



US Centre Summer Research Grant

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Project title: Privacy Regulation and Firm Innovation: Evidence from US Patents

Summary of project:

This research addresses the gap by studying the extent to which company innovation in privacy-enhancing technologies (PETs) occurs as a response to the CCPA. In particular, it is hypothesised that lower data availability, higher consumer privacy awareness, and greater legal pressure induced by the CCPA prompt firm innovation in privacy-enhancing technologies that allow companies to harness individuals' data while safeguarding their privacy and complying with the regulation. Thereby, the study builds on Martin et al. (2019), who investigate how the GDPR affects data-related innovation and finds that the outcome of the regulation is a reduction in the availability of data for firms, which the authors interpret as a negative prerequisite for innovation. By studying innovation in PETs, this research tests an alternative hypothesis, one where the limitations to data access imposed by the privacy regulation present the key mechanism triggering innovation in PETs rather than limiting innovation, as suggested as a final outcome by Martin et al. (2019).

Introduction and Objective

Although the concept of privacy has attracted attention throughout human history, the increasingly widespread use of Internet technology has given privacy a prominent new place on the public, academic and regulatory agendas (Gasser, 2016). Fostered by enhanced computational power and the cornucopia of personal data resulting from a significant portion of society accessing the Internet, the sharing of data without users' consent and the exposition of sensitive data has intensified threats to individual privacy. Consequently, an important pillar of the debate on privacy has become how to effectively craft and enforce privacy regulations. Throughout the last decade, a variety of privacy regulations have been passed, most notably the European General Data Protection Regulation (GDPR) and the California Consumer Privacy Act (CCPA). The passing and enforcement of these regulatory efforts presents policy evaluation researchers with the opportunity to study the effectiveness of privacy regulations and thereby support the effective safeguarding of individuals' personal data.

A broad stream of research has been investigating the impact of privacy regulations on firms. For instance, Koski & Valmari (2020), examined almost 267,000 US and EU businesses between 2014 and 2018 and found a statistically significant impact of the GDPR on the decline of profit margins in the EU's data-intensive sectors. Relatedly, Jia et al. (2021) showed that the GDPR reduced investment for EU technology ventures. Yet, much of this attention has been focused on the role of privacy regulations in shaping financial measures. Studies examining the effects of privacy regulations on firm innovation have been scant in comparison. Considering that the argument of privacy regulations being a potential threat to industry innovation constitutes one of the key hindrances in regulatory efforts that might otherwise benefit consumers, this gap in the literature is a relevant one.

This research addresses the gap by studying the extent to which company innovation in privacy-enhancing technologies (PETs) occurs as a response to the CCPA. In particular, it is hypothesised that lower data availability, higher consumer privacy awareness, and greater legal pressure induced by the CCPA prompt firm innovation in privacy-enhancing technologies that allow companies to harness individuals' data while safeguarding their privacy and complying with the regulation. Thereby, the study builds on Martin et al. (2019), who investigate how the GDPR affects data-related innovation and finds that the outcome of the regulation is a reduction in the availability of data for firms, which the authors interpret as a negative prerequisite for innovation. By studying innovation in PETs, this research tests an alternative hypothesis, one where the limitations to data access imposed by the privacy regulation present the key mechanism triggering innovation in PETs rather than limiting innovation, as suggested as a final outcome by Martin et al. (2019).

Methodology

While the majority of research on privacy regulation focuses on the GDPR (e.g., Aridor et al., 2020; de Matos & Adjerid, 2022), this study draws on the CCPA. The introduction of the CCPA in California presents an advantageous opportunity for researchers as, in the absence of a US wide privacy regulation, California was the first state to introduce a privacy regulation in January 2020. In contrast to the GDPR, which covers the entire Europe, this setting lends itself to a Difference-in-Differences (DiD) approach as within the same country, one state issued a privacy regulation while the others didn't.

To address the research question, a DiD design is applied where two comparisons are made. First, the treatment group that is subject to the policy intervention is compared to the control group that is not. Second, the outcomes of both groups before and after the intervention are compared (Cameron & Trivedi, 2005).

The outcome of interest is company innovation in PETs measured through the number of patents registered within a US county per month. The data was collected in September 2023, and to ensure equal pre- and post-treatment periods, we included patent data from April 2017 to September 2023. Additionally, we explore patents filed in the patent class G06F (“electric digital data processing”) that the majority of PET patents belong to. Patent filing has been a widely applied proxy measure for innovation activities (J. Lee, 2013; Mogee, 1991). Patents offer a standardised source of information regarding technological innovation at the industry and state levels, making them useful for revealing technological trends and present levels of technological progress (Archibugi, 1992; Brockhoff, 1992; M. Lee, 2020). Patent data can be retrieved from the Patent Public Search Database (USPTO, 2023). The keywords (e.g., differential privacy, homomorphic encryption, and federated learning) used for the search are taken from the PET technologies classification by the OECD (OECD, 2023).

A key assumption is the stable unit treatment value assumption (SUTVA), which implies that the CCPA does not affect the control group (Angrist & Pischke, 2015). However, the CCPA has substantial spillovers because the regulation’s scope includes not only Californian firms, but also companies residing outside California that process data of more than 100,000 Californians. Hence, a direct comparison between all companies residing in California versus the rest of the US is complicated. This issue could be addressed thanks to the support received from the Phelan Centre. We hired a research assistant who (fuzzy) matched the patent data to company information retrieved from the Orbis database based on the company name. Thereby, we could retrieve information on each company’s branches across the US. We classified counties outside of California where companies with branches in California operate as partially treated. The size of the partial treatment is calculated as the share of companies operating branches in California. Figure 1 shows the partial treatment by county. Dark grey counties are not treated while there were no patents registered from companies in light grey counties.

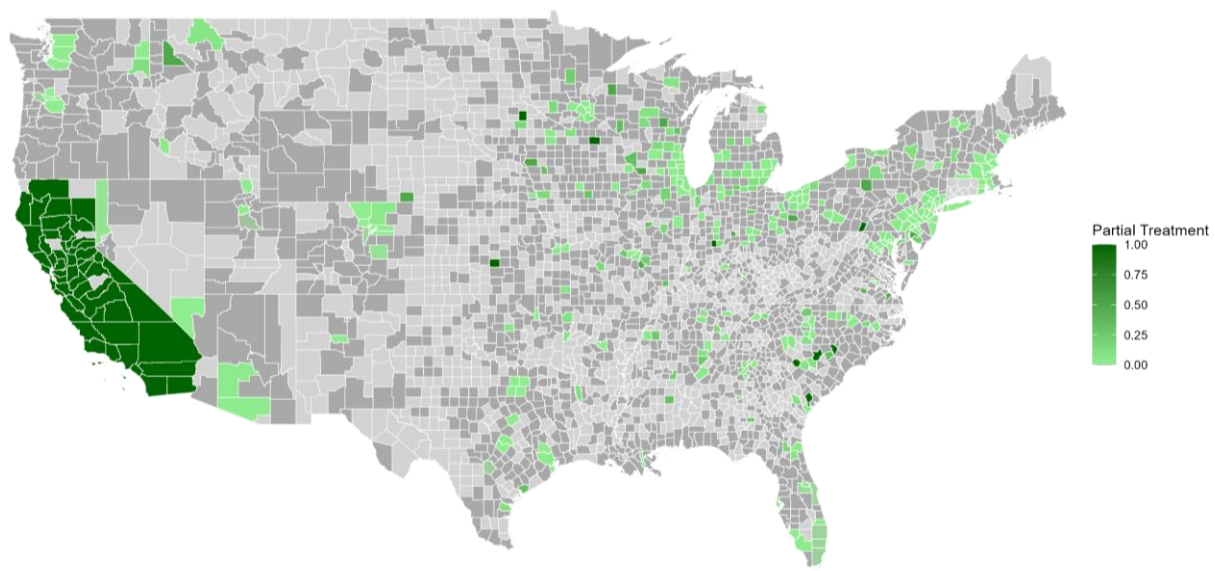


Figure 1: Partial treatment by US county

Through the matching of the patent to the Orbis data, we could further retrieve information on company characteristics (e.g., industry, size of the company) required for the robustness checks as well as to provide industry specific policy recommendations. Another core assumption underlying DiD estimates is the parallel trends assumption, which is mostly supported in our preliminary analyses.

The DiD approach calculates the impact of the CCPA by deducting the before-after means comparison in the control group from that in the treatment group. The following regression is estimated: $Y_{dt} = \alpha + \beta TREAT_d + \gamma POST_t + \delta_{rDD}(TREAT_d \times POST_t) + e_{dt}$ where $TREAT_d$ is a dummy variable for counties in the treatment group (i.e., counties in California as well as partially treated counties), $POST_t$ is a dummy for post-treatment months in the period 2021-2023, and $TREAT_d \times POST_t$ is an interaction term whose coefficient indicates the causal effect (Angrist & Pischke, 2015).

Preliminary Findings

Baseline analyses were calculated that use the patents in the category “electric digital data processing” more broadly as well as the patents containing keywords related to privacy-enhancing technologies more specifically as the outcome variables (in logarithmic form to account for the high number of 0 patents in US counties). The analyses were performed on a county and month basis. The results shown in Tables 1 and 2 indicate that after the CCPA came into effect, patents filed in both categories decreased.

patent count (G06F patents)	
$TREAT_d \times POST_t$	-0.141958*** (0.043602)
Observations	156,624
R2	0.813070
Adjusted R2	0.810548
Residual Std. Error	0.222737 (df = 154538)
F Statistic	322.387700*** (df = 2085; 154538)

Note: *p<0.1; **p<0.05; ***p<0.01. Cluster robust standard errors in parenthesis

Table 1: Effects of the CCPA on data-intensive innovation

patent count (PET patents)	
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$TREAT_d \times POST_t$	-0.037705** (0.016776)
Observations	156,624
R2	0.562058
Adjusted R2	0.556149
Residual Std. Error	0.074493 (df = 154538)
F Statistic	95.124740*** (df = 2085; 154538)

Note: *p<0.1; **p<0.05; ***p<0.01. Cluster robust standard errors in parenthesis

Table 2: Effect of the CCPA on innovation in privacy-enhancing technologies

The results indicate a decline in data-intensive innovation more broadly after the enactment of the CCPA. Surprisingly, there was also a decrease in the innovation in privacy-enhancing technologies as a response to the CCPA. Potential explanations for the decline that will be investigated further could include general hesitancy regarding the enforcement of the regulation or broader shifts towards products and services relying less on data. Another explanation might be a shifting focus towards buying privacy solutions rather than developing these themselves.

Next Steps

The research presented in this report is still in the early stages and will be developed over the coming months. In particular, county-specific control variables such as the GDP of the county and proxies for its innovative capacity will be added to the analyses. Beyond that, different reactions to the CCPA across industries will be explored - the high-tech industry might, for instance, react differently than the non-high-tech industry. The sample period will further be extended to investigate potential shifts in organisational innovation since September 2023.

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