.7 weeks on average per person while also increasing the take-up of government programs by 1.3

weeks on average. The effects are, additionally, found to vary strongly across groups in the population. People with a relatively weak financial background are more strongly affected by changes in the eligibility age, presumably because they face liquidity constraints. For them, the early retirement age is binding as they cannot retire unless they get government benefits. Also, people with more unemployment spells, facing poorer working conditions, and with more severe health issues are found to be further affected by the retirement reform. This suggests that already vulnerable groups facing more difficult labor market situations are impacted the most by the reform.

Interestingly, people who are partly forced to bridge the gap between employment and retirement with other government benefits are not easily separated from those who continue to work when facing higher early retirement ages. Both types of people tend to be struggling in the labor market with health issues and few financial resources. The study finds that people who react to the reform by entering government benefit programs mostly differ in terms of having much higher health expenses before they turned 60 compared to people who extend employment.

Adding to the heated #Metoo debate, the study finds that women are much more affected by the reform than men. To understand which individual characteristics that drive the differences between men and women, the gender gap is decomposed into several factors, including but not limited to financial circumstances, family context, and health status. It turns out that more than one-third of the differences in the reactions to the retirement reform between men and women can be attributed to differences in income. This finding points to the many adverse consequences of a gender gap in income with long-lasting effects through retirement.

The trade-off between increasing the employment while partly forcing certain individuals to take up public benefits highlights the need to assess the fiscal impact of the reform. For all but one group, the fiscal benefits of the reform are found to be net positive, meaning that the additional taxes collected from the increases in employment more than offset the additional benefits paid out to people who enter government programs. The threshold at which the benefits exactly outweigh the costs is only reached if the weekly costs of supporting one on benefits exceed US\$ 1230, which is too high for any benefit program in Denmark. For instance, if one considers the sickness benefits program, the weekly amount of sickness benefits is roughly US\$ 650. Thus, from a purely financial perspective, the retirement reform is found to have had a net positive impact on the public finances. It should be emphasized, however, that this back-of-the-envelope calculation ignores several non-fiscal factors that are important in determining the total costs and benefits of the retirement reform. For instance, there are considerable utility gains from working that are not taken into account. Besides the increase in consumption opportunities due to higher income, the good habits derived from having a work routine

that involves mental and physical exercises are some of the intangible benefits. On the other hand, people also derive pleasure from leisure, which has become more expensive with the reform as early retirement benefits are postponed. One can argue that there is also disutility in relying on government benefits for a living, and that continued work may not only be associated with utility gains as certain people might be physically run down after a long working life.

The study contributes to the heavily debated topic on how to design the Danish retirement system and quantifies the important trade-offs that policy-makers are facing. In particular, the findings suggest that those who tend to be already under-resourced and vulnerable are mostly affected by the retirement reform, which raises the question of whether retirement policies should take into account personal characteristics such as labor market seniority, the severity of health issues, etc.

Relocating the US embassy to Jerusalem doubles the violence

Monday afternoon December 6, 2017, the US President fulfilled a major campaign promise by announcing the relocation of the embassy from Tel Aviv to Jerusalem. Many international media reported intensively on the decision that broke with decades of US policy by recognizing Jerusalem as the capital of Israel, although former US presidents have also been commenting on the relocation. For instance, Bill Clinton supported recognizing Jerusalem as the capital and the principle of relocating the embassy there. George W. Bush said before taking office that he intended to relocate the embassy, and Barack Obama spoke of Jerusalem as the capital of Israel that ought to remain undivided. However, the former presidents all consistently signed waivers to postpone the relocation.

The relocation should be viewed as the most recent event in the ongoing Israeli-Palestinian conflict, dating back to the mid-20th century in which the Jewish immigration and the sectarian conflict in Mandatory Palestine between Jews and Arabs took place. In 1948, the establishment of the State of Israel alongside the State of Palestine was proclaimed, and US President at the time Harry S. Truman recognized the new nation. Since 1967, Israel has held all of the pre-war cities of West and East Jerusalem, and in addition, the Gaza Strip has been under Israel's control. Ever since, several wars have been fought between the Arab countries and Israel, and a permanent solution is still to be found.

The study *Tree-based Synthetic Control Methods: Consequences of Relocating the US Embassy* assesses the effects of relocating the US embassy from Tel Aviv to Jerusalem on the conflict level in Israel and Palestine. The results indicate that the weekly conflicts have increased by 26 incidents on average after the relocation was announced on December 6, 2017, until November 3, 2018. This corresponds to more than doubling the number of conflicts per week. The increase is statistically significant at a 1% level. Specifically, the study finds that in a counterfactual state of the world in

which the US embassy had never been relocated, the average number of weekly conflicts in Israel and Palestine would have been only 23, whereas this number in reality was almost 49 conflicts per week.

Another way to assess the consequences of the reform is to compare the weekly level of conflicts before and after the relocation was announced. In particular, the average number of the weekly conflicts was roughly 25 in the period before the relocation from December 28, 2015, to December 3, 2017, just before the announcement. This should then be compared to the average number of weekly conflicts in the period after the relocation was announced. This simple estimate of the effects suggests an increase of 24 conflicts weekly. Under mild assumptions, this estimate is what statisticians call *unbiased*, which means right on average. However, this does not mean that the before-after estimate is particularly accurate. The framework of comparing counterfactual and observed realities achieves higher accuracy than the before-after comparison as it uses additional data on the level of conflicts in the entire region of the Middle East. In this way, the general conflict level in the remaining countries in the Middle East is properly taken into account. The data are collected by the Armed Conflict Location & Event Data Project and the conflicts cover riots, protests, strategic development, remote violence, violence against civilians, various types of battles, and headquarter or base establishments.

The framework of using counterfactuals has a long-standing tradition in the economics literature and is commonly referred to as the synthetic control group method. The basic idea is to construct a synthetic control group as a combination of the other countries in the Middle East (the control units) and compare it to Israel and Palestine (the treated units). However, the standard approach to forming synthetic control groups relies on strong assumptions on the relationship between Israel and Palestine on the one hand and the remaining countries on the other. But in this situation, as the study documents, the assumptions do not hold, for which reason the standard methodology fails. As an alternative, the study proposes a new method that extends the standard synthetic control method by using machine learning to construct a synthetic Israel and Palestine based on the other countries in the Middle East. The study argues that the new method is particularly suited for situations where the empirical question is not guided by any economic model that can justify specific assumptions on the statistical model.

In conclusion, the study sheds light on an important political issue by confirming the fears that the relocation of the US embassy has led to more violence in the Middle East using extensive empirical evidence. The developed method, in addition, is not limited to this application and has the potential to assess the consequences of other political interventions, where standard techniques come short.