E-Privacy Provisions and Venture Capital Investments in the EU

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1. Introduction

In the digital economy, many firms create value for consumers by collecting and parsing data that are then used, directly or indirectly, to offer new and superior services to them. For example, firms can track users to then customize content to their interests, and online news publishers are able to offer users news services for free because they can sell advertising impressions to advertisers.

However, the collection of user data has also raised concerns among European Union (EU) public policy makers about user privacy. In an effort to address new and emerging concerns regarding user privacy, the EU enacted the Privacy and Electronic Communications Directive (2002/58/EC) (the "EU e-Privacy Directive") in 2002, which is focused on a number of issues, including the treatment of traffic data, the confidentiality of consumers' information, unsolicited email, and the treatment of cookies (pieces of data sent from a website and stored on the user's computer while the user is browsing to collect user data, allowing for fine-grained segmentation and targeting).[2]

While the EU e-Privacy Directive was motivated, in part, to protect consumers, concerns have been voiced that restricting the ability of firms to collect and use data may unintentionally hurt revenue opportunities for firms in the digital sectors and, by implication, reduce investment in digital industries, especially those that rely on the collection and parsing of large amounts of user data.

[2] The directive was amended in 2006 (Directive 2006/24/EC) and in 2009 (Directive 2009/136/EC).

In this paper, we examine whether changes to EU e-privacy law as prescribed by the EU e-Privacy Directive, enacted in 2002, Directive 2006/24/EC, and Directive 2009/136/EC were associated with a change in the level of VC investment in the EU. We also discuss potential implications of pending modifications to e-privacy law in the EU for VC investment. Building on Lerner (2012b), who studied the effects of the EU e-Privacy Directive on VC investment in online advertising, we focus on three sectors that are likely to be affected by such changes in legislation: online news, online advertising, and cloud computing.

Online news firms generate the vast majority of their revenues from advertising on their sites. Increasingly, online advertising relies on targeting the most relevant ads to users (see, for example, recent research on retargeting such as Lambrecht and Tucker (2013) or Johnson et al. (2017)). Thus, policies which limit the effectiveness of cookies or otherwise restrict the ability to target advertisements potentially harm online news providers by decreasing the precision by which relevant ads are displayed to users, thereby decreasing conversion rates and revenues.[3] Depressed advertising revenues may not only affect revenues of online news sites but also, indirectly, revenues of other players in the online advertising ecosystem (e.g., adtech companies and exchanges). In addition, innovation in online advertising has increasingly relied on the ability to identify consumer preferences using detailed user data, and then target the most relevant advertisements to them. Thus, it seems plausible that restricting the ability to track and collect data on user preferences would affect the revenue potential of online advertising. Reduced revenue may, in turn, lead VC firms to reduce their investment into the sector. In the cloud computing

[3] Recently, online news sites have turned to complementing advertising revenues by charging users for access to content. However, our empirical analysis focuses on years up to 2013 when content was predominantly free for users.

sector, companies that provide analytics services likewise may have to deal with the increased regulation with regard to using cookies to collect and process user data. In addition, cloud computing firms serving telecommunications customers have to deal with requirements imposed upon them with regards to data security and data breach notification. These policies may lead firms to invest disproportionately into complying with governmental guidelines, decreasing their profitability and distracting management from a focus on innovation, or alternatively steer them away from this potential customer segment.

Note also that since EU Directives, such as the EU e-Privacy Directive, are implemented via a diverse set of differing country-specific laws (with different implementation timelines), companies which operate across national jurisdictions in any of the three sectors are likely impacted by complicated compliance requirements.

To understand the relationship between passage of EU e-privacy provisions and VC investment, we focus our empirical analysis on the years 1998 through 2013. We rely on a standard difference-in-differences approach to measure whether the level of VC investment in the EU into start-ups that focus on online advertising, online news, and cloud computing changed after the EU e-Privacy Directive was enacted in 2002 (and amended in 2006 and 2009),[4,5] relative to corresponding types of investments in the U.S. The U.S. is an appropriate benchmark because it has no overarching federal-level privacy law, in contrast to the EU. Instead, the U.S. has pursued

[4] European Commission, "Directive 2006/24/EC," *Official Journal of the European Union* (April 13, 2006), http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32006L0024&qid=1501856654741&from=EN.

[5] European Commission, "Directive 2009/136/EC," *Official Journal of the European Union* (December 18, 2009), http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0136&qid=1501858706889&from=EN.

a strategy of "sectoral" or self-regulating approach in which specific legislation may address discrete subjects[6] and industry is encouraged to create its own standards.[7] Further, some states have implemented their own privacy regulations within their jurisdictions;[8] however, these tend to place limited administrative burden on firms such as requiring websites to list their cookie or tracking policies within "privacy policies" on their pages but not requiring them to obtain user consent.[9]

Our results suggest that in the EU, VC investments into online news, online advertising, and cloud computing increased at a slower pace than in the U.S. after the passage of the 2002 EU e-Privacy Directive, after controlling for several drivers of VC investments into firms in these industries. In particular, our regression results imply that VC investment across these three sectors was between 58 to 75 percent lower in aggregate each year than it otherwise would have been if the EU and U.S. had maintained similar trends in investment after 2002Q2. We emphasize that this measures the difference in the investment trends in the EU and U.S. during the period of our study and that there may be factors other than the introduction of the EU e-Privacy Directive that might also be driving the effect. The available data does not allow us to pin down the effect of the EU e-Privacy Directive separately from other contributing factors.

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6 Such as the Health Insurance Portability and Accountability Act (HIPAA), the Fair and Accurate Credit Transaction Act (FACTA), and the Children's Online Privacy Protection Act (COPPA).

7 "White House: Consumer Privacy Bill of Rights," *Electronic Privacy Information Center*, https://epic.org/privacy/white_house_consumer_privacy_.html.

8 "State Laws Related to Internet Privacy," *National Conference of State Legislatures* (June 20, 2017), http://www.ncsl.org/research/telecommunications-and-information-technology/state-laws-related-to-internet-privacy.aspx.

9 See for example, California Business & Professions Code § 22575-22578 (CalOPPA).

This research relates to prior literature that discusses the role of privacy legislation and its broader impacts on the economy and technological development. Romanosky et al. (2011) analyzed how the passage of "data breach disclosure laws" at the state level affected the prevalence of identity theft in the United States over the 2002-2009 time period. They conclude that policies requiring companies to notify users in the event of a data breach decreased the frequency of identity thefts by 6.1 percent. On the other hand, in a study of state laws designed to promote increased privacy protection of hospital medical information, Miller and Tucker (2009) find that these laws reduce the adoption of Electronic Medical Records (EMR), a technology which could substantially decrease U.S. healthcare costs.

Our research also contributes to a broader understanding of factors that may affect the level of VC investments and how VC investments relate to regulatory decisions. Romain et al. (2004) evaluated the VC environment across 16 OECD countries from 1990-2000 and find that governmental policies, like minimum wages or unemployment insurance, that control the flexibility of the labor market moderate factors correlated with VC investment in a country. Likewise, Schertler (2003) asserts that, among other factors, labor market rigidity is associated with a country's level of early stage VC investment. These studies thus indicate a relationship between governmental policies and VC investment at the national level.[10]

Research further suggests a link between VC investment and both job creation and innovation. Gornall and Strebulaev (2015) find that, as of 2014, nearly one in five U.S. publicly-traded firms had received venture capital funding early in their history. These firms were responsible for 11 percent of employment and 44 percent of the total research and development

[10] For an additional discussion of factors impacting the level of VC investment, see Jagwani (2000).

spending among publicly-traded companies. Similarly, Lerner (2012a) finds that U.S. venture-backed firms that have gone public employed six percent of public-company employees, often in high-salary, high-skill tech jobs. These findings suggest that the level of VC investment may have a wider impact on national economies.

In addition, Puri and Zarutskie (2012) find that venture-backed firms show stronger growth than comparable firms that do not receive VC investment. Further, Hellmann and Puri (2000) have associated the presence of VC investment with a reduction in the time taken to bring a new product to market, particularly for innovators, and Kortum and Lerner (2000) find that venture capital investment benefits innovation and that VC investment is much more effective at yielding patentable discoveries than private corporate research and development, generating up to ten percent of innovation between 1983 and 1992 while contributing less than three percent of total spending.

Though VC investments have historically been of a lower scale in Europe than in the U.S., the conclusions generally also hold for Europe. Bottazzi and Da Rin (2002) find that while the results linking VC investment and long-term innovation in European firms are inconclusive, they can say with a high degree of certainty that early stage financing by VC investors is a critical component in the survival of innovative companies in Europe during their initial period of development. Similarly, Popov and Rosenboom (2011) examine the European VC landscape from 1991-2008 and find that the relationship between VC investment and innovation is strongest in countries which have adopted favorable conditions for early stage firms, such as greater access to capital and less strict labor policies. To promote increased efficiency in VC investment across Europe, the authors make the suggestion for "more coherent and harmonized legislation."

Our research contributes to this literature as it demonstrates a correlation between increased e-privacy provisions in the EU and a dampening of VC investments into three industries that may plausibly be affected by such legislation: online news, online advertising, and cloud computing.

Of note, the author is not a legal expert or an expert on regulation. The focus of this report is the empirical analysis of VC investments in the EU relative to the U.S. In the interpretation of the result and the broader discussion of the potential implications of the findings, the legal interpretations of trade associations, firms involved in these sectors, and other actors cited here are taken as being correct and proper.

2. Background

We first summarize key aspects of EU e-privacy legislation and then discuss the potential impact of EU e-privacy legislation on VC funding in the three focal sectors: online news, online advertising and cloud computing.

2.1. EU e-Privacy Frameworks

In August 2000, the European Commission submitted a proposal to the Council of the European Union and European Parliament concerning the "processing of personal data and the protection of privacy in the electronic communications sector."[11] The EU e-Privacy Directive was adopted on July 31, 2002, repealing Directive 97/66/EC.[12] The EU e-Privacy Directive, compared

[11] European Commission, "COM/2000/0385," *Official Journal of the European Communities* (December 12, 2000), http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52000PC0385&from=EN.

[12] See http://eur-lex.europa.eu/procedure/EN/158278 for a timeline of the procedure and a summary of the legislation.

with Directive 97/66/EC,[13] sought to cover a broader range of digital communication technologies, especially those enabled by the proliferation of the Internet. Member States had until October 31, 2003 (the transposition date) to implement laws compliant with the Directive at the national level.

More specifically, the EU e-Privacy Directive standardized the process for informing users and obtaining consent for cookies to be placed on users' devices. It also required organizations to provide users with the choice to give and withdraw consent from a service provider at any point regarding the use of cookies and the use and storage of user data. Firms were told to only retain and process user internet traffic and location data "to the extent and for the duration necessary for such services or marketing." Further, firms were expected to implement an adequate level of security to protect user data and advise users of potential security threats. Collectively, these rules significantly altered how technology companies could track and target individuals and groups of users.

The EU e-Privacy Directive was amended first in 2006 and then again in 2009. After the Madrid train bombings in March, 2004, the EC adopted a Declaration on Combating Terrorism and in 2006, the EC adopted Directive 2006/24/EC, which focused on the retention of user data to be able to identify users for investigation into criminal activity.[14] This policy requires firms to aid law enforcement agencies in the prevention of crimes and terrorism by obliging them to retain certain data for periods of up to two years, after which it must be destroyed.[15] Specifically, data

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[13] The passage of the EU e-Privacy Directive repealed Directive 97/66/EC, which applied the laws established by Directive 95/46/EC to the "processing of personal data and the protection of privacy in the telecommunications sector." European Commission, "Directive 2002/EC/58," *Official Journal of the European Communities* (July 31, 2002), http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32002L0058&from=EN.

[14] European Commission, "Directive 2006/24/EC," *Official Journal of the European Union* (April 13, 2006), http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32006L0024&qid=1501856654741&from=EN.

[15] Ibid.

needed to identify the source, destination, date, time, duration, type, equipment, and location of a communication were designated to be retained and could be requested by authorities for use in criminal investigations. Member States were required to enact legislation by September 15, 2007 to comply with the provisions of the Directive.[16] As of 2010, 22 of the 27 EU Member States[17] had laws in place compliant with this directive.[18]

Directive 2009/136/EC amended multiple EU Directives, including the EU e-Privacy Directive.[19] It strengthened the earlier provisions around data breaches and cookies. In particular, the new rules compel telecommunication service providers to notify the authorities of a data breach within 24 hours, or at least as soon as possible.[20] For cloud computing firms offering services to telecommunications operators, they would have to implement a similar data breach notification mechanism to help their customer comply with statutory provisions. Other obligations such as maintaining records of past breaches and a precise record of their mitigation measures may, in practice, be passed on to cloud vendors. In addition, national authorities were given the right to examine a firm's security system and oversee whether a firm was complying with the policies for data breach notification. Further, the policy on cookies was tightened by refining the requirements around user consent prior to the installation of a cookie.[21] And finally, the 2009 rules obliged firms

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16 Ibid.

17 Croatia joined the EU in 2013.

18 European Commission, COM/2011/0225," (April 18, 2011), https://www.eff.org/files/filenode/dataretention/20110418_data_retention_evaluation_en_0.pdf.

19 European Commission, "Directive 2009/136/EC," *Official Journal of the European Union* (December 18, 2009), http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0136&qid=1501858706889&from=EN.

20 European Commission, "Regulation (EU) No 611/2013," (June 24, 2013), http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32013R0611.

21 Directive 2009/36/EC spelled out the conditions of user consent in more precise terms than had been done previously. The Directive does not allow for the placement of cookies without prior user consent and states that the user must be "provided with clear and comprehensive information" about the purposes of the cookie prior to the act of giving consent. Ibid.

to participate in cross-border cooperation with law enforcement agencies. Directive 2009/136/EC had a transposition date of May 25, 2011, by which all EU Member States had to pass it into law.[22]

EU Directives, unlike EU Regulations, are not immediately enacted by Member States as law, but rather are implemented under national legislation that can vary significantly from one jurisdiction to another. This approach can result in a wide range of requirements that a firm may be subject to at any given time. Further, there have been delays between the initial discussion of new regulatory changes, adoption of a Directive by the EU and, then finally, implementation of laws at the national level. For example, though the EU e-Privacy Directive entered into law on July 31, 2002, and Member States had until October 31, 2003 to implement laws compliant with the Directive, only three Member States created corresponding legislation by that deadline. (See Appendix A for details regarding when Member States adopted laws relating to the EU e-Privacy Directive.)

2.2. Potential Relationship between e-Privacy Provisions and VC Funding

The new e-privacy legislation introduced in the EU starting in 2002 has heightened the restrictions on companies in the online news, online advertising, and cloud computing sectors. The effects of these Directives play out particularly along the dimensions of user tracking and data storage and processing. We provide a non-exhaustive discussion of ways in which these effects may have been felt in each of the three sectors we focus on.

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[22] European Commission, "Directive 2009/136/EC," *Official Journal of the European Union* (December 18, 2009), http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0136&qid=1501858706889&from=EN.

The first sector we focus on is online news. We consider as online news firms companies involved in the process of delivering news and current information through the Internet. This sector includes firms that either create original news content and provide it to users via a website (or to internet-enabled devices such as smart TVs), firms that aggregate content from other media providers and firms that provide a platform for others to share news content in an organized and categorized fashion.

A large proportion of revenue in the online news sector comes from advertising that is shown to users on the websites of online news publishers – online news publishers earn revenue from displaying advertising while firms that provide content or platforms benefit from this revenue stream indirectly when their services are purchased by online news publishers. While some news publishers fully or partly charge their readers to access online content, the majority of online news publishers still earn the majority of their revenue from selling advertising space.[23]

Cookies allow for fine-grained segmentation and targeting of advertising to consumers. Policies that limit the use of cookies by firms are problematic for online news firms as these provisions may affect their ability to earn advertising revenue. In general, the greater precision with which advertising firms can display relevant ad content to users will increase their response rates to the ad – in terms of clicks on the ad and, ultimately, purchases. If an ad is more likely to generate a purchase for an advertiser, the advertiser's willingness-to-pay for the ad exposure

[23] Advertising provides 81 percent of digital revenue for mixed media publishers, and an estimated 90 percent+ of revenues for natively digital publishers. "The Economic Contribution of Digital Advertising in Europe," *IHS Markit* (September 2009).

increases and, in turn, revenues for online publishers (as well as for the multiple players in the ad ecosystem) increase.

By implication, a reduction in the ability to track users will likely reduce the ability to target them with great precision, decreasing conversion rates. For example, Goldfarb and Tucker (2011) report that, after the implementation of the EU e-Privacy Directive, internet banner ads in Europe experienced an average reduction in effectiveness by 65 percent They directly attribute this result to the policies of the Directive that decrease the ease by which user data is leveraged for targeted advertising. Holding everything else constant, reduced advertising effectiveness is likely to reduce the amount that advertisers are willing to pay for ad exposure, thus, depressing revenue for online news firms. For online news providers, it is not straightforward to compensate for a potential drop in revenues by charging users for access to news as paywalls typically lead to a significant decrease in viewership as many users are unwilling to pay for access to content (Lambrecht & Misra 2016; Chiou & Tucker 2013). Thus, VC investments in this sector are likely to reflect such a reduced revenue potential.

The second sector we consider is online advertising. The universe of online advertising is increasingly complex, encompassing a wide range of players ranging from demand-side-platforms to supply-side-platforms, advertising exchanges, and more specialized providers of advertising technology or information such as, for example, providers of traffic analytics solutions, and firms that provide software for online advertising. Throughout, the industry increasingly relies on the ability to track individual users and to target advertising to specific users based on attributes such as their past browsing history, their (inferred) interest or their (inferred) demographics or geography.

Legislation that hinders firms' ability to track users and target advertising to them is likely to also be disruptive to firms in the online advertising sector. If revenues of online (news) publishers are depressed due to their reduced ability to target advertising, this has knock-on effects on revenue streams that can be invested into online advertising technologies. Additionally, for European online advertising firms, policies surrounding cookies may be particularly problematic as they may also limit these firms' ability to innovate and invest into developing new technologies that could potentially be monetized beyond the European market. Again, VC investments in this sector is likely to reflect limited revenue opportunities.

Indeed, in a qualitative study of venture capitalists, Marston et al. (2013) suggest that limited opportunities to monetize data in the EU due to e-privacy provisions may depress investments. Several American VC investors in the sample voiced concerns on the impact of e-privacy laws on business in the EU, claiming that such laws act as a "barrier to business" and impede the development of tech start-ups which rely on data as a source of revenue.[24] Investors also expressed displeasure because updates to EU e-privacy laws have increased the number of legal requirements which companies need to be compliant with. As a result, for example, a company developing an algorithm to process user data might fail to attract funding over concerns that the algorithm may be disallowed under existing or future privacy laws or it may be valued less because its uses within the confines of the EU law are too limited.

The third industry we focus on in this report is cloud computing. According to the National Institute of Standards and Technology (NIST), an agency of the United States Department of

[24] Marston, Louise, Collins, Liam, Bravo-Biosca, & Lane, Henry, "Unchaining Investment: Barriers to US Venture Investment in UK Internet and Digital Businesses," *Nesta* (2013).

Commerce, cloud computing is a "model for enabling ubiquitous, convenient, on-demand network access to a shared pool of a configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction."[25] In other words, the cloud computing industry consists of companies who either provide internet-based applications which users may access via a network connection or provide data processing and storage solutions which reside in a location outside of the user's local network. In addition, we consider under the umbrella of cloud computing firms that offer Infrastructure-as-a-Service, Platform-as-a-Service or Software-as-a-Service using cloud computing, as well as those that offer security and software management.

EU e-privacy provisions related to the use of cookies may also have affected firms in the cloud computing sector that provide analytics services. Restrictions on placing cookies and requesting user consent as well as uncertainty about the correct legal interpretation of how user consent can be obtained may have distracted cloud-based analytics firms from innovation if they instead focused on complying with regulatory requirements.

Another potential way in which EU e-privacy provisions may have affected the cloud computing sector is via stricter policies related to data security and data breach notifications for PaaS and IaaS providers who may wish to provide their infrastructure and data processing capabilities to telecommunications firms. Specifically, in the EU, national authorities may audit the security systems of cloud-based providers that offer services to telecommunications customers, even if there is no indication of a breach.[26] In addition, authorities may offer recommendations for

[25] "The NIST Definition of Cloud Computing," *National Institute of Standards and Technology* (2011).

[26] Directive 2009/136/EC states that "Relevant national authorities shall be able to audit the measures taken by providers of publicly available electronic communications services and to issue recommendations about best

proper security measures. These provisions may lead cloud computing firms who wish to serve telecommunications customers to dedicate a larger amount of management attention and resources to matching standards set by national governments. The requirement for these firms to keep detailed records of data breaches and the fact that firms are subject to examination as to whether they complied with data breach notification policies adds further regulatory pressure and administrative burden.

Together, the effects of these policies may lead firms to invest disproportionately into complying with governmental guidelines, or alternatively to decide not to serve this potential customer segment, decreasing their profitability and growth prospects. The provisions may also distract management from a focus on technological advancement and developing new services for customers. Lack of profitability and industry growth could thus diminish VC investment into the cloud computing sector.

Finally, under the EU e-Privacy Directive, all three sectors face the challenge of dealing with legislation that varies across different geographic regions since EU Member States were allowed flexibility in how they transposed Directives into national law.[27] For example, while Ireland fully transposed the EU e-Privacy Directive into Irish law, Germany devised a separate

practices concerning the level of security which those measures should achieve." European Commission, "Directive 2009/136/EC," *Official Journal of the European Union* (December 18, 2009), http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0136&qid=1501858706889&from=EN.

[27] Recent EU legislation has sought to harmonize the various policies of EU member states.

Telecommunications Act in 2004 which enacted the policies of the Directive in a slightly modified form.[28]

Dealing with multiple different legal requirements within the EU is challenging as many companies hold operations in multiple (European) countries. In addition, the data possessed and managed by companies in these sectors are no longer constrained to a single geographic location; rather, data can be transferred between locations and across national borders instantly.[29] As a result, firms which store or process the data of users from multiple different EU countries needed to have procedures in place which allowed them to comply with the various national laws on data protection. These procedures may have interfered with the steady flow of data through a firm's network, imposing costs on the firm, and thereby decreasing their profitability. A lack of harmonization in Member States' laws may have also caused firms to be less likely to expand their operations across borders. Instead, firms may have opted to restrict their business to a single country, limiting their potential for growth.

Recent empirical evidence emphasizes the challenges of variation in legislation across the EU for firms. A study by Ecommerce Europe noted that businesses interested in cross-border selling found that "merchants who want to sell cross-border are forced to invest heavily in legal and IT system costs to adhere to privacy laws in different European countries."[30] According to The Information Technology and Innovation Foundation, annual compliance costs for cookie laws of

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[28] European Commission, "Eighth Annual Report of the Article 29 Working Party on Data Protection," (November 2005), http://ec.europa.eu/justice/data-protection/article-29/documentation/annual-report/files/2005/8th_annual_report_en.pdf.

[29] Schwartz, Paul M, "Information Privacy in the Cloud," *University of Pennsylvania Law Review* Vol. 161, No. 1623 (2013).

[30] "Completing the #DigitalSingleMarket: How to Boost Cross-border e-Commerce in Europe?," *Ecommerce Europe* (April 2016), https://www.ecommerce-europe.eu/app/uploads/2016/07/Ecommerce-Europe-Priority-Paper.pdf.

EU firms is 1.3 billion euros per year, and additional productivity losses are 725 million euros per year.[31] Deloitte, in a study commissioned by the EC, estimated that compliance with the cookie provisions within the EU e-Privacy Directive cost over 1.8 billion euros per year between 2002 and 2015.[32]

In sum, beginning in 2002 with the adoption of the EU e-Privacy Directive, technology firms operating within the EU were obliged to comply with additional policies that substantially affected the way in which they were allowed to collect, process, and use the electronic data of users.[33] This obligation may impact the business models of these firms, their profitability and the attractiveness of these firms to VC investors.

3. Data

3.1. Venture Capital Funding Data

In order to estimate the impact of e-privacy provisions on VC investment, we require granular data on investments by VC firms. We therefore rely on deal-level VC investment data from the Thomson ONE database. Thomson ONE, which is operated by Thomson Reuters, provides the largest and most comprehensive source of VC investment data available.[34] For our

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31 Castro, Daniel, & McQuinn, Alan, "The Economic Costs of the European Union's Cookie Notification Policy," *The Information Technology & Innovation Foundation* (2014), http://www2.itif.org/2014-economic-costs-eu-cookie.pdf.

32 European Commission, "Commission Staff Working Documents Accompanying the Proposal Part 1 of 3," (January 2017), https://ec.europa.eu/digital-single-market/en/news/proposal-regulation-privacy-and-electronic-communications.

33 European Commission, "Directive 2002/EC/58," *Official Journal of the European Communities* (July 31, 2002), http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32002L0058&from=EN.

34 This data source was known as VentureXpert until it was merged with the Thomson ONE product.

analysis, we focus on VC investments made between January 1998 and December 2013, and select a relevant subset of deal-level variables made available by Thomson ONE.

The process of identifying the list of relevant companies receiving VC investment in each of the three sectors of interest includes multiple steps. First, we conducted qualitative research to understand the different players and subsectors within each sector. This research provided a framework for the types of companies that we would want to include in our definition of each sector, enabling us to generate lists of keywords typically used to describe those companies.

Second, we queried the Thomson ONE database for deals where the description of the funded company included at least one of these keywords. We limited our searches to deals that Thomson ONE classified as startup/seed, early stage, expansion, or later stage. For each deal the extracted data include the funded company's name, the country in which the company is located, the date of funding, the amount of funding, the name of the investor, and the business description of the company. We checked a subset of the query results to ensure that they were relevant and consistent with our prior industry definition. Queries were then adjusted in an iterative process in order to maximize the number of deals and companies captured while minimizing false-positive results. In addition to this iterative process, we conducted Google Trends research to identify popular search terms similar to our keywords as a means to validate our final set of keywords.[35]

[35] Google Trends is a publicly available tool provided by Google that allows for exploration of various metrics related to how often a particular search-term is entered into Google Search. For our analyses, we relied on the "related queries" feature, which shows a list of the most popular other queries that were used by users who were also searching for the term entered into Google Trends. This approach helped to explore possible alternative keywords and ensure that the set of keywords was broad enough.

Third, two independent coders reviewed each business description in the resulting dataset to determine whether indeed a given company operated in the relevant sector.[36] Coders were also allowed to assign the company to one of the other two sectors, so that a given company could have been assigned to more than one sector. The two coders agreed on 73 percent of the online news companies, 81 percent of the online advertising companies, and 86 percent of the cloud computing companies. In case of disagreement, a third coder reviewed the classification and made a final decision. Per this categorization procedure, 1,615 companies for which the data were extracted were categorized into at least one of three sector categories (473 in online news, 430 in online advertising, and 743 in cloud computing). For these companies, our data contain a total of 10,134 deals, of which 2,295 fall into online news, 2,703 into online advertising, and 5,368 into cloud computing categories respectively.[37] We briefly describe each of the sectors below.

- Online news companies are involved in the process of delivering news and current information through the Internet. This includes both general news content as well as news content for a particular area or topic of interest. Companies classified within this sector include media content creators and publishers (both those with an exclusive online presence and multi-media companies where online is only part of the business model), news content providers, aggregators and publishing platforms, as well as internet-based broadcasters.[38]

[36] Given the large number of companies to be categorized, coders were instructed to base their decisions exclusively on the company business descriptions and not to conduct any additional research.

[37] As sector categories were not mutually exclusive, 31 companies were categorized in more than one sector. 232 deals thus fell into multiple sectors.

[38] Of note, online news platforms are different from social networks in that online news companies offer information on current affairs in an organized and categorized manner.

- Online advertising companies provide services or technologies required so that advertisers can deliver promotional marketing messages to users on the websites of web publishers. Companies classified within this sector include advertising agencies, platforms (e.g. demand-side-platforms, supply-side-platforms), networks and exchanges, companies involved in ad analytics, and software companies providing support software for the placement of online ads.
- Cloud computing companies provide resources that enable user access to an application or computing resource in a virtual environment across a network connection. This includes providers of Infrastructure-as-a-Service (physical hardware), Platform-as-a-Service (deployed applications, services, and tools), Software-as-a-Service, cloud data storage, cloud software management, and cloud computing security.

For the purpose of this report, we will refer to these companies as online news, online advertising, and cloud computing firms, acknowledging that these are broad definitions. Table 1 below summarizes the venture capital investments in the three different sectors across three geographic regions – U.S., the EU,[39] and all remaining countries – by whether the investments were made before or after the EU e-Privacy Directive was enacted. Among the three sectors, the largest number of deals was in cloud computing, followed by online news. The largest number of

[39] This includes Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom. While not all of these countries were EU Member States at the time of the EU e-Privacy Directive, all but three countries (Croatia, Bulgaria, and Romania) were members by the end of 2004, and all nations applying to join the EU would expect to implement required directives in order to join.

deals was in the U.S., while the EU and all remaining countries had a broadly similar number of deals. The data show that overall, investment increased over time.

Table 1: Summary Statistics of Venture Capital Investments

Region	Sector	Total Companies	Number of Deals 1998Q1 - 2002Q2	Number of Deals 2002Q3 - 2013Q4	Total Amount Invested ($ Millions) 1998Q1 - 2002Q2	Total Amount Invested ($ Millions) 2002Q3 - 2013Q4
EU	Online News	102	159	134	$310	$170
	Online Advertising	78	28	198	$54	$310
	Cloud Computing	118	44	374	$137	$591
U.S.	Online News	265	788	921	$3,017	$2,138
	Online Advertising	273	438	1783	$1,607	$4,448
	Cloud Computing	499	432	3934	$2,032	$10,515
Other	Online News	106	102	191	$253	$685
	Online Advertising	79	60	196	$79	$565
	Cloud Computing	126	44	540	$80	$1,057

Source: Venture Capital (VC) Investment Data from Thomson One.

Figures 1 through 4 below show the annual VC Investment in Europe and the U.S. in the aggregate of the online news, online advertising, and cloud computing sectors, as well as in each individual sector, respectively. VC investment in the U.S. outpaces investment in the EU in all three sectors. Additionally, while the trends of VC investment in both regions tend to follow a broadly similar pattern, the figures are suggestive of a somewhat more pronounced growth in the U.S., especially in online news and cloud computing.

Figure 1: Annual VC Investment in the Aggregate Across Sectors ($ Millions)

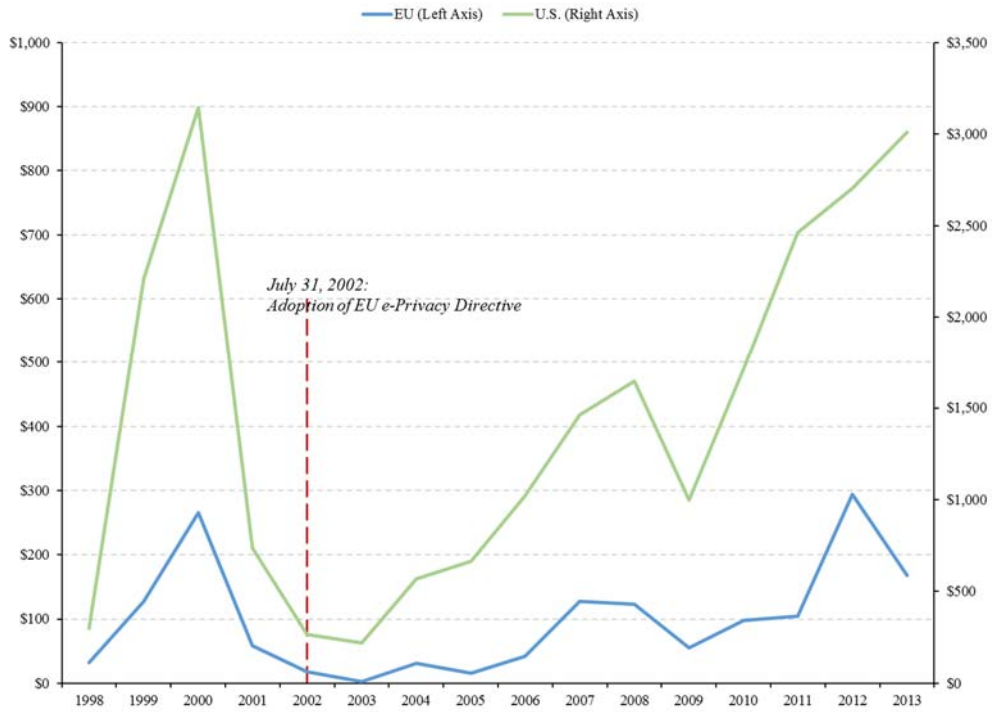


Figure 2: Annual VC Investment in Online News Sector ($ Millions)

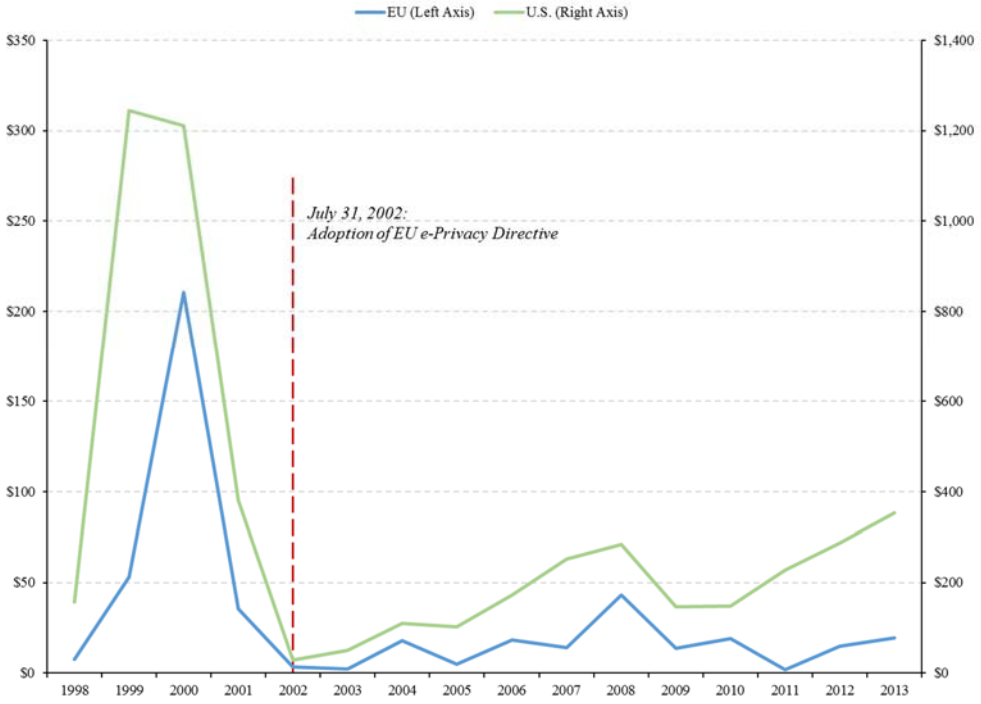
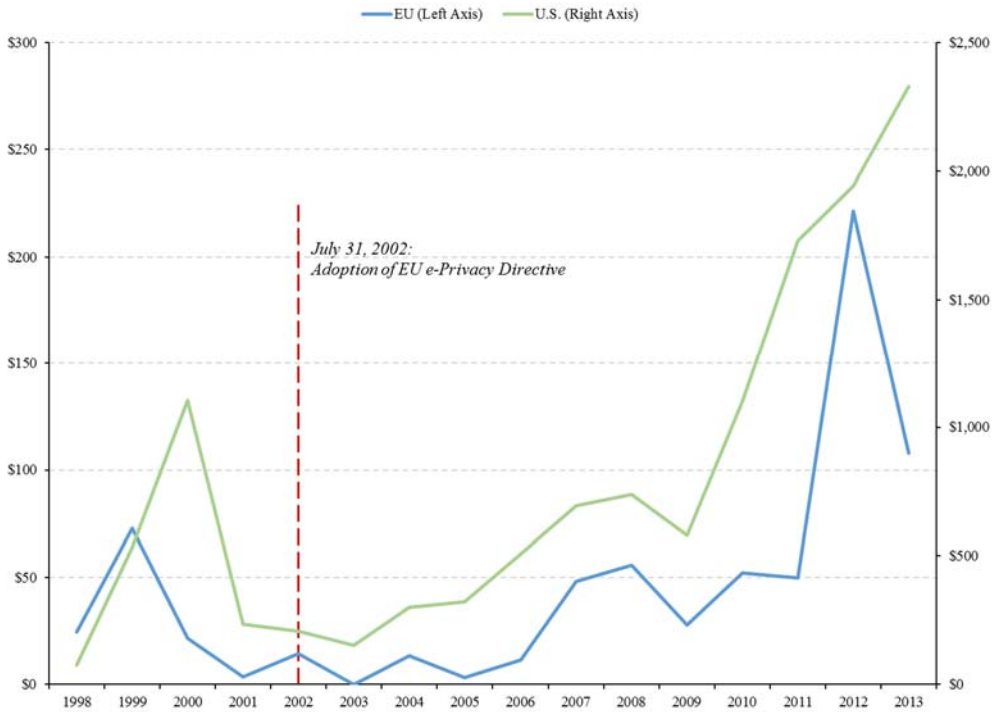


Figure 3: Annual VC Investment in Online Advertising Sector ($ Millions)

Figure 4: Annual VC Investment in Cloud Computing Sector ($ Millions)



3.2. Supplemental Data

We collected supplemental data to account for other factors that may influence the levels of VC investment in online news, online advertising, and cloud computing. This includes the gross domestic product (GDP), the number of internet users for given geographies, and the overall level of VC investments in the IT sector. These factors may, respectively, account for the overall strength of the economy, the size of the potential market for internet-related businesses, and the level of VC activity in a particular geographic market.

GDP data were primarily sourced from the Organization for Economic Co-Operation and Development (OECD). These data were provided at the quarterly level for all 35 member countries of the OECD as well as for the EU (28 countries).[40] The particular measure of GDP relied upon was the seasonally adjusted gross domestic product (expenditure approach) reported in U.S. dollars based on volume estimates and constant purchasing power parities (PPPs) fixed to 2010.[41] For countries not included in the OECD, data were sourced from the World Development Indicators provided by The World Bank. The World Bank data were provided at the annual level. To interpolate between missing data points, we used a natural cubic spline.[42] The particular measure of GDP relied upon from The World Bank is the gross domestic product reported in international dollars[43] based on constant purchasing power parities (PPPs) fixed to 2011.[44] Before merging these

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40 The European Union originally had 15 countries in 1995 and an additional 13 countries have joined the EU since. As of 2017, the European Union has 28 countries in total.

41 Variable name is "VPVOBARSA: US dollars, volume estimates, fixed PPPs, OECD reference year [2010], annual levels, seasonally adjusted."

42 A natural cubic spline uses a piecewise third order polynomial to interpolate quarterly values from the observed annual values, such that the second derivative equals zero at the endpoints. Kvarving, Anne Morten, "Natural Cubic Splines," *Department of Mathematical Sciences Norwegian University of Science and Technology* (October 21, 2008).

43 An international dollar has the same purchasing power over GDP as the U.S. dollar has in the United States.

44 Variable name is "NY.GDP.MKTP.PP.KD: GDP, PPP (constant 2011 international $)."

two data sets, the World Bank GDP figures were deflated to 2010 dollars using country-specific inflation rates, also sourced from the World Bank, in order to make them consistent with OECD GDP figures.[45] The final GDP figure is then used to calculate the country-specific GDP quarterly growth variable used in the regression (percentage difference from the prior quarter's GDP).

Data on the number of internet users were primarily sourced from the International Telecommunication Union (ITU), accessed via the World Bank World Development Indicators. Specifically, we use the percent share of the population using the internet from any location in the past three months.[46] The data are provided at the annual level and are therefore expanded to the quarterly level using the natural cubic spline. This figure is used to calculate the total number of internet users by multiplying that percentage figure against the total population for the given geography, sourced from the World Development Indicators provided by The World Bank.[47] This quarterly number of internet users is then used to calculate the region-specific quarterly growth in internet users used in the regression as a control variable.

Further, we extract the overall venture capital investment in the IT sector by region from Thomson ONE as a summary report for all deals categorized in the Thomson Venture Economics Industry Codes (VEIC) as "1000 - Information Technology." According to Thomson Reuters, its proprietary VEIC codes classify companies on the basis of the core function of their business.[48] This measure of overall IT investment is used in the denominator of the dependent variable to allow for analysis of each sector as a share of the overall IT investment in the region (VC Ratio).

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45 Variable name is "NY.GDP.DEFL.KD.ZG.AD: Inflation, GDP deflator: linked series (annual %)."
46 Variable name is "IT.NET.USER.ZS: Individuals using the Internet (% of population)."
47 Variable name is "SP.POP.TOTL: Population, total."
48 "Private Equity Glossary," *Thomson Financial*, http://banker.thomsonib.com/ta/help/webhelp/Private_Equity_Glossary.htm#v.

The VC Ratio is calculated by dividing the sector investment in a given time period and region by the total IT investment in that region for the same time period. An adjustment is made to the denominator to subtract the sector investment for the three sectors of interest in order to isolate the effects of investment in our three core sectors to the numerator of the VC Ratio.[49] This forecloses the possibility that, for example, the effect of potentially reduced investment in cloud computing will confound the estimated effect for online advertising.

3.3. Summary of Key Variables

Table 2 presents summary statistics for the variables included in our regression for both the EU and the U.S. over the entire analysis period from 1998Q1 through 2013Q4, as well as for the periods before and after the passage of the EU e-Privacy Directive.

[49] For example, if there were $100 million in IT VC investment in the EU in a particular quarter, of which a combined total of $10 million was invested in the OA, ON, and CC sectors, the denominator of the EU VC ratio variable in that quarter would be $90 million.

Table 2: Summary Statistics for Investment Levels and Regression Variables
Online News, Online Advertising, Cloud Computing

	1998Q1 - 2013Q4					1998Q1 - 2002Q2					2002Q3 - 2013Q4				
Regression Variables	Mean	St. Dev	Min	Med	Max	Mean	St. Dev	Min	Med	Max	Mean	St. Dev	Min	Med	Max
VC Investment in Online News															
$ Millions															
EU	$8	$15	$0	$2	$90	$18	$25	$0	$3	$90	$4	$6	$0	$2	$36
U.S.	$81	$103	$0	$41	$494	$168	$157	$2	$114	$494	$46	$38	$0	$33	$152
As % of VC Investment in IT															
EU	0.8%	1.2%	0.0%	0.3%	5.1%	1.2%	1.6%	0.0%	0.3%	5.1%	0.6%	0.9%	0.0%	0.3%	4.3%
U.S.	1.3%	0.9%	0.0%	1.2%	4.0%	1.4%	1.0%	0.0%	1.4%	4.0%	1.3%	0.9%	0.0%	1.1%	3.6%
VC Investment in Online Advertising															
$ Millions															
EU	$6	$10	$0	$0	$48	$3	$8	$0	$0	$31	$7	$11	$0	$0	$48
U.S.	$6	$10	$0	$0	$48	$3	$8	$0	$0	$31	$7	$11	$0	$0	$48
As % of VC Investment in IT															
EU	0.8%	1.8%	0.0%	0.0%	10.0%	0.1%	0.3%	0.0%	0.0%	1.0%	1.1%	2.1%	0.0%	0.1%	10.0%
U.S.	2.2%	1.9%	0.1%	1.9%	7.7%	0.7%	0.6%	0.1%	0.5%	2.2%	2.8%	1.9%	0.1%	2.9%	7.7%
VC Investment in Cloud Computing															
$ Millions															
EU	$11	$19	$0	$4	$114	$8	$12	$0	$1	$45	$13	$20	$0	$5	$114
U.S.	$196	$192	$8	$145	$853	$113	$148	$8	$57	$634	$229	$199	$12	$175	$853
As % of VC Investment in IT															
EU	1.9%	3.2%	0.0%	0.7%	20.1%	1.5%	2.4%	0.0%	0.1%	7.2%	2.1%	3.5%	0.0%	1.0%	20.1%
U.S.	4.8%	4.8%	0.2%	2.7%	20.4%	0.9%	0.6%	0.2%	0.9%	2.6%	6.3%	4.9%	0.4%	5.2%	20.4%
Aggregated VC Investment in Online News, Online Advertising, and Cloud Computing															
$ Millions															
EU	$25	$30	$0	$13	$163	$29	$33	$0	$16	$121	$23	$29	$0	$13	$163
U.S.	$361	$284	$37	$294	$1,278	$362	$378	$49	$207	$1,278	$361	$244	$37	$310	$1,024
As % of VC Investment in IT															
EU	3.5%	4.5%	0.0%	2.3%	28.9%	2.8%	2.9%	0.0%	1.8%	10.4%	3.8%	5.0%	0.0%	2.4%	28.9%
U.S.	8.0%	6.1%	1.0%	5.8%	23.7%	3.0%	1.8%	1.0%	2.5%	7.7%	10.0%	6.1%	1.3%	9.9%	23.7%
Total IT Investment ($ Millions)															
EU	$787	$701	$100	$605	$3,783	$1,298	$1,159	$100	$802	$3,783	$587	$186	$301	$582	$965
U.S.	$5,493	$5,087	$1,721	$3,832	$24,091	$10,490	$7,605	$2,721	$7,766	$24,091	$3,538	$698	$1,721	$3,455	$5,385
Quarter-Over-Quarter Real GDP Growth															
EU	0.4%	0.6%	-2.6%	0.5%	1.3%	0.6%	0.3%	0.2%	0.6%	1.3%	0.3%	0.7%	-2.6%	0.5%	1.0%
U.S.	0.5%	0.7%	-2.1%	0.6%	1.9%	0.8%	0.6%	-0.3%	0.8%	1.9%	0.4%	0.7%	-2.1%	0.6%	1.7%
Quarter-Over-Quarter Percentage Change of Internet Users Year by Year															
EU	4.5%	4.5%	0.1%	2.5%	15.5%	10.4%	3.8%	4.6%	10.7%	15.5%	2.1%	1.8%	0.1%	1.6%	9.0%
U.S.	2.2%	2.7%	-1.5%	1.5%	9.8%	5.5%	2.0%	3.2%	5.1%	9.8%	0.8%	1.4%	-1.5%	0.9%	5.0%

Notes and Sources:

[1] Venture Capital (VC) Investment Data from Thomson ONE.

[2] Information Technology (IT) Investment Data from Thomson ONE. IT Investment was adjusted to exclude any investment in Online Advertising, Online News, or Cloud Computing.

[3] GDP Data from OECD, available at https://stats.oecd.org/index.aspx?queryid=60702#.

[4] Internet Usage Data from World Bank, available at http://databank.worldbank.org/data/reports.aspx?source=2&series=IT.NET.USER.ZS&country=#advancedDownloadOptions.

4. Estimation and Results

4.1. Model

To determine whether the passing of the EU e-Privacy Directives in 2002, 2006 and 2009 was associated with a change in VC investment activity in the EU, we utilize a difference-in-differences framework as described by equation (1).

$$VC\ Ratio_{r,t} = \beta_0 + \beta_1(EU\ Indicator)_r + \beta_2(After\ 2002Q2\ Dummy)_t + \beta_3(EU\ After\ the\ e\text{-}Privacy\ Directive)_{r,t} + \theta X_{r,t} + y_t + k_t + \varepsilon_{r,t} \quad (1)$$

Here, the dependent variable, VC $Ratio_{r,t}$, is the amount of VC investment in U.S. dollars in companies that focus on online advertising, online news, or cloud computing with headquarters in region *r* in quarter *t* divided by the total amount of VC investment in IT companies in region *r* in quarter *t* measured in U.S. dollars.

The explanatory variable *EU Indicator* equals one for investment in companies headquartered in one of the EU28 countries, and zero for investment in U.S. companies. The variable *After 2002Q2 Dummy* equals zero for all quarters before the EU e-Privacy Directive was issued in July 2002 and one in 2002Q3 and all quarters thereafter. The variable *EU After the e-Privacy Directive* is a dummy variable that captures the interaction between the *EU Indicator* and the *After 2002Q2 Dummy*. Thus, it equals one for investment in EU companies in 2002Q3 and thereafter, and zero otherwise. Finally, $X_{r,t}$ is a vector of other explanatory variables including the quarterly growth rate in gross domestic product (GDP) and the percent change in the number of internet users, relative to the previous quarter. y_t are year fixed effects that control for any

additional factors that may affect VC investment in both the EU and U.S. similarly each year. We further control for a linear trend over all quarters in our sample period, k_t.

4.2. Results

Table 3 presents the results of our regression analysis for the aggregate of VC investments in online news, online advertising, and cloud computing. Column 1 displays results of an ordinary least squares (OLS) estimation that focuses only on the main effect of location (EU vs U.S.), whether a quarter was post 2002Q2, and the interaction of both effects. The results indicate a significantly lower ratio of investment into our focal sectors, measured as a share of all VC investments into IT, in the EU relative to the U.S. following the enactment of the EU e-Privacy Directive. Column 2 includes as additional controls GDP growth and the percent change in internet users and Column 3 presents results when we also include a linear trend across all of the quarters in our sample period.

Given the potential for the error term in our model to be correlated across years within regions, one would typically cluster the standard errors by region. However, this is not practical for a regression with only two regions. In Column 4, we do, however, correct for correlation across observations within each year by estimating standard errors clustered by year. We continue to find a significant effect of the key variable. In what follows, we will refer to this as our main specification.

For the specification in Column 5, we limit our data to 4.5 years before and after the passage of the directive. This is motivated by the concern that the longer the time period following adoption of the e-Privacy legislation, the greater is the likelihood that other factors could influence

the results. This includes, for example, the adoption of smartphones following the introduction of the iPhone in 2007 which could have spurred investment levels in different countries to varying degrees. Another potentially confounding factor that might have affected investment into our focal sectors is the use of ad blockers. Ad blocker technology, which first became widely available with the launch of Adblock Plus in 2002, has been adopted by internet users at an exponential rate in recent years.[50] While little data are available that would cover the entire period of our analysis, investigations into global ad blocker usage suggest that adoption of ad blockers over the past few years has varied both between the EU and the U.S., and within the EU itself.[51] Additionally, the relative frequency of Google searches for the term "adblock," as reported by Google Trends starting in 2004, suggests that ad block adoption varied significantly between the U.S. and the EU as well as across EU Member States. Such variation could potentially confound our analysis, and possibly more so in the years post 2006. Importantly, even for this shorter time period, we continue to find a significantly lower ratio of investment into our focal sectors, measured as a share of all VC investments into IT, in the EU relative to the U.S. following the enactment of the EU e-Privacy Directive.

In Column 6 we then present results where the EU is limited to the top five countries in terms of VC investment in IT (United Kingdom, France, Germany, Ireland, and Sweden). This analysis is motivated by the fact that the EU is a heterogeneous collection of countries, including

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50 "The Rise of Adblocking," *PageFair* (August 2013), https://pagefair.com/blog/2013/the-rise-of-adblocking/.

51 For a more complete picture of the growth of ad blocking, see, for example, "The State of the Blocked Web. 2017 Global Adblock Report," *PageFair* (February 2017), https://pagefair.com/downloads/2017/01/PageFair-2017-Adblock-Report.pdf and "The Cost of Ad Blocking. PageFair and Adobe 2015 Ad Blocking Report," *PageFair* (2015), https://downloads.pagefair.com/wp-content/uploads/2016/05/2015_report-the_cost_of_ad_blocking.pdf.

some that do not experience any, or very little, VC investment in the three sectors we consider during the period of our data. The results are robust to the more narrow specification of the sample.

Finally, given that 12.5 percent of observations in the EU have investment levels of $0 in our three focal sectors, we use in Column 7 a Tobit estimator.[52] Here, we find that the coefficient of the *EU After the e-Privacy Directive* variable is negative and significant with a p-value <0.001.

Table 3: EU vs U.S. Difference-in-Differences Results, Aggregate Across Sectors

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	1998 - 2013 Robust SE	1998 - 2013 Robust SE	1998 - 2013 Robust SE	1998 - 2013 Clustered SE	1998 - 2006 Clustered SE	1998 - 2013 Top 5 EU Countries Clustered SE	1998 - 2013 Tobit
EU Indicator	-0.0062	-0.0132	-0.0158	-0.0158	-0.0091	-0.0086	-0.0107
	(0.0067)	(0.0124)	(0.0129)	(0.0096)	(0.0055)	(0.0138)	(0.0157)
After 2002Q2 Dummy	0.0172+	0.0157+	0.0079	0.0079	0.0046	0.0099	-0.0107
	(0.0101)	(0.0090)	(0.0103)	(0.0065)	(0.0040)	(0.0062)	(0.0243)
EU After the e-Privacy Directive	-0.0401***	-0.0347***	-0.0329***	-0.0329**	-0.0195**	-0.0408**	-0.0437**
	(0.0095)	(0.0077)	(0.0084)	(0.0097)	(0.0058)	(0.0132)	(0.0149)
GDP Growth		0.0010	0.0003	0.0003	-0.0002	-0.0022	0.0015
		(0.0039)	(0.0039)	(0.0043)	(0.0035)	(0.0039)	(0.0054)
Percentage Change in Internet Users		0.1466	0.1981	0.1981	0.0589	0.1812	0.0077
		(0.2873)	(0.2888)	(0.2130)	(0.0970)	(0.2492)	(0.2538)
Linear Quarter Trend			0.0035	0.0035	0.0013	0.0036	0.0039
			(0.0021)	(0.0025)	(0.0021)	(0.0025)	(0.0024)
Constant	0.0189**	0.0052	-0.0073	-0.0073	0.0107	0.0060	0.0034
	(0.0067)	(0.0284)	(0.0295)	(0.0236)	(0.0094)	(0.0244)	(0.0269)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	128	128	128	128	72	128	128
Adjusted R-squared	0.555	0.548	0.553	0.553	0.282	0.591	
Pseudo R-squared							-0.404

Notes:
[1] Columns (1) - (6) present Ordinary Least Squares estimation results.
[2] Columns (1) - (3) use robust standard errors. Columns (4) - (6) use standard errors clustered by year. Column (7), "Tobit", uses standard errors that are neither clustered nor
[3] Standard errors are shown in parentheses.
[4] "+" shows p<0.10, "*" shows p<0.05, "**" shows p<0.01, and "***" shows p<0.001.

[52] The ratio between VC investment for each sector and total VC IT investment (net of VC IT investment in all three sectors) is censored at a minimum of 0 and a maximum of 1 for the Tobit estimator. This ratio is always below 1.

Next, we estimate similar specifications separately for each of our three focal sectors. Table 4 displays the corresponding set of results for online news, Table 5 for online advertising and Table 6 for cloud computing. For all three sectors, regardless of the specification, the estimator used, the precise time period, or the set of countries considered, the coefficient of the *EU After the e-Privacy Directive* variable is negative. Taking online news in isolation, only the specifications in Columns 4 and 7 are significant. For online advertising, the specifications in Columns 1-4, 6 and 7 are significant. For cloud computing, each specification is significant at least at the 5 percent confidence level.

Table 4: EU vs U.S. Difference-in-Differences Results: Online News

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	1998 - 2013 Robust SE	1998 - 2013 Robust SE	1998 - 2013 Robust SE	1998 - 2013 Clustered SE	1998 - 2006 Clustered SE	1998 - 2013 Top 5 EU Countries Clustered SE	1998 - 2013 Tobit
EU Indicator	-0.0027	0.0005	0.0000	0.0000	0.0030	0.0072	0.0016
	(0.0040)	(0.0052)	(0.0055)	(0.0040)	(0.0049)	(0.0082)	(0.0056)
After 2002Q2 Dummy	-0.0005	0.0000	-0.0016	-0.0016	-0.0016	-0.0007	-0.0084
	(0.0030)	(0.0032)	(0.0038)	(0.0025)	(0.0034)	(0.0038)	(0.0087)
EU After the e-Privacy Directive	-0.0039	-0.0065	-0.0061	-0.0061+	-0.0027	-0.0113	-0.0104+
	(0.0044)	(0.0047)	(0.0049)	(0.0034)	(0.0041)	(0.0073)	(0.0053)
GDP Growth		-0.0014	-0.0016	-0.0016	0.0011	-0.0027	-0.0016
		(0.0017)	(0.0018)	(0.0018)	(0.0024)	(0.0018)	(0.0019)
Percentage Change in Internet Users		-0.0697	-0.0592	-0.0592	-0.1119	-0.1922	-0.1229
		(0.1091)	(0.1116)	(0.0873)	(0.0789)	(0.1446)	(0.0897)
Linear Quarter Trend			0.0007	0.0007	-0.0000	0.0005	0.0010
			(0.0008)	(0.0008)	(0.0013)	(0.0010)	(0.0009)
Constant	0.0129*	0.0202	0.0177	0.0177*	0.0215*	0.0352*	0.0211*
	(0.0050)	(0.0128)	(0.0135)	(0.0081)	(0.0081)	(0.0128)	(0.0094)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	128	128	128	128	72	128	128
Adjusted R-squared	0.171	0.166	0.164	0.164	0.158	0.080	
Pseudo R-squared							-0.092

Notes:
[1] Columns (1) - (6) present Ordinary Least Squares estimation results.
[2] Columns (1) - (3) use robust standard errors. Columns (4) - (6) use standard errors clustered by year. Column (7), "Tobit", uses standard errors that are neither clustered nor robust.
[3] Standard errors are shown in parentheses.
[4] "+" shows p<0.10, "*" shows p<0.05, "**" shows p<0.01, and "***" shows p<0.001.

Table 5: EU vs U.S. Difference-in-Differences Results: Online Advertising

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	1998 - 2013 Robust SE	1998 - 2013 Robust SE	1998 - 2013 Robust SE	1998 - 2013 Clustered SE	1998 - 2006 Clustered SE	1998 - 2013 Top 5 EU Countries Clustered SE	1998 - 2013 Tobit
EU Indicator	-0.0055***	-0.0060	-0.0059	-0.0059	-0.0060	-0.0068	-0.0068
	(0.0015)	(0.0048)	(0.0046)	(0.0044)	(0.0041)	(0.0039)	(0.0097)
After 2002Q2 Dummy	0.0062	0.0065	0.0069	0.0069	0.0030	0.0072+	0.0041
	(0.0044)	(0.0041)	(0.0051)	(0.0043)	(0.0026)	(0.0039)	(0.0149)
EU After the e-Privacy Directive	-0.0114**	-0.0107**	-0.0107**	-0.0107+	-0.0053	-0.0100+	-0.0156+
	(0.0040)	(0.0036)	(0.0037)	(0.0052)	(0.0043)	(0.0049)	(0.0092)
GDP Growth		0.0023	0.0023	0.0023	0.0007	0.0025	0.0050
		(0.0022)	(0.0022)	(0.0026)	(0.0027)	(0.0028)	(0.0033)
Percentage Change in Internet Users		0.0184	0.0156	0.0156	0.0121	0.0435	-0.2157
		(0.0951)	(0.0932)	(0.0954)	(0.0893)	(0.0927)	(0.1617)
Linear Quarter Trend			-0.0002	-0.0002	0.0002	-0.0004	0.0000
			(0.0013)	(0.0014)	(0.0008)	(0.0012)	(0.0014)
Constant	0.0050***	0.0012	0.0019	0.0019	0.0028	-0.0002	0.0139
	(0.0009)	(0.0088)	(0.0092)	(0.0099)	(0.0105)	(0.0094)	(0.0169)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	128	128	128	128	72	128	128
Adjusted R-squared	0.413	0.405	0.400	0.400	0.394	0.384	
Pseudo R-squared							-0.285

Notes:

[1] Columns (1) - (6) present Ordinary Least Squares estimation results.

[2] Columns (1) - (3) use robust standard errors. Columns (4) - (6) use standard errors clustered by year. Column (7), "Tobit", uses standard errors that are neither clustered nor robust.

[3] Standard errors are shown in parentheses.

[4] "+" shows p<0.10, "*" shows p<0.05, "**" shows p<0.01, and "***" shows p<0.001.

Table 6: EU vs U.S. Difference-in-Differences Results: Cloud Computing

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	1998 - 2013 Robust SE	1998 - 2013 Robust SE	1998 - 2013 Robust SE	1998 - 2013 Clustered SE	1998 - 2006 Clustered SE	1998 - 2013 Top 5 EU Countries Clustered SE	1998 - 2013 Tobit
EU Indicator	0.0052	-0.0034	-0.0074	-0.0074	0.0036	-0.0003	-0.0092
	(0.0057)	(0.0114)	(0.0125)	(0.0144)	(0.0116)	(0.0225)	(0.0147)
After 2002Q2 Dummy	0.0226*	0.0208**	0.0088	0.0088	0.0080	0.0113	-0.0092
	(0.0087)	(0.0078)	(0.0102)	(0.0098)	(0.0062)	(0.0104)	(0.0217)
EU After the e-Privacy Directive	-0.0470***	-0.0405***	-0.0376***	-0.0376*	-0.0239*	-0.0466*	-0.0419**
	(0.0085)	(0.0087)	(0.0098)	(0.0149)	(0.0101)	(0.0208)	(0.0140)
GDP Growth		0.0017	0.0005	0.0005	-0.0067	-0.0029	0.0016
		(0.0044)	(0.0040)	(0.0029)	(0.0036)	(0.0029)	(0.0049)
Percentage Change in Internet Users		0.1794	0.2595	0.2595	0.0141	0.2973	0.1057
		(0.2139)	(0.2207)	(0.2219)	(0.1012)	(0.2918)	(0.2341)
Linear Quarter Trend			0.0054*	0.0054+	0.0008	0.0060*	0.0057*
			(0.0023)	(0.0030)	(0.0019)	(0.0027)	(0.0022)
Constant	0.0186*	0.0015	-0.0180	-0.0180	0.0217+	-0.0084	-0.0036
	(0.0090)	(0.0236)	(0.0270)	(0.0254)	(0.0107)	(0.0275)	(0.0242)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	128	128	128	128	72	128	128
Adjusted R-squared	0.608	0.603	0.621	0.621	0.209	0.551	
Pseudo R-squared							-0.486

Notes:

[1] Columns (1) - (6) present Ordinary Least Squares estimation results.

[2] Columns (1) - (3) use robust standard errors. Columns (4) - (6) use standard errors clustered by year. Column (7), "Tobit", uses standard errors that are neither clustered nor robust.

[3] Standard errors are shown in parentheses.

[4] "+" shows p<0.10, "*" shows p<0.05, "**" shows p<0.01, and "***" shows p<0.001.

4.3. Robustness Checks

We conduct a number of further checks to ensure that our results are robust to different specifications. First, instead of using as the dependent variable the ratio of VC investments in the focal sectors relative to total VC investments into IT, we use as dependent variable the amount of VC investment in U.S. dollars. Here, we include the corresponding level of IT VC investment as an explanatory variable. Table 7 displays these results estimated over the 1998 through 2013 time period. Consistent with our earlier results, the coefficient of the *EU After the e-Privacy Directive* variable is negative and significant for the aggregate of all three sectors as well as for each sector

individually. Table 8 presents these results estimated over the 1998 through 2006 time period. While the coefficient of the *EU After the e-Privacy Directive* variable is negative across sectors, only the aggregate and cloud computing results are statistically significant.

Table 7: EU vs U.S. Difference-in-Differences Results: Amount of VC Investments ($ Millions), 1998-2013

	(1) Aggregate	(2) Online News	(3) Online Advertising	(4) Cloud Computing
IT VC Investment	0.0505***	0.0184***	0.0136***	0.0188***
	(0.0040)	(0.0029)	(0.0016)	(0.0043)
EU Indicator	72.0468	66.5955*	13.6310	-19.1496
	(87.2600)	(30.9846)	(24.1528)	(71.7050)
After 2002Q2 Dummy	180.9740**	23.1066*	63.9640**	93.6023*
	(59.7669)	(9.6207)	(19.0803)	(41.7266)
EU After the e-Privacy Directive	-273.5051*	-42.6526*	-68.4802*	-162.5783+
	(97.0583)	(19.7474)	(25.1274)	(77.5093)
GDP Growth	24.3780	-0.0762	12.2822	10.3483
	(23.4456)	(6.4332)	(14.7365)	(17.1455)
Percentage Change in Internet Users	1277.0343	-959.9312	542.0183	1797.6642
	(2308.5864)	(746.3295)	(504.1314)	(1351.8160)
Linear Quarter Trend	4.3699	0.2499	-6.3804	10.5411
	(13.5896)	(3.4559)	(4.2363)	(8.7845)
Constant	-265.0238	58.3103	-79.3658	-248.8958
	(258.5423)	(67.0322)	(63.4896)	(157.2537)
Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	128	128	128	128
Adjusted R-squared	0.758	0.833	0.630	0.625

Notes:
[1] Standard errors are clustered by year and shown in parentheses.
[2] "+" shows p<0.10, "*" shows p<0.05, "**" shows p<0.01, and "***" shows p<0.001.

Table 8: EU vs U.S. Difference-in-Differences Results: Amount of VC Investments ($ Millions), 1998-2006

	(1) Aggregate	(2) Online News	(3) Online Advertising	(4) Cloud Computing
IT VC Investment	0.0476***	0.0180***	0.0137***	0.0162**
	(0.0026)	(0.0029)	(0.0024)	(0.0033)
EU Indicator	154.6053*	82.4611+	31.1563	37.4436
	(51.4314)	(38.8110)	(18.6263)	(37.7753)
After 2002Q2 Dummy	130.6576	22.4169	49.0116+	56.9562
	(73.1605)	(16.5460)	(25.7088)	(35.1801)
EU After the e-Privacy Directive	-133.8032*	-24.8888	-35.1069	-71.7631*
	(45.7204)	(22.9038)	(20.6477)	(28.0557)
GDP Growth	6.1349	4.3840	30.4633	-36.2692*
	(49.6589)	(12.0075)	(43.6543)	(13.7797)
Percentage Change in Internet Users	-1013.4242	-1350.1500+	253.4509	22.3324
	(1271.0447)	(711.9057)	(502.2003)	(242.9445)
Linear Quarter Trend	-15.9882	-4.7384	-6.0214	-5.9495
	(23.8160)	(6.2033)	(6.5696)	(12.1268)
Constant	20.7067	103.1262	-73.0062	7.0040
	(156.3713)	(58.7874)	(90.9511)	(38.0391)
Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	72	72	72	72
Adjusted R-squared	0.811	0.874	0.623	0.593

Notes:
[1] Standard errors are clustered by year and shown in parentheses.
[2] "+" shows p<0.10, "*" shows p<0.05, "**" shows p<0.01, and "***" shows p<0.001.

Second, since VC investment may potentially vary across time of years, we estimate a further set of specifications where we control for fixed effects for each quarter of the year. Table 9 and Table 10 display the results for the 1998-2013 period and the 1998-2006 period, respectively.

Again, our results are consistent. As the quarter fixed effects are not significant, that is, we do not find any evidence of seasonality, we do not include these effects in our primary specification.

Table 9: EU vs U.S. Difference-in-Differences Results: Quarter Fixed Effects, 1998-2013

	(1) Aggregate	(2) Online News	(3) Online Advertising	(4) Cloud Computing
EU Indicator	-0.0112	-0.0000	-0.0059	-0.0073
	(0.0185)	(0.0040)	(0.0044)	(0.0146)
After 2002Q2 Dummy	0.0110	-0.0013	0.0060	0.0062
	(0.0133)	(0.0029)	(0.0042)	(0.0096)
EU After the e-Privacy Directive	-0.0535*	-0.0061+	-0.0108+	-0.0377*
	(0.0194)	(0.0034)	(0.0053)	(0.0150)
GDP Growth	0.0010	-0.0019	0.0022	0.0004
	(0.0054)	(0.0019)	(0.0027)	(0.0034)
Percentage Change in Internet Users	0.1873	-0.0594	0.0147	0.2570
	(0.3300)	(0.0880)	(0.0965)	(0.2257)
Linear Quarter Trend	0.0019**	-0.0000	0.0003	0.0017**
	(0.0006)	(0.0002)	(0.0002)	(0.0005)
Second Quarter	0.0064	0.0039+	-0.0003	0.0024
	(0.0049)	(0.0019)	(0.0027)	(0.0049)
Third Quarter	0.0184	0.0036	0.0017	0.0135
	(0.0130)	(0.0028)	(0.0039)	(0.0104)
Fourth Quarter	0.0092	0.0026	-0.0022	0.0089
	(0.0096)	(0.0023)	(0.0043)	(0.0082)
Constant	0.0056	0.0174*	0.0010	-0.0146
	(0.0328)	(0.0080)	(0.0097)	(0.0233)
Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	128	128	128	128
Adjusted R-squared	0.638	0.165	0.394	0.621

Notes:

[1] Standard errors are clustered by year and shown in parentheses.

[2] "+" shows p<0.10, "*" shows p<0.05, "**" shows p<0.01, and "***" shows p<0.001.

Table 10: EU vs U.S. Difference-in-Differences Results: Quarter Fixed Effects, 1998-2006

	(1) Aggregate	(2) Online News	(3) Online Advertising	(4) Cloud Computing
EU Indicator	0.0012	0.0029	-0.0060	0.0037
	(0.0167)	(0.0052)	(0.0041)	(0.0121)
After 2002Q2 Dummy	0.0086	-0.0003	0.0039	0.0048
	(0.0091)	(0.0039)	(0.0028)	(0.0047)
EU After the e-Privacy Directive	-0.0318+	-0.0027	-0.0053	-0.0239+
	(0.0146)	(0.0043)	(0.0043)	(0.0106)
GDP Growth	-0.0039	0.0010	0.0006	-0.0062
	(0.0064)	(0.0027)	(0.0023)	(0.0038)
Percentage Change in Internet Users	-0.0788	-0.1116	0.0123	0.0139
	(0.2201)	(0.0809)	(0.0898)	(0.1077)
Linear Quarter Trend	0.0002	-0.0004	0.0004	0.0002
	(0.0007)	(0.0003)	(0.0003)	(0.0003)
Second Quarter	0.0023	0.0050	0.0030+	-0.0054
	(0.0043)	(0.0032)	(0.0013)	(0.0052)
Third Quarter	0.0063	0.0017	-0.0000	0.0047
	(0.0088)	(0.0043)	(0.0017)	(0.0044)
Fourth Quarter	0.0016	0.0021	0.0004	-0.0009
	(0.0091)	(0.0039)	(0.0019)	(0.0059)
Constant	0.0435+	0.0203*	0.0016	0.0232+
	(0.0205)	(0.0071)	(0.0099)	(0.0108)
Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	72	72	72	72
Adjusted R-squared	0.295	0.158	0.399	0.243

Notes:
[1] Standard errors are clustered by year and shown in parentheses.
[2] "+" shows p<0.10, "*" shows p<0.05, "**" shows p<0.01, and "***" shows p<0.001.

4.4. Rest of World

Ideally, we would like to check the robustness of our results by conducting a similar analysis as in Section 4.2 where we use a region other than the U.S. as a comparison group that, similarly to the U.S., had significantly less restrictive e-privacy provisions than the EU.

Unfortunately this is complicated by two factors. First, there are only ten countries outside of the EU and U.S. with a significant number of VC investments within our three focal sectors during the time period 1998 – 2013: Australia, Brazil, Canada, China (excluding Hong Kong), Hong Kong, India, Israel, Japan, Singapore, and South Korea. Each of these countries has at least one quarter with non-zero investment levels in at least one of our focal sectors and total IT VC investment over 1998-2013 of at least $1 billion.

Second, e-privacy policies vary to a large degree across individual countries. Some countries have a regulatory regime that at least in some dimensions is closer to that of the EU after 2002Q2 while others have a regime that more closely resembles that of the U.S. For example, Canada pursues a privacy strategy similar to the EU by enacting a federal-level regulation, the Personal Information Protection and Electronic Documents Act of 2000 (PIPEDA), which "sets out the ground rules for how private-sector organizations collect, use or disclose personal information in the course of commercial activities across Canada."[53] On the other hand, Japan follows more closely the example of the United States by allowing industry wider leniency to regulate itself, although it does have a national law to specify this arrangement, the Act on Protection of Personal Information (APPI).[54] Given that regulatory regimes vary along multiple dimensions (e.g. tracking individual users, requirements to store data, and limitations on data processing), it is difficult to select a specific subset of countries as an optimal comparison group. Even if we were to do so, given that the markets outside the U.S. and EU are significantly smaller,

[53] "Overview of Privacy Legislation in Canada," *Office of the Privacy Commissioner of Canada*, https://www.priv.gc.ca/en/privacy-topics/privacy-laws-in-canada/02_05_d_15/

[54] "Online Privacy Law: Japan," *Library of Congress*, https://www.loc.gov/law/help/online-privacy-law/japan.php.

such a sub-group would have many quarters with investment levels of $0 making estimation difficult.[55]

Nonetheless, we estimate a further set of regressions where instead of using the U.S. as a comparison group, we use the aggregate levels of these ten countries as our comparison group to the EU. Table 11 illustrates the results of this analysis that otherwise mirrors those presented in Column 4 of Table 3 through Table 6. The coefficient of the *EU After the e-Privacy Directive* variable continues to be negative, although not significant, for the aggregate, online news, and cloud computing analyses. The coefficient for online advertising is positive.

[55] Japan and Singapore are the closest to the US, but given that they do not attract the same levels of VC investment in IT as that in the US or EU, they also have very little investment in our focal sectors. Specifically, for Japan and Singapore, 88 percent of quarters have $0 in total investments.

Table 11: EU vs "Rest of World" Difference-in-Differences Results, 1998- 2013

	(1) Aggregate	(2) Online News	(3) Online Advertising	(4) Cloud Computing
EU Indicator	0.0169	0.0083	-0.0008	0.0096
	(0.0097)	(0.0056)	(0.0034)	(0.0073)
After 2002Q2 Dummy	-0.0056	0.0067	-0.0045	-0.0081
	(0.0122)	(0.0070)	(0.0046)	(0.0063)
EU After the e-Privacy Directive	-0.0063	-0.0080	0.0079+	-0.0065
	(0.0142)	(0.0057)	(0.0044)	(0.0100)
GDP Growth	0.0144	0.0071	0.0059**	0.0012
	(0.0088)	(0.0081)	(0.0017)	(0.0031)
Percentage Change in Internet Users	0.0761	0.0921	0.0116	-0.0155
	(0.3661)	(0.1964)	(0.0960)	(0.1763)
Linear Quarter Trend	0.0017	-0.0019	0.0005	0.0032
	(0.0036)	(0.0027)	(0.0014)	(0.0022)
Constant	-0.0019	-0.0073	-0.0050	0.0082
	(0.0537)	(0.0281)	(0.0136)	(0.0276)
Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	128	128	128	128
Adjusted R-squared	0.110	0.004	0.113	0.190

Notes:

[1] Rest of World includes Australia, Brazil, Canada, China, Hong Kong, India, Israel, Japan, Singapore, and South Korea.

[2] Standard errors are clustered by year and shown in parentheses.

[3] "+" shows p<0.10, "*" shows p<0.05, "**" shows p<0.01, and "***" shows p<0.001.

One could also perform a falsification test where instead of the EU itself, countries outside the EU are compared with the U.S. to see if there is an effect where one would not expect an effect to be. As discussed above, such a comparison is complicated by the inherent differences in the available set of countries outside the U.S. and EU, because this group invariably includes some with an e-privacy regime that is more restrictive than that of the U.S. When we perform this

analysis, we find a significant negative effect for this set of countries, relative to the U.S., after 2002Q3 for the aggregate analysis, as well as for the online advertising and cloud computing sectors, though not for online news. Note, however, that the magnitude of the estimated coefficients for the variable of interest for the aggregate analysis, the online news sector, and the cloud computing sector, is smaller when the countries outside the EU are compared with the U.S., than when the EU is compared with the U.S.

5. Implications

In this section, we first use our estimates to quantify how VC investment in our focal sectors changed in the EU relative to the U.S. in the time period of our empirical study. We then discuss implications for e-privacy regulation more broadly.

5.1. Quantifying the Estimates

We use our estimates in Column 4 in Table 3 to Table 6 to quantify how VC investment in our focal sectors changed in the EU relative to the U.S. following 2002Q2 when the EU e-Privacy Directive was enacted.

Table 12 below summarizes the results for the aggregate of online news, online advertising, and cloud computing, as well as for each of the sectors in isolation. The magnitude of the coefficient of the *EU After the e-Privacy Directive* variable represents the implied change in the sector investment as a percent of overall IT investment in the EU after 2002Q2. For example, our model implies that, but for the change in trend in the EU relative to the U.S. after 2002Q2, aggregate investment in the focal sectors would have been 5.3 percentage points higher, as a share of overall IT investment in the EU. Put differently, instead of 4 percent of IT investments (net of

investments in our focal sectors) in the EU, investments in the focal sectors would have been 9.3 percent. Given that overall IT investment in the EU averaged $2.3 billion per year between 2002Q3 and 2013Q4, our model implies that VC investment across these three sectors would have been $125 million higher each year if the EU and U.S. had maintained similar trends in investment after 2002Q2. Note that the actual average yearly investment in these three sectors in the EU during the period we study was $92 million. Thus, our results suggest that VC investments in the EU were 58 percent lower than they would have been if the EU had maintained trends similar to the U.S. after 2002Q2. We emphasize that this measures the difference in the investment trends in the EU and U.S. during the period of our study. Note that there may be factors other than the introduction of the EU e-Privacy Directive that might also be driving the effect such as potentially different rates of the adoption of ad-blocker software or differing smart phone penetration rates. The available data do not allow us to pin down the effect of the EU e-Privacy Directive separately from other contributing factors.

Table 12: Implied Change in EU VC Investment by Sector, 2002Q3 - 2013Q4

		(1) Aggregate	(2) Online News	(3) Online Advertising	(4) Cloud Computing
EU After the e-Privacy Directive	[A]	-0.0534*	-0.0061+	-0.0107+	-0.0376*
		(0.0193)	(0.0034)	(0.0052)	(0.0149)
Average Annual IT VC in EU After 2002Q2 Through 2013Q4 ($ Millions)	[B]	$2,346.72	$2,346.72	$2,346.72	$2,346.72
Implied Annual Difference in EU Sector Investment ($ Millions)	[C]=[A]x[B]	-$125.31	-$14.31	-$25.11	-$88.24
Annual EU Sector Investment ($ Millions)	[D]	$92.09	$14.74	$26.95	$51.37
Implied Annual EU Sector Investment After 2002Q2 ($ Millions)	|[C]|+[D]	$217.41	$29.06	$52.06	$139.61
Implied Percentage Difference in Investment	[C]/(|[C]|+[D])	-57.64%	-49.26%	-48.23%	-63.20%

Notes:
[1] Standard errors are clustered by year and shown in parentheses.
[2] "+" shows p<0.10, "*" shows p<0.05, "**" shows p<0.01, and "***" shows p<0.001.
[3] The remaining model coefficients are not shown in this table.

To reduce the extent to which factors other than EU privacy provisions contribute to differences in VC investments between the EU and the U.S., we also estimate the implied change in aggregate investment across the sectors using data through the end of 2006 rather than 2013, when factors such as the adoption of ad-blocking software or smartphone penetration are less likely to significantly influence our results. The coefficient of the *EU After the e-Privacy Directive* variable from Column 5 of Table 3 implies that investment in the aggregate of the three sectors would have been 3.2 percentage points higher in terms of overall IT investment in the EU between 2002Q3 and 2006Q4. Given that overall IT investment in the EU averaged $1.9 billion per year between 2002Q3 and 2006Q4, our model implies that VC investment across these three sectors would have been about $62 million higher each year if the EU and U.S. had maintained similar

trends in investment after 2002Q2 - that is they were 75 percent lower than they would have been if the EU had maintained similar trends to the U.S.. These results are summarized in Table 13.

Table 13: Implied Change in EU VC Investment by Sector, 2002Q3 - 2006Q4

		(1) Aggregate	(2) Online News	(3) Online Advertising	(4) Cloud Computing
EU After the e-Privacy Directive	[A]	-0.0318+	-0.0027	-0.0053	-0.0239*
		(0.0142)	(0.0041)	(0.0043)	(0.0101)
Average Annual IT VC in EU After 2002Q2 Through 2006Q4 ($ Millions)	[B]	$1,946.79	$1,946.79	$1,946.79	$1,946.79
Implied Annual Difference in EU Sector Investment ($ Millions)	[C]=[A]x[B]	-$61.91	-$5.26	-$10.32	-$46.53
Annual EU Sector Investment ($ Millions)	[D]	$20.23	$9.65	$4.39	$6.19
Implied Annual EU Sector Investment After 2002Q2 ($ Millions)	|[C]|+[D]	$82.14	$14.90	$14.71	$52.72
Implied Percentage Difference in Investment	[C]/(|[C]|+[D])	-75.37%	-35.27%	-70.15%	-88.26%

Notes:
[1] Standard errors are clustered by year and shown in parentheses.
[2] "+" shows p<0.10, "*" shows p<0.05, "**" shows p<0.01, and "***" shows p<0.001.
[3] The remaining model coefficients are not shown in this table.

5.2. Discussion of Further e-Privacy Legislation

In this section, we offer some thoughts on the potential impact of the forthcoming EU e-Privacy legislation on the three sectors that are the focus of the historical analysis in this paper. Recall, that the author is not a legal expert or an expert on regulation and in the interpretation of legal provisions relies on the views of trade associations and firms involved in these sectors.

The empirical findings of this paper are in line with the view that policy makers face a trade-off between tighter privacy policies and VC investments that can, in turn, affect innovation and job growth. One implication of this insight is that public bodies that consider passing

legislation to tighten privacy laws may want to consider the broader economic impact of such policies. Specifically, the EU is currently in the process of replacing Directive 2002/58/EC with the Regulation on Privacy and Electronic Communications (or "e-Privacy Regulation"). Intended as *lex specialis* to the General Data Protection Regulation (GDPR), the proposed "e-Privacy Regulation", seeks to limit the access to and processing of user data, raise privacy standards and harmonize legal protection for privacy across EU Member States. It also has implications for firms in, and VC investment into, online news, online advertising, and cloud computing.

First, as the European Data Protection Supervisor (EDPS) points out, the proposed e-Privacy Regulation is highly complex.[56] For example, the EDPS Opinion on the Proposal for an e-Privacy Regulation concludes that "communications are sliced into metadata, content data, data emitted by terminal equipment. Each being entitled to a different level of confidentiality and subject to different exceptions. This complexity may bring a risk of -perhaps unintended- gaps in protection."[57] Requiring different levels of confidentiality for different types of data could also increase the administrative burden for firms in many sectors of the digital economy that deal with or store these different types of data as they need to ensure that each piece of data is treated according to the specific requirements pertaining to its characteristics. However, it appears

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[56] European Data Protection Supervisor, "EDPS Opinion on the Proposal for a Regulation on Privacy and Electronic Communications (e-Privacy Regulation)," (April 24, 2017), https://edps.europa.eu/sites/edp/files/publication/17-04-24_eprivacy_en.pdf.

[57] As EDPS identifies in its report, per Article 6(2), metadata may be processed in order to meeting minimum quality of service requirements, if it is necessary for billing, detecting fraudulent use of or subscription to services, or if the user has consented. However, Article 6(3) allows processing of content data only "for the sole purpose of the provision of a specific service to an end-user" or "if all end-users concerned have given their consent…for one or more specific purposes that cannot be fulfilled by processing information that is made anonymous and the provider has consulted the supervisory authority." For example, per Articles 6 and 7, metadata such as the full URL of a website visited by a user may be processed as a regular course of business (for billing reasons, etc.). However, the content of, say, an image sent from one user to another may not be processed except when given specific consent by the user to do so but the metadata used to send it could be. Ibid.

particularly challenging for cloud computing firms that would need to analyze the vast range of data being uploaded by users, categorize that data and, based on such categorization, either retain or delete it immediately after the user request has been completed. Further, the GDPR and proposed e-Privacy Regulation will extend the restrictions already applied to telecommunications companies to a much wider array of communications technologies, including over-the-top ("OTT") services and cloud firms. Such provisions could decrease firms' profitability and, as a consequence, make them less attractive for VC investors.

Second, Article 6 of the proposed e-Privacy Regulation defines permitted processing of electronic communications data by communications networks and services.[58] In particular, Article 6(1) would limit electronic communications networks and services, including cloud-based online communications services, to processing data only if they were transmitting the user communication or maintaining the security of the network or service. Compliance with this provision would potentially be difficult for the providers of cloud-based services, who need to process data and metadata in order to properly store and reallocate data even if this is not part of a direct request by a user.[59]

Related, Article 6(3) seeks to limit providers' ability to process the content of electronic communications to the "sole purpose of the provision of a specific service to a user, if the user(s) concerned have given their consent…and the provision of the service cannot be fulfilled without

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[58] Article 6 sets out different provisions that concern the processing of data by the communications network or service providers (in Article 6(1)), the processing of metadata by the communications service (in Article 6(2)), and the processing of content data by the communications service (in Article 6(3)). European Commission, "Proposal for a Regulation on Privacy and Electronic Communications," (January 10, 2017), https://ec.europa.eu/digital-single-market/en/news/proposal-regulation-privacy-and-electronic-communications.

[59] "The Proposal for an ePrivacy Regulation," *BusinessEurope* (June 14, 2017), https://www.businesseurope.eu/sites/buseur/files/media/position_papers/internal_market/2017-06-14_eprivacy_regulation.pdf.

the processing of such content" or if "the provider has consulted with the supervisory authority." This approach appears to require each handler of data to be given explicit permission to process the data by each individual user or by the "supervisory authority." In the case of cloud computing, this is difficult because different cloud services, which may not necessarily qualify as "electronic communication service providers", are often nested together with one relying upon the other to function. For example, online communication software companies may sell a service to users which itself is hosted by the platform service of another cloud provider.

For the purpose of illustration, one prominent example of this arrangement is Slack, an OTT service hosted on Amazon's Web Services (AWS) platform which allows users to communicate, in many instances free of charge.[60] The complication here is that since AWS is not an electronic communications services provider, it would not be able to process a Slack client's data unless it had an agreement with each individual user to that effect. It is also presently unclear whether first parties would be able to accept consent on behalf of third parties.[61] Such complications may in turn affect firms' profitability and VC investment.

Third, as a clarification to Recital 30 of the GDPR, Article 8 of the Proposal proposes to increase the number of occasions in which the user must consent to tracking, cookies, and other data transfers between the user's device and the service provider for the user to receive the service. For example, the user may have to consent to each usage of data, including by third parties via

[60] https://aws.amazon.com/solutions/case-studies/slack/

[61] "Position Paper, Regulation on Privacy and Electronic Communications (ePrivacy Regulation)" *News Media Europe* (March 29, 2017), http://www.newsmediaeurope.eu/issues/position-paper-regulation-on-privacy-and-electronic-communications-eprivacy-regulation/

content publishers, unless they have universally agreed to cookies in their browser settings.[62] These policies could impact firms in online news and online advertising: if users do not give consent to tracking, then online advertising is likely to be less relevant to them, decreasing click-rates and conversions and so depressing advertisers' willingness-to-pay for online ads and ultimately reducing web publishers' revenues which may result in a greater share of paid content. Again, such limitations may reduce firms' profitability and ultimately VC investments into these sectors.

That said, even though a study by the International Association of Privacy Professionals and Ernst and Young indicates that members of the Fortune 500 will spend a combined $7.8bn to comply with the GDPR,[63] the proposed e-Privacy Regulation and the GDPR offer in some aspects considerable improvements over the current policy that may reduce the regulatory burden for firms in online news, online advertising and cloud computing. Most importantly, the GDPR and the proposed e-Privacy Regulation collectively will replace the numerous and conflicting national policies firms currently have to adhere to, thus easing to some extent the regulatory burden for these firms. Further, such a greater harmonization of rules within the Digital Single Market may encourage firms to invest in Europe-wide digital infrastructure which is currently challenging or lacking legal clarity.[64]

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62 Ryan, Johnny, "Here is What GDPR Consent Could Look Like. Will People Click Yes?," *PageFair* (August 3, 2017), https://pagefair.com/blog/2017/gdpr-consent/.

63 Mehreen Khan, "Companies face high cost to meet new EU data protection rules," Financial Times (November 19, 2017).

64 Sapiro, Miriam, "Forging an EU Digital Single Market: Difficulties and Opportunities," *Brookings Institution* (September 22, 2015), https://www.brookings.edu/blog/up-front/2015/09/22/forging-an-eu-digital-single-market-difficulties-and-opportunities/.

6. Conclusions

Regulators of the digital economy are facing conflicting demands. The increasing availability of fine-grained consumer data has led, in the EU, to an increase in laws governing how firms can or cannot use such data and the precise requirements they have to comply with. The objective of such policies is largely consumer protection.[65] However, increasing governmental interference may potentially also increase barriers for entrepreneurs and hinder innovation.

This paper attempts to contribute to our understanding on the effect of EU e-privacy provisions on VC investments. Specifically, we focus on how VC investments into three sectors of the digital economy, online news, online advertising, and cloud computing, changed after the introduction of the EU e-Privacy Directive when compared with the U.S.. Our results suggest that following the introduction of the EU e-Privacy Directive, VC investments into the three focal industries decreased substantially, relative to the U.S. Our analysis focuses on the period from 1998 to 2013 and compares the period before and after the enactment of the EU e-Privacy Directive in the EU relative to the U.S. It controls for the overall level of VC investments into IT, time trends, growth in GDP and the growth in the population with Internet access. It is also robust to including different controls and model specifications. Yet, we cannot rule out that other factors likewise affected our estimates. Notwithstanding, our results are consistent with a view that tighter privacy policies may negatively affect VC investments into firms in online advertising, online news, and cloud computing.

[65] Another aspect is to enhance the ability of law enforcement to make use of stored user data as a means of protecting the general public from criminal action.

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Appendix A: Timeline of e-Privacy Legislative Action by EU Member States

Member State	Date of Legislative Action
Denmark	May 2000-July 2003
Malta	July 2003
Sweden	July 2003
Ireland	November 2003
Spain	November 2003
United Kingdom	December 2003
Italy	January 2004
Portugal	January/August 2004
Austria	March 2004
Lithuania	May 2004
Slovenia	May 2004
The Netherlands	May 2004
Germany	June 2004
France	June 2004
Estonia	August 2004
Finland	September 2004
Poland	September 2004
Latvia	November 2004
Cyprus	January 2004
Hungary	January 2004
Czech Republic	May 2005
Belgium	June 2005
Luxembourg	July 2005
Slovakia	January 2006
Greece	June 2006

Notes:

[1] Denmark achieved compliance with the EU e-Privacy Directive via several national laws passed during the May 2000-July 2003 time period.

[2] Portugal tranposed the EU e-Privacy Directive via two national laws passed in January 2004 and August 2004.

Sources:

[1] National transposition timelines found in: "Eighth Annual Report of the Article 29 Working Party on Data Protection," (November 2005), http://ec.europa.eu/justice/data-protection/article-29/documentation/annual-report/files/2005/8th annual report en.pdf.

[2] Information about the transposition timeline of Greece found in: "Law 3471," *Government Gazette of the Hellenic Republic* No. 113 (June 28, 2006), http://www.dpa.gr/pls/portal/docs/PAGE/APDPX/ENGLISH_INDEX/LEGAL%20FRAMEWORK/LAW_%203471_06EN.PDF.