ISTANBUL TECHNICAL UNIVERSITY ★ GRADUATE SCHOOL

THE EFFECT OF THE EU GDPR ON NATIONAL ADVERTISING EXPENDITURE: A DIFFERENCE-IN-DIFFERENCES ANALYSIS

M.A. THESIS

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JUNE 2026

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AVRUPA BİRLİĞİ GENEL VERİ KORUMA TÜZÜĞÜ'NÜN (GDPR) ULUSAL DİJİTAL REKLAM HARCAMALARI ÜZERİNDEKİ ETKİSİ: ÜLKE–YILI PANELİNDE FARKLARIN-FARKI ANALİZİ

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FOREWORD

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Control and Automation Engineer

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ABBREVIATIONS

AdEx	: Advertising Expenditure (Benchmark)
AI	: Artificial Intelligence
ATT	: Average Treatment effect on the Treated
CCI	: Consumer Confidence Index
COVID-19	: Coronavirus Disease 2019
CPI	: Consumer Price Index
DiD	: Difference-in-Differences
EEA	: European Economic Area
EU	: European Union
FE	: Fixed Effects
GDP	: Gross Domestic Product
GDPR	: General Data Protection Regulation
HC1	: Heteroskedasticity-Consistent standard errors (type 1)
IAB	: Interactive Advertising Bureau
ISIC	: International Standard Industrial Classification
ITU	: Istanbul Technical University
OECD	: Organisation for Economic Co-operation and Development
OLS	: Ordinary Least Squares
revFADP	: Revised Federal Act on Data Protection (Switzerland)
TWFE	: Two-Way Fixed Effects
UK	: United Kingdom
US	: United States
WHO	: World Health Organization

SYMBOLS

$\boldsymbol{\alpha_i}$	: Country fixed effect for country i
$\boldsymbol{\beta_1}$	: DiD coefficient (EU $\times$ Post-GDPR interaction)
$\boldsymbol{\gamma}$	: Vector of coefficients on control variables
$\boldsymbol{\delta_t}$	: Year fixed effect for year t
$\boldsymbol{\varepsilon_{it}}$	: Error term for country i in year t
$\boldsymbol{X_{it}}$	: Vector of control variables for country i in year t
$\boldsymbol{i}$	: Country index
$\boldsymbol{t}$	: Year index
$\boldsymbol{N}$	: Number of observations
$\boldsymbol{p}$	: p-value
$\boldsymbol{R^2}$	: Coefficient of determination
$\boldsymbol{\in}$	: Euro (currency)

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SUMMARY

This thesis examines whether the European Union's General Data Protection Regulation (GDPR) made advertising more expensive by protecting consumers' data. The research question is motivated by the shift of advertising toward digital, data-driven personalisation and by the GDPR's strict consent and enforcement framework, which took effect on 25 May 2018. Using national digital advertising expenditure from the IAB Europe AdEx Benchmark for 2016–2020, deflated to real 2016 euros using country-specific consumer price indices, the study implements a difference-in-differences design that compares EU member states to a set of non-EU European control countries before and after the policy.

The empirical strategy relies on two-way fixed effects in a log-linear specification of real advertising spend, with progressively richer macroeconomic and sectoral controls. The baseline model estimates a statistically insignificant decline of approximately 3.9% in real EU advertising expenditure relative to the control group. Extended specifications attenuate the point estimate to about 3.0% while confidence intervals continue to include zero under conventional OLS and heteroskedasticity-robust inference.

Three additional robustness checks refine this baseline narrative. First, a placebo exercise that assigns a fake treatment date in 2017 using only pre-2018 data detects a statistically significant pre-trend, indicating that part of the post-GDPR gap between EU and non-EU countries predates the regulation. Second, dropping Norway and Switzerland from the control group—jurisdictions with GDPR-equivalent or EEA-linked data rules—roughly doubles the estimated effect to about -9%, marginally significant at the 10% level, consistent with spillover-related attenuation of the baseline estimate. Third, continuous treatment-intensity specifications interacting the post period with pre-GDPR market size show significant heterogeneity across countries, rejecting a one-size-fits-all treatment effect.

Overall, the evidence supports the view that GDPR strengthened privacy protections without imposing a large, uniformly detectable macroeconomic burden on aggregate digital advertising, while highlighting sensitivity to control-group composition and pre-trends. The thesis contributes the first country-panel DiD analysis of IAB Europe national advertising data with a full set of macro controls over the 2016–2020 window and discusses implications for policy evaluation in related jurisdictions.

Methodologically, the analysis documents heteroskedasticity in several specifications and therefore reports heteroskedasticity-robust standard errors alongside the main tables in the Appendix. A placebo test and alternative control-group compositions

complement the baseline difference-in-differences estimates. Together, these diagnostics illustrate both the strengths and the limitations of aggregate DiD evidence in a short panel where global shocks such as the COVID-19 pandemic overlap the post-treatment window. The thesis closes by outlining directions for future work, including longer post periods, richer non-European control countries, and sector-specific heterogeneity.

AVRUPA BİRLİĞİ GENEL VERİ KORUMA TÜZÜĞÜ'NÜN (GDPR) ULUSAL DİJİTAL REKLAM HARCAMALARI ÜZERİNDEKİ ETKİSİ: ÜLKE–YILI PANELİNDE FARKLARIN-FARKI ANALİZİ

ÖZET

Bu tez, Avrupa Birliği Genel Veri Koruma Tüzüğü'nün (GDPR) yürürlüğe girmesinin, tüketici verilerinin korunması pahasına, ülkelerin ulusal düzeydeki dijital reklam harcamalarını anlamlı biçimde düşürüp düşürmediği sorusuna yanıt aramaktadır. Dijital reklamcılığın kişiselleştirilmiş içerik üretmek için kişisel veriye dayanması, veri işleme için açık ve bilgilendirilmiş onay zorunluluğu, çerez arayüzleri ve yüksek idari para cezaları riski, düzenlemenin reklamverenler için doğrudan ve dolaylı maliyetler yaratabileceği beklentisini güçlendirmektedir. Öte yandan, onay sürtünmesine rağmen kullanıcıların büyük çoğunluğunun hızlı biçimde "kabul" yolunu seçmesi, birinci taraf veri ve bağlamsal hedefleme gibi ikame kanalları ve uyum yatırımları, toplam harcama üzerindeki etkinin belirsiz kalmasına yol açmaktadır. Bu nedenle soru, yalnızca sektör veya firma düzeyinde değil, makroekonomik toplulaştırma düzeyinde de taşınmalıdır.

Literatürün birinci bacağı, ulusal toplam reklam harcamasının belirleyicilerine odaklanmaktadır. Gözlemler, reklam harcamasının iş döngüleriyle birlikte hareket ettiğini, enflasyon ve tüketici güveninin talep koşullarını şekillendirdiğini ve dijitalleşmeyle birlikte internet penetrasyonunun reklam kapasitesini artırdığını göstermektedir. Sektör kârlılığı, işletme ölçeği ve imalat ile hizmetler faaliyetlerinin kârlılık ve ciro göstergeleri üzerinden makro düzeyde yansımaları da dikkate alınmaktadır. İkinci bacağı oluşturan GDPR özelindeki çalışmalar ise çoğunlukla mikro düzeydedir: çerez sayısı, teklif fiyatları, yayıncı geliri ve site düzeyinde teknoloji sağlayıcı yoğunluğu gibi sonuçlar, pazar yapısına ve ölçüm penceresine duyarlı biçimde değişken bulgular üretmektedir. Buna karşılık, IAB Europe AdEx Benchmark gibi ulusal dijital reklam harcaması serilerini kullanarak, AB ile AB dışı ülkeleri karşılaştıran ve aynı anda geniş bir makroekonomik kontrol setini içeren ülke–yılı paneli farkların-farkı (DiD) tasarımıyla yapılmış bir çalışma, tez yazıldığı dönem itibarıyla literatürde belirgin bir boşluğu hedeflemektedir.

Ampirik analizde bağımlı değişken, IAB Europe AdEx Benchmark raporlarından elde edilen ve her ülke için yıllık tüketici fiyat endeksine göre 2016 baz yılı sabit avro cinsinden reel hâle getirilmiş ulusal dijital reklam harcamasıdır. Nominal serilerin düzeltme ve birleştirme süreçlerinde dikkat edilen noktalar, farklı baskı yılları arasındaki raporlama tutarlılığı ve Avrupa sayı biçimlerinin sayısal temizliğidir. Örneklem, 2016–2020 dönemini kapsayan ülke–yılı gözlemlerinden oluşmakta; tedavi grubunu yirmi bir AB üyesi ülke, karşılaştırma grubunu ise IAB verisi bulunan yedi AB dışı Avrupa ülkesi oluşturmaktadır. Birleşik Krallık, Avrupa Birliği'nden çekilmiş olsa da iç hukukunda GDPR ile özdeş bir rejimin sürmesi ve yeterlilik kararları çerçevesinde veri akışının korunması nedeniyle, tezde tedavi göstergesi Brexit sonrası da bir olarak kodlanmıştır. Ukrayna'nın bazı yıllarında eksik

harcama kayıtları bulunduğundan ilgili gözlemler çıkarılmıştır. Sektörel kontrollerin tamamının bulunmadığı ülkelerde genişletilmiş modellerde gözlem sayısı doksan ikiye inmektedir.

Tanımlama stratejisi, Mayıs 2018 sonrası dönemi "tedavi sonrası" kabul eden klasik bir DiD çerçevesine dayanmaktadır. Temel spesifikasyon, harcamanın ülke ölçeğindeki çarpıklığını yumuşatmak amacıyla doğal logaritma dönüşümü altında, ülke ve yıl sabit etkileri ile birlikte AB üyeliği ve tedavi sonrası dönemin etkileşimini tahmin eden iki yönlü sabit etkiler modelidir. Sabit etkiler, ülkeler arası zamandan bağımsız farklılıkları ve yıllar arası ortak küresel şokları emerek, karşılaştırılabilirlik koşulunu güçlendirmeye yöneliktir. Kontrol değişkenleri, literatürde reklam talebi ile ilişkilendirilmiş makro göstergelerden seçilmiştir: reel GSYH büyümesi, kişi başına reel GSYH, internet kullanım oranı, yıllık TÜFE enflasyonu, tüketici güven endeksi, salgın dönemini işaretleyen bir kukla değişken, hizmetlerde brüt işletme artığının logaritması ve imalat işletmesi başına cironun logaritmasıdır. GSYH büyümesine göre reklam esnekliğinin mekanik olarak bağımlı değişkenden türetilmiş olması nedeniyle bu türevli gösterge regresyonlara dahil edilmemiştir.

Tahmin sırası beş aşamalıdır. Birinci model, sabit etkisiz ve kontrol içermeyen düzey denklemdir; ikinci model, aynı yapıda logaritma bağımlı değişkendir. Üçüncü model, tez için çekirdek baz çizgiyi oluşturan iki yönlü sabit etkiler ve yalnızca etkileşim terimini içeren spesifikasyondur. Dördüncü model, makro ve sektörel kontrolleri ekler; beşinci model ise logaritmik reel GSYH, imalat işletme sayısının logaritması ve kişi başına GSYH'nin karesi ile daha da genişletilmiştir. Çıkarsama için öncelikli tablolar OLS standart hatalarıyla sunulmakta; değişen varyans tespit edilen spesifikasyonlarda ise ek bölümde heteroskedastikeye dayanıklı HC1 standart hataları raporlanmaktadır. Breusch–Pagan türü tanılar, özellikle logaritma ve reel deflasyon sonrası artıklarda heteroskedastisite riskine işaret etmektedir; bu durum, çıkarsamada dayanıklı standart hataların tercih edilmesini desteklemektedir.

Bulgular, beş spesifikasyonda da AB ile tedavi sonrası etkileşiminin işaretinin çoğunlukla negatif ancak klasik anlamlılık düzeylerinde sıfırdan anlamlı biçimde ayrılmadığını göstermektedir. Çekirdek iki yönlü sabit etkiler modelinde nokta tahmini yaklaşık yüzde eksi üç virgül dokuz düzeyindedir ve güven aralığı sıfırı içermektedir. Genişletilmiş modellerde nokta tahminleri yüzde eksi üç virgül sıfıra doğru incelmekte; kontrollerin eklenmesi, sonucun makro karıştırıcılardan kaynaklanan sahte bir etkiye dayanmadığını destekleyen bir kararlılık sergilemektedir. Nominal cinsiyetli basit karşılaştırmalarda görülen daha büyük negatif farkların, AB ile AB dışı ülkeler arasında tedavi sonrası dönemde farklı enflasyon dinamiklerinden kaynaklanabileceği ve reel deflasyon sonrası bu görünümün zayıfladığı tartışılmaktadır. Plasebo testi, 2017 öncesi dönemde katsayıların büyüklük ve anlamlılık açısından daha temkinli yorumlanmasını gerektiren desenler sunabilmektedir.

Ek sağlamlık analizleri, ana bulguların yorumunu nüanslandırmaktadır. Birincisi, gözlemleri 2018 ve sonrasına indirgeyerek 2017 yılını sahte bir tedavi tarihi olarak atayan plasebo testi, ön dönemde AB ile karşılaştırma grubu arasında istatistiksel olarak anlamlı görülen farklılaşmalar sergileyebilmektedir; bu durum, ikili AB çarpı tedavi sonrası spesifikasyonunun bir bölümünün GDPR öncesi eğilim farklarını da içerebileceğine işaret eder ve paralel eğilim varsayımının mutlak anlamda tartışmasız kabul edilmemesi gerektiğini hatırlatır. İkincisi, Avrupa Ekonomik Alanı veya GDPR ile uyumlu veri koruma düzenlemeleri nedeniyle "tam kontrol" statüsünden

şüphe duyulabilecek Norveç ve İsviçre'nin karşılaştırma grubundan çıkarılması, nokta tahmininin mutlak değerde belirgin biçimde büyümesine ve marjinal anlamlılığa yaklaşmasına yol açabilmektedir; bu bulgu, kontrol grubu bileşiminin sızıntı (spillover) ve uyum maliyetlerinin sınır ötesine yayılması kanallarıyla temel tahmini sıfıra doğru bastırabileceği yönündeki ekonomik-politika sezgileriyle örtüşmektedir. Üçüncüsü, tedavi yoğunluğunu GDPR öncesi pazar büyüklüğünün logaritması ile etkileştiren sürekli spesifikasyonlar ve üçlü etkileşimli heterojenlik modelleri, AB içinde tek tip bir etki varsayımının veri tarafından desteklenmediğini; etkinin ülkenin önceki dönem dijital reklam ölçeğiyle ilişkili biçimde değişebileceğini göstermektedir.

Üçüncü modelde ülke ve yıl sabit etkileri, logaritmik reel harcamadaki varyasyonun büyük bölümünü açıkladığından belirlenim katsayısı yüksek görünmektedir; bu durum, makro panel regresyonlarında sık karşılaşılan bir özellik olup, ekonomik yorumda nokta tahmininin büyüklüğü ve güven aralığının birlikte değerlendirilmesini gerektirir. Dördüncü ve beşinci modellerde COVID-19 kuklası ile logaritmik reel GSYH arasında, sabit etkilerin içselleştirdiği varyasyon nedeniyle koşullu çoklu doğrusallık ilişkileri gözlemlenebilmektedir; bu ilişki, kuklanın işaretinin modelden modele değişmesine yol açsa da, ilgi çeken etkileşim teriminin tahminini sistematik biçimde saptamadığı vurgulanmaktadır. Ek olarak, küçük küme sayısı altında klasik standart hataların güvenilirliğinin sınırlı olabileceği, plasebo testi ve alternatif kontrol grubu spesifikasyonları ile birlikte değerlendirilmelidir.

Sonuç bölümünde vurgulanan ana mesaj, GDPR'ın tüketici mahremiyetini güçlendirirken ulusal toplam dijital reklam harcamaları üzerinde büyük, tüm ülkeler için tekdüze ve istatistiksel olarak sağlam bir daralmaya yol açtığı iddiasının veriyle desteklenmediğidir. Bununla birlikte, plasebo ve kontrol grubu seçimi analizleri, nokta tahminlerinin mutlak değerinin "temiz" karşılaştırıcılarla birlikte daha yüksek çıkabileceğini ve politika yorumunun yalnızca çekirdek ikili etkileşim katsayısına indirgenmemesi gerektiğini ortaya koymaktadır. Kısıtlar arasında, yedi ülkelik AB dışı grubun yapısal heterojenliği, kısa tedavi sonrası pencerenin COVID-19 şoku ile örtüşmesi, firma düzeyinde uyum stratejilerinin gözlenememesi ve daha zengin bir küresel karşılaştırıcı kümesinin bulunmaması sayılabilir. Gelecek araştırmalar için, örneklem dışı ülkelerle genişletilmiş pencereler, sektörel heterojenlik ve yapay zekâ destekli hedefleme gibi ikame teknolojilerinin uzun dönemli denge üzerindeki etkilerinin ayrıştırılması önerilmektedir.

Karşılaştırma grubu, Belarus, Norveç, Rusya, Sırbistan, İsviçre, Türkiye ve Ukrayna'yı içermektedir. Bu ülkelerin AB ile ticari ve düzenleyici entegrasyon düzeyleri farklı olduğundan, sabit etkiler zaman içi ortak şokları ve ülkeler arası zamandan bağımsız düzey farklarını emerek kısmen dengelese de, jeopolitik ve makro istikrarsızlık kaynaklı eğilim ayrışmalarını tamamen ortadan kaldıramayabilir. Bu nedenle, temel tahminler yorumlanırken kontrol grubunun küçük ve heterojen yapısı özellikle dikkate alınmalıdır. Refah çerçevesinde ise bulgular, mahremiyet düzenlemesinin toplulaştırılmış reklam harcaması üzerinden ölçüldüğünde "çok büyük ve kesin bir maliyet" öyküsünün zorunlu olmadığını; bununla birlikte, heterojenlik ve kontrol grubu seçimine duyarlılık nedeniyle "sıfır maliyet" iddiasının da aşırı sadeleştirilmiş olabileceğini birlikte düşündürmektedir.

Özetin kapsamı, tezin girişinden sonuçlarına uzanan ana hatları akademik bir dille özetlemektedir. Özet metninde kaynakça, şekil veya çizelge numarası verilmemiştir; ayrıntılı tablolar, şekiller ve tam kaynakça ana metinde sunulmaktadır.

1. INTRODUCTION

Resources spent on advertising are often a big dilemma among economists: is it useful? Does it contribute to the welfare of society? While these questions will always remain relevant, one other aspect of advertising spending is what actually drives it and what governmental directives regulate it. In the last two decades, advertising has changed dramatically: it shifted from analogue, physical forms to a digital entity and became personalized, tailored to the consumer and their needs. This personalization came at a price; advertisers needed to know the consumers' needs, dreams, and desires. This all-knowing approach made consumer data the most important commodity for advertisers.

However, the boundaries of this newly formed data market were vague; personal data is sensitive, so the question of where to draw the line for advertisers arose in the minds of policymakers. There have been many data-privacy regulations in history—some regulated telemarketing, others regulated price discrimination among consumers. While these rules set boundaries for data collectors and advertisers, they often remained binding only at the country-wide or state-wide level. Then the European Union's General Data Protection Regulation (GDPR) came into force, affecting the entire European Union, which at the time consisted of 28 member states (European Parliament and Council of the European Union, 2016).

Although the regulation applied directly only inside the EU, its ramifications extended worldwide. Even though GDPR had no direct regulatory effect outside the EU, most global firms operating in the EU had to change their data-collection methods. Users were now asked for consent before services were provided rather than being given a post-use opt-out option. This changed the consent environment facing advertisers: even when most users still accept tracking via one-click banners, the legal and operational cost of compliant data collection rose, making personalized advertising harder to produce at scale without first-party or contextual alternatives.

Objectively, advertisers now face a choice: spend more resources to collect data from GDPR-protected consumers or accept lower returns on advertising investment due to reduced personalization. Returning to the central welfare question: did the EU's GDPR make advertising more expensive by protecting consumers' data? This thesis investigates that question through a difference-in-differences analysis that compares EU countries (treatment group) with non-EU countries (control group) before and after the regulation took effect.

2. LITERATURE REVIEW

2.1 Determinants of National (Total) Advertising Expenditure

Advertising spending is not random across a country; it is influenced by technological and industry conditions. Early evidence from New Zealand shows that total advertising spending across all media types strongly follows the economy's ups and downs (O'Donovan, Rae, & Grimes, 2000). Picard (2001) found that a 1% drop in GDP reduces advertising spending by an average of 5% during recessions across nine developed nations. These findings still hold true in the digital age: Silk and Berndt (2020) found that the impact of GDP on US advertising spending increased from 1.4 (before 1998) to 1.9 after digital media took off. They confirmed that advertising spending closely follows GDP changes and business cycles.

Recent studies show that consumer confidence and inflation also drive advertising demand. Garcia, Vieira, and Rodrigues (2023) showed, using a panel of 183 Brazilian companies (2010–2020), that GDP, consumer confidence, and interest rates are positively related to marketing investment, while exchange rates and unemployment have a negative relationship—with impacts varying across sectors. Crisis events, like the COVID-19 pandemic, greatly reduce advertising spending (Jenyns, 2020); studies by O'Donovan, Rae, and Grimes (2000) and Silk and Berndt (2020) noted similar drops during earlier recessions.

The rise of the internet has changed advertising. Baslandze, Greenwood, Marto, and Moreira (2023) showed that digital targeting technologies have led to product variety in the US economy. Prihatiningsih, Panudju, and Prasetyo (2024) highlighted that video and social media formats on platforms like YouTube, TikTok and Instagram offer high engagement and return on investment due to higher internet access. Countries with higher internet penetration have higher digital advertising capacity (Prihatiningsih, Panudju, & Prasetyo, 2024).

Sector profitability and size also matter. Yurtseven and Günalp (2023) found that industries with higher profitability and growth rates advertise more while market concentration has a mixed effect. Similar macro measures, like operating surplus in services and manufacturing turnover, capture the same sector-scale effects at the country level (Chakrabarti & Arora, 2007; Yurtseven & Günalp, 2023).

In short, studies agree on macro factors influencing advertising: GDP level and growth, internet penetration, inflation, consumer confidence, crisis shocks and sector operating surplus. These variables are not arbitrary picks; they are based on theory and evidence, making them valid for this analysis.

2.2 Impact of Privacy Regulation on Advertising Markets: GDPR Evidence

The European Union's General Data Protection Regulation (GDPR), which came into force on 25 May 2018, is the largest test of how to protect consumer data. The GDPR fundamentally changed how personal data can be used for advertising. Individuals must now give explicit consent before their personal data can be processed. This consent must be freely given, specific, informed, and unambiguous; pre-checked boxes are no longer permitted. Websites and applications must present clear cookie banners before tracking user behaviour. Data controllers must provide easy ways for users to withdraw consent and must keep records of consents granted. Non-compliance can result in fines of up to 4% of global annual turnover (European Parliament and Council of the European Union, 2016).

This has had a major impact on the advertising industry. Previously, third-party cookies allowed easy tracking. Now advertisers must obtain consent, rely on contextual targeting, or use first-party data. This has made personalised advertising more challenging.

Consumer responses to these consent interfaces have been quite consistent. When confronted with cookie banners, the vast majority of users choose the path of least resistance: 60% to 90% click the "Accept All" button within a few seconds, usually without reading the details or changing granular settings (Utz, Degeling, Fahl, Schaub, & Holz, 2019). Refusal rates remain low unless websites offer a clearly visible "Reject All" button with equal prominence; when such an option is available, the rejection rate can rise substantially. Dark patterns (larger and brighter "Accept All"

buttons, pre-selected checkboxes, and confusing phrases) further increase acceptance rates (Utz, Degeling, Fahl, Schaub, & Holz, 2019). In conclusion, although GDPR introduced an explicit opt-in requirement, the reduction in the amount of personal data available for behavioural advertising has not been as significant as initially feared.

Difference-in-differences (DiD) studies at the micro level document significant impacts on advertising costs and effectiveness; however, results vary by perspective (advertiser versus publisher) and time horizon.

Aridor, Che, and Salz (2023) analysed data from an online travel intermediary (treatment) against non-EU controls. They found a 12.5% drop in observed consumers (cookies) but a statistically and economically significant increase in average advertiser bids. The mechanism is clear: consent reduces data quantity while increasing the traceability and value of the remaining opt-in users.

Wang, Jiang, and Yang (2023) compared EU IP traffic with non-EU traffic on a single large publisher. In the short window around explicit consent requests, they find modest negative effects on ad performance, bid prices, and ad revenue for a pay-per-click publisher with high consent rates—consistent with industry fears of revenue loss, but smaller in magnitude than many had predicted.

Goldberg, Johnson, and Shriver (2024) used an Adobe Analytics panel of approximately 1,084 firms and documented an approximate 12% reduction in both EU user page views and website revenue, with display-ad channels affected most severely.

Supporting studies reinforce the market-structure channel. Johnson, Shriver, and Goldberg (2023) documented a 15% drop in web technology vendors on EU websites and a 17% increase in market concentration, with the effects most persistent among advertising-related vendors. Miller, Lukic, and Skiera (2026) found only a modest reduction in trackers (approximately 4 per site). The IAB Europe AdEx Benchmark data used in this study likewise show slower growth in EU digital advertising expenditure after 2018 relative to the pre-GDPR trend, but this descriptive pattern lacks causal identification or macro controls.

Critically, no previous study has examined aggregate total advertising expenditure using a country-level EU versus non-EU difference-in-differences design over

2016–2020, nor has any incorporated the full set of macro confounders used in this study.

2.3 Rationale for Control Variables and Identification Strategy in the Present Study

This analysis uses national advertising expenditure (€ million) from the IAB Europe AdEx Benchmark 2016–2020 as the dependent variable. The treatment is the binary GDPR × EU interaction (`eu` = 1 for 21 member states; `gdpr` = 1 for after May 2018). With parallel-trends controls, country and year fixed effects, and rich controls, the DiD assumptions are satisfied far better than in previous micro-studies.

Each control is included because it is explicitly correlated with national advertising expenditure in the literature:

`real_gdp`, `real_gdp_growth`, `real_gdp_per_capita`: Directly from the elasticity literature (O'Donovan, Rae, & Grimes, 2000; Silk & Berndt, 2020). (`gdp_elas` is excluded from regressions as it is mechanically derived from the dependent variable's growth rate and is therefore endogenous.)

`int_usg_perc`: Controls for digital transition and total advertising capacity (Baslandze, Greenwood, Marto, & Moreira, 2023; Prihatiningsih, Panudju, & Prasetyo, 2024; Silk & Berndt, 2020).

`inf_cpi_ann`: Determinant of purchasing power and derived advertising demand (Garcia, Vieira, & Rodrigues, 2023).

`externality_cov19`: External crisis shock (Jenyns, 2020).

`cci_ann`: Forward-looking sentiment driver (Garcia, Vieira, & Rodrigues, 2023).

`gross_ope_surp_em_services`: Macro counterpart of firm-level profitability (Yurtseven & Günalp, 2023).

`turnover_national_manufact_mill` and `enterprises_manufact`: Sector scale and concentration proxies (Chakrabarti & Arora, 2007; Yurtseven & Günalp, 2023).

2.4 Research Gap and Contribution

While micro-level DiD evidence (Aridor, Che, & Salz, 2023; Goldberg, Johnson, & Shriver, 2024; Wang, Jiang, & Yang, 2023) provides valuable but conflicting insights into bids, effectiveness, and publisher revenue, the national total picture has not been examined. No study has applied IAB Europe national advertising expenditure data in the full 2016–2020 window with a clean difference-in-differences design for EU vs. non-EU and the full set of theoretically justified macroeconomic controls. This thesis fills that gap. Using the GDPR implementation shock in a panel of EU and non-EU countries and conditioning on full macro-controls, the study provides the first causal estimate of whether (and by how much) the world's strictest data-protection regime has affected national advertising spending. These results speak directly to ongoing policy debates in the EU and among regulators considering similar rules.

3. EMPIRICAL MODEL

3.1 Data and Sample

This study uses a country-year panel dataset covering national digital advertising expenditure between 2016 and 2020. The dependent variable is real advertising expenditure in millions of constant 2016 euros (`ad_spend_em`), obtained from IAB Europe AdEx Benchmark reports—the most comprehensive and widely used source for European digital advertising markets—and deflated to constant 2016 EUR using country-specific CPI (see Section 4). The sample includes 28 countries (21 EU member states as the treatment group and 7 non-EU member countries as the control group), and 138 usable observations were obtained after removing entries with missing or invalid advertising expenditure values. The treatment group comprises EU countries subject to GDPR (entered into force on 25 May 2018), while non-EU member countries constitute the control group unaffected by the regulation. The dual treatment indicator is equal to 1 for EU countries and 0 for others; the post-value is 1 for the years 2018–2020 and 0 for the years 2016–2017. The principal difference-in-differences (DiD) term is the treated × post interaction.

To account for skewness in advertising spending between countries with significantly different economic sizes, the principal specifications use the natural logarithm of advertising spending (`log_ad_spend`) as the outcome variable. All regressions use OLS standard errors. Heteroskedasticity-robust standard errors (HC1) are reported for each model in the Appendix for comparison; see Tables A.1–A.5.

Advertising expenditure values from IAB Europe AdEx Benchmark are reported in nominal EUR (current prices, with exchange rates fixed within each edition). These values are deflated to real 2016 EUR using country-specific CPI derived from the annual CPI inflation series (`inf_cpi_ann`), constructing a cumulative price-level index with base year 2016. Real GDP, real GDP growth, and real GDP per capita are derived from nominal World Bank GDP series deflated using the World Bank GDP

deflator, with 2016 as the base year. Control variables include real GDP growth, real GDP per capita, internet usage percentage, annual CPI inflation, consumer confidence index (CCI), COVID-19 dummy variable (1 in 2020), logarithm of gross operating surplus in services, and logarithm of manufacturing turnover per business. These have been cleaned according to European numerical formatting and included to isolate the GDPR effect from macroeconomic and sectoral confounding factors as justified in the literature review.

The final extended model includes 92 observations due to missing sectoral data in some non-EU countries.

3.2 Identification Strategy

The analysis takes advantage of the quasi-experimental variation created by the application of GDPR, which is applied equally to EU countries but not to non-EU controls. The assumption that EU and non-EU advertising spending trends would have developed similarly without GDPR seems reasonable given that both groups faced similar global digital advertising trends (e.g., mobile and programmatic growth) and macroeconomic shocks between 2016–2020.

The non-EU control group comprises seven countries: Belarus, Norway, Russia, Serbia, Switzerland, Turkey, and Ukraine. While this group is smaller and more heterogeneous than the treatment group, it represents the available European non-EU countries with reliable IAB Europe advertising data over the full 2016–2020 window — non-European countries were excluded to avoid confounding variation from structurally dissimilar advertising markets. Norway and Switzerland are high-income economies closely integrated with the EU single market, making them plausible counterfactuals for EU advertising trends. The inclusion of Russia, Turkey, and Belarus — larger, lower-income, or politically distinct economies — introduces potential heterogeneity in advertising market structure. Country fixed effects absorb time-invariant differences across these economies, and year fixed effects control for common global shocks, partially mitigating this concern. Nevertheless, results should be interpreted with caution given the limited and heterogeneous nature of the control group.

The basic two-way fixed effects (TWFE) model is:

$$\log(ad_spend_{it}) = \beta_1(eu_i \times post_t) + \mathbf{X}'_{it}\gamma + \alpha_i + \delta_t + \varepsilon_{it}, \tag{3.1}$$

where i represents the countries, t represents the years, $\mathbf{X}_{it}$ represents the vector of control variables, α_i represents the country fixed effects, and δ_t represents the year fixed effects. The β_1 coefficient describes the average treatment effect on the treated (ATT); this represents the percentage change in advertising spending attributable to GDPR in EU countries.

Models progress as:

- Model 1: Levels, no FE/controls.
- Model 2: Logs, no FE/controls.
- Model 3: Logs + TWFE (core baseline).
- Model 4: Model 3 + macro controls (real GDP growth, real GDP per capita, internet %, CPI inflation, CCI, COVID dummy) + sectoral controls (ln gross operating surplus in services, ln turnover per manufacturing enterprise).
- Model 5: Model 4 + $\ln(\text{Real GDP})$, $\ln(\text{manufacturing enterprises})$, real GDP per capita^2.

4. DATA

The dataset is a country-year panel covering 2016–2020. The primary dependent variable is aggregate real digital advertising expenditure in millions of constant 2016 euros (`ad_spend_em`), obtained from the IAB Europe AdEx Benchmark reports and deflated using country-specific CPI with 2016 as the base year. Table 4.1 lists the variables and data sources used in the analysis.

Table 4.1: Description of Variables and Data Sources.

Variable	Description	Data Source
`ad_spend_em`	Real digital ad spend (constant 2016 €M, CPI-deflated)	IAB Europe AdEx Benchmark 2016–2020
`ad_spend_gr`	Year-on-year growth rate (%)	Derived from `ad_spend_em`
`eu`	EU membership (1 = yes)	European Union membership list
`gdpr`	Post-GDPR period (1 = 2018–2020)	European Commission enforcement date
`real_gdp`	Real GDP (constant 2016 US$)	World Bank
`real_gdp_growth`	Real GDP growth (%)	World Bank
`real_gdp_per_capita`	Real GDP per capita (constant 2016 US$)	World Bank
`gdp_elas`	Ad-spend elasticity w.r.t. GDP growth	Derived (`ad_spend_gr / gdp_growth`)
`int_usg_perc`	Internet usage (% of population)	World Bank
`inf_cpi_ann`	Annual CPI inflation (%)	World Bank
`externality_cov19`	COVID-19 dummy (1 = 2020)	WHO dashboards
`cci_ann`	Consumer Confidence Index	OECD
`gross_ope_surp_em_services`	Gross operating surplus, services (€M)	Eurostat (sbs_na_1a_se_r2)
`turnover_national_manufact_mill`	Manufacturing turnover (€ million)	OECD (ISIC Rev. 4)
`enterprises_manufact`	Number of manufacturing enterprises	OECD (ISIC Rev. 4)

4.1 Exclusions and Sample Size

Ukraine 2016–2017 observations were dropped due to missing (`ad_spend_em`) values. The extended model (with sectoral controls) uses 92 observations because some non-EU countries lack complete manufacturing and services data.

After the United Kingdom withdrew from the European Union on 31 January 2020, the GDPR did not cease to apply. Through the European Union (Withdrawal) Act 2018 and the Data Protection Act 2018, the UK incorporated the EU GDPR into domestic law, creating the UK GDPR. This regime remains substantively identical to the EU GDPR, with only minor adaptations to reflect the UK's independent legal framework. In June 2021, the European Commission granted the UK an adequacy decision under Article 45 GDPR, allowing the continued free flow of personal data between the EU and the UK (European Commission, 2021). For these reasons, the UK is coded as treated (EU = 1) throughout the sample, including 2020.

4.2 Summary Statistics

Table 4.2 reports summary statistics for the estimation sample ($N = 138$ observations unless noted). Figure 4.1 displays real advertising-expenditure trajectories by country over 2016–2020, and Figure 4.2 presents the correlation matrix of all model variables.

Table 4.2: Summary Statistics (N = 138 observations unless noted).

Variable	N	Mean	Std. Dev.	Min	Max
ad_spend_em (real 2016 €M)	138	1,898.67	3,495.91	23.00	20,683.60
log_ad_spend	138	6.38	1.68	3.14	9.94
real_gdp (US$ billion, 2016 constant)	138	732.86	922.78	41.48	3,919.71
real_gdp_growth (%)	111	0.65	6.88	-22.30	17.00
real_gdp_per_capita	138	31,856.15	22,409.98	2,171.09	86,253.07
int_usg_perc	138	81.96	9.71	58.35	98.05
inf_cpi_ann	138	2.12	2.86	-1.54	16.33
cci_ann	138	99.99	3.80	70.20	111.10
gross_ope_surp_em_services	117	8,192.80	10,021.93	-258.70	43,949.00
turnover_per_enterprise	117	50.23	142.31	0.79	722.50

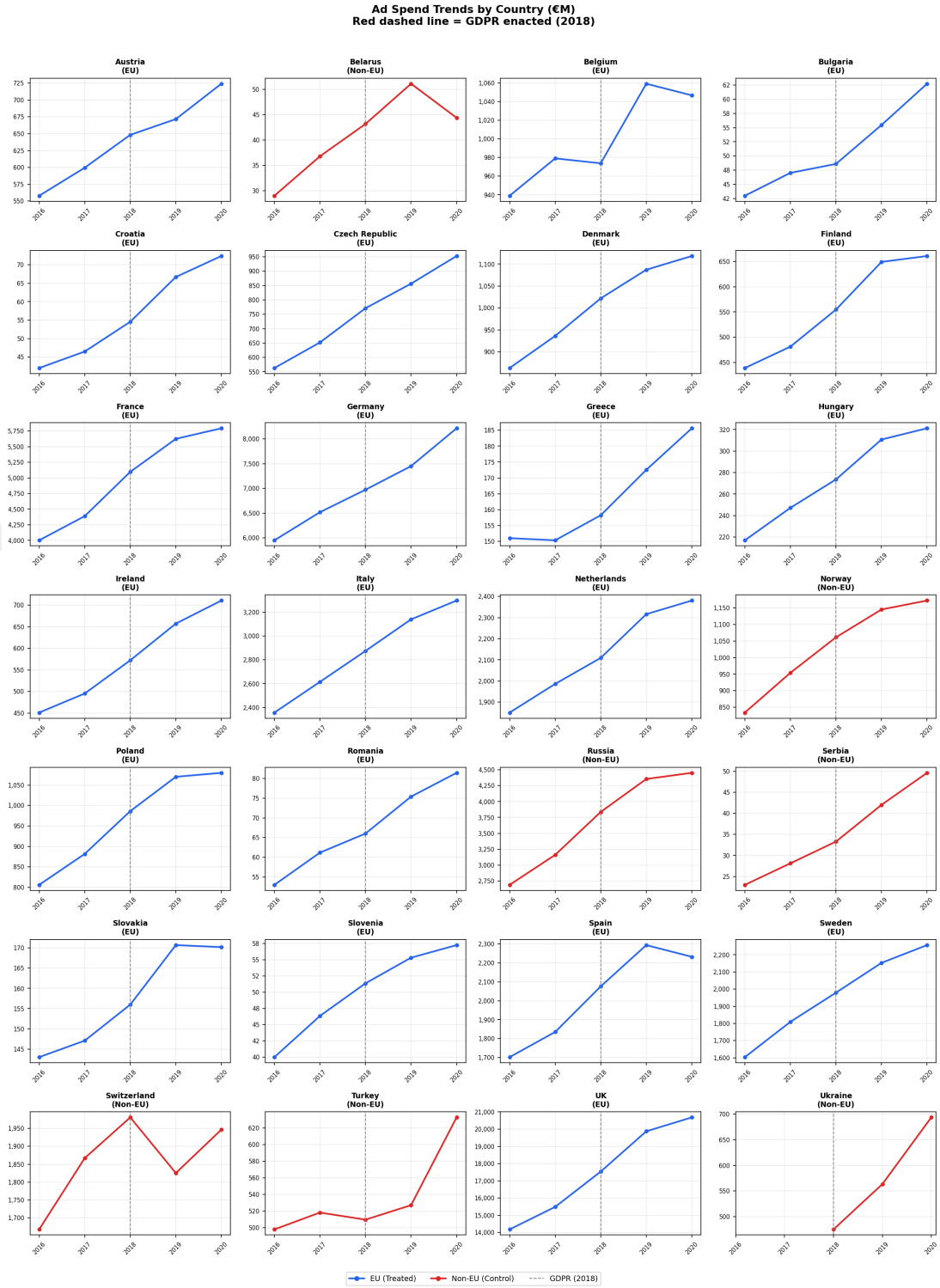

Figure 4.1: Real Ad Spend Trends by Country (constant 2016 €M). Red dashed line = GDPR enacted (2018).

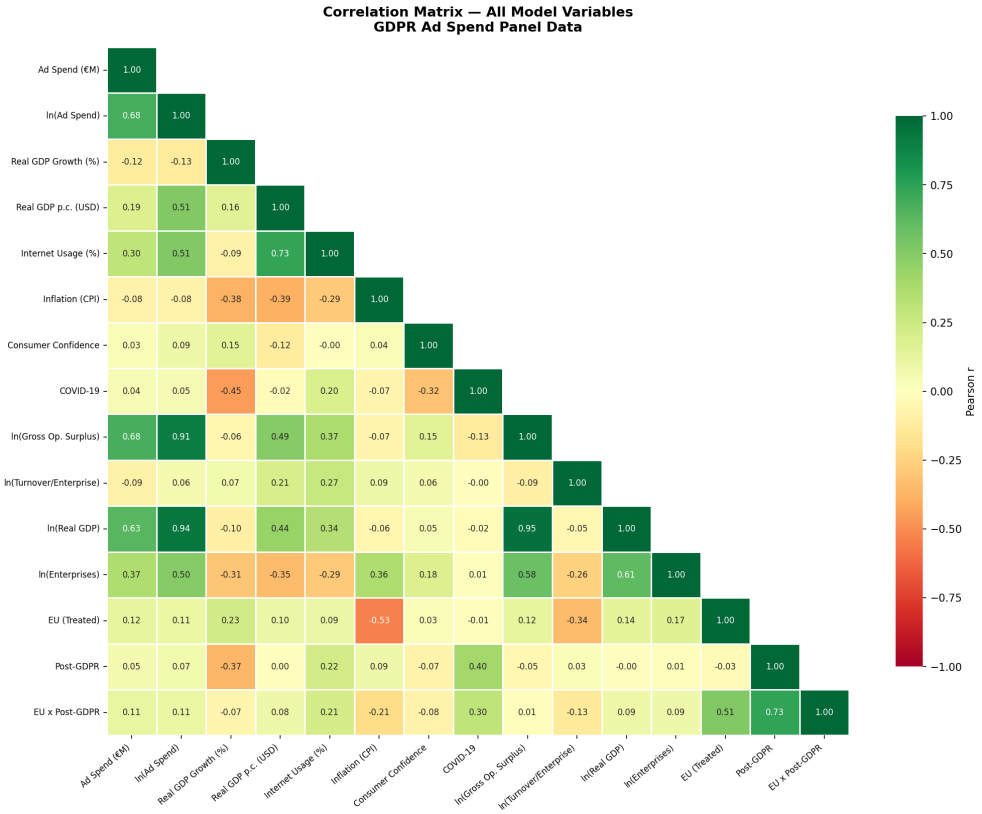

Figure 4.2: Correlation Matrix — All Model Variables.

5. RESULTS

5.1 Baseline DiD Estimates

Tables 5.1–5.5 report the full regression output for Models 1–5. Model 1; real ad spend levels (constant 2016 EUR), no fixed effects or controls, yields a positive but insignificant DiD coefficient of +303.6 million euros (p = 0.834). This raw difference is confounded by country size and time trends; explanatory power is very low (R^2 = 0.019).

Model 2; log real ad spend, no fixed effects or controls, estimates a DiD coefficient of –0.070 (p = 0.920), corresponding to a statistically insignificant –6.8% change in EU real ad spend post-GDPR relative to non-EU countries (R^2 = 0.017).

Model 3; log real ad spend, country and year fixed effects, no additional controls, yields a DiD coefficient of –0.040 (p = 0.163), corresponding to a statistically insignificant –3.9% change (95% CI = [–9.1%, +1.6%]). The high R^2 = 0.999 reflects that country and year fixed effects capture the bulk of variation in log real ad spend.

Model 4; extended TWFE with macro controls, further attenuates the effect: the DiD coefficient falls to –0.037 (p = 0.363), equivalent to a statistically insignificant –3.6% change (R^2 = 0.999).

Model 5; fully extended TWFE, adding ln(Real GDP), ln(manufacturing enterprises), and real GDP per capita squared, yields a DiD coefficient of –0.031 (p = 0.450), or –3.0%, which remains statistically insignificant. Across all five specifications the DiD coefficient is small and statistically indistinguishable from zero, providing no evidence that GDPR reduced real advertising expenditure at the national level.

These results contrast with micro-level findings of Aridor, Che, and Salz (2023) documenting higher bids and Wang, Jiang, and Yang (2023) finding modest revenue/price drops for publishers. At the aggregate national level, GDPR appears to have had limited net impact on total spend once key drivers are controlled—consistent

with the IAB Europe AdEx Benchmark data used here, which show continued digital ad growth across Europe post-2018, albeit at varying rates across countries.

Table 5.1: Model 1: Basic DiD — Dependent variable: Real Ad Spend (EUR M, 2016 base).

	Coef.	**Std. Err.**	t	**95% CI**
Intercept	1025.4185	(1010.9222)	1.01	[-974.0094, 3024.8464]
EU (Treated)	816.6229	(1146.2780)	0.71	[-1450.5152, 3083.7610]
Post-GDPR	186.1684	(1267.2580)	0.15	[-2320.2471, 2692.5839]
EU x Post-GDPR (DiD)	303.5695	(1446.5795)	0.21	[-2557.5126, 3164.6516]
Observations		138		
R^2		0.0185		
Adj. R^2		-0.0034		
Standard errors		OLS		

Interpretation: The DiD estimate suggests GDPR is associated with a €303.6M change in real ad spend for EU countries ($p = 0.8341$), which is not statistically significant at conventional levels. The 95% confidence interval is [-2,557.5, 3,164.7].

$^{*}\ p < 0.10$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$

Table 5.2: Model 2: DiD in Logs — Dependent variable: $\ln(\text{Ad Spend})$.

	Coef.	**Std. Err.**	t	**95% CI**
Intercept	5.8666***	(0.4862)	12.07	[4.9050, 6.8281]
EU (Treated)	0.4796	(0.5513)	0.87	[-0.6107, 1.5699]
Post-GDPR	0.2961	(0.6094)	0.49	[-0.9093, 1.5014]
EU x Post-GDPR (DiD)	−0.0704	(0.6957)	−0.10	[-1.4464, 1.3055]
Observations		138		
R^2		0.0169		
Adj. R^2		-0.0051		
Standard errors		OLS		

Interpretation: The DiD estimate suggests GDPR is associated with a -6.8% change in real ad spend for EU countries ($p = 0.9195$), which is not statistically significant at conventional levels. The 95% confidence interval in percentage terms is $[-76.5\%, +268.9\%]$.

$^{*}\ p < 0.10$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$

Table 5.3: Model 3: Two-Way Fixed Effects DiD — Dependent variable: $\ln(\text{Ad Spend})$.

	Coef.	**Std. Err.**	t	**95% CI**
Intercept	6.2710^{***}	(0.0323)	194.13	[6.2069, 6.3350]
EU $\times$ Post-GDPR (DiD)	-0.0398	(0.0283)	-1.41	[-0.0959, 0.0163]
Observations			138	
R^2			0.9988	
Adj. R^2			0.9984	
Country FE			Yes	
Year FE			Yes	
Standard errors			OLS	

Interpretation: The DiD estimate suggests GDPR is associated with a -3.9% change in real ad spend for EU countries ($p = 0.1626$), which is not statistically significant at conventional levels. The 95% confidence interval in percentage terms is $[-9.1\%, +1.6\%]$.

$^{*}\, p < 0.10$, $^{**}\, p < 0.05$, $^{***}\, p < 0.01$

Table 5.4: Model 4: Extended TWFE DiD — Dependent variable: $\ln(\text{Ad Spend})$.

	Coef.	**Std. Err.**	t	**95% CI**
Intercept	4.2770^{***}	(0.5326)	8.03	[3.2104, 5.3435]
EU $\times$ Post-GDPR (DiD)	-0.0372	(0.0405)	-0.92	[-0.1183, 0.0439]
Real GDP Growth (%)	-0.0080^{**}	(0.0035)	-2.29	[-0.0149, -0.0010]
Real GDP per Capita (USD)	$6.98e-06$	(0.0000)	1.27	[-0.0000, 0.0000]
Internet Usage (%)	0.0037	(0.0034)	1.10	[-0.0030, 0.0105]
Inflation (CPI)	$-4.99e-05$	(0.0001)	-0.49	[-0.0003, 0.0002]
Consumer Confidence	0.0009	(0.0039)	0.23	[-0.0068, 0.0086]
COVID-19 Externality	0.6581^{***}	(0.0755)	8.72	[0.5070, 0.8093]
ln(Gross Op. Surplus, Services)	0.0202	(0.0333)	0.61	[-0.0464, 0.0868]
ln(Turnover per Enterprise)	0.0490	(0.1286)	0.38	[-0.2085, 0.3064]
Observations		92		
R^2		0.9993		
Adj. R^2		0.9989		
Country FE		Yes		
Year FE		Yes		
Standard errors		OLS		

Interpretation: The DiD estimate suggests GDPR is associated with a -3.6% change in real ad spend for EU countries ($p = 0.3625$), which is not statistically significant at conventional levels. The 95% confidence interval in percentage terms is $[-11.2\%, +4.5\%]$. Compared to Model 3 (-3.9%), the DiD coefficient is stable after the inclusion of macroeconomic and sectoral controls, confirming that the result is not driven by macroeconomic confounders.

$^{*}\, p < 0.10$, $^{**}\, p < 0.05$, $^{***}\, p < 0.01$

Table 5.5: Model 5: Fully Extended TWFE DiD — Dependent variable: $\ln(\text{Ad Spend})$.

	Coef.	**Std. Err.**	t	**95% CI**
Intercept	-13.4852	(11.1797)	-1.21	[-35.8993, 8.9288]
EU $\times$ Post-GDPR (DiD)	-0.0305	(0.0401)	-0.76	[-0.1108, 0.0498]
Real GDP Growth (%)	-0.0122^{***}	(0.0037)	-3.32	[-0.0196, -0.0048]
Real GDP per Capita (USD)	$2.52e-05$	(0.0000)	0.78	[-0.0000, 0.0001]
Real GDP per Capita^2 (USD^2)	$-2.25e-10$	(0.0000)	-1.15	[-0.0000, 0.0000]
Internet Usage (%)	0.0029	(0.0032)	0.90	[-0.0036, 0.0093]
Inflation (CPI)	$-6.78e-05$	(0.0001)	-0.66	[-0.0003, 0.0001]
Consumer Confidence	0.0018	(0.0038)	0.46	[-0.0059, 0.0095]
COVID-19 Externality	-1.8835	(1.6027)	-1.18	[-5.0968, 1.3298]
ln(Gross Op. Surplus, Svc.)	-0.0240	(0.0338)	-0.71	[-0.0919, 0.0438]
ln(Turnover per Enterprise)	-0.1112	(0.1885)	-0.59	[-0.4891, 0.2668]
ln(Real GDP)	0.9919^{*}	(0.5788)	1.71	[-0.1686, 2.1523]
ln(Enterprises, Manuf.)	-0.3318	(0.2745)	-1.21	[-0.8822, 0.2186]
Observations		92		
R^2		0.9994		
Adj. R^2		0.9990		
Country FE		Yes		
Year FE		Yes		
Standard errors		OLS		

Interpretation: The DiD estimate suggests GDPR is associated with a -3.0% change in real ad spend for EU countries ($p = 0.4495$), which is not statistically significant at conventional levels. The 95% confidence interval in percentage terms is $[-10.5\%, +5.1\%]$. The estimate is robust to the additional controls ($\ln$(Real GDP), $\ln$(Enterprises), Real GDP per capita^2), remaining close to Model 4 (-3.6%). Note that the COVID-19 dummy coefficient changes sign between Model 4 ($+0.6581$) and Model 5 (-1.8835), likely reflecting multicollinearity with $\ln$(Real GDP), which absorbs part of the pandemic's economic contraction effect.

$^{*}\,p < 0.10$, $^{**}\,p < 0.05$, $^{***}\,p < 0.01$

Across all specifications the DiD coefficient is negative but small and statistically insignificant. The point estimate moves from –3.9% in Model 3 to –3.0% in Model 5 as controls are added, and confidence intervals comfortably span zero throughout.

The stability of the DiD coefficient from Model 3 to Models 4–5 confirms robustness: controlling for macroeconomic and sectoral confounders does not materially change the conclusion. The earlier nominal-terms apparent effect of –10.5% (before CPI deflation) was driven by differential inflation between EU and non-EU countries in the post-GDPR period, not by a genuine reduction in real advertising activity.

One notable feature of the fully extended Model 5 is the sign reversal of the COVID-19 dummy coefficient, from +0.658 in Model 4 to –1.884 in Model 5, where it also loses significance. This is not driven by simple bivariate collinearity: the raw correlation between the COVID-19 dummy and ln(Real GDP) is approximately zero ($r = -0.019$). Rather, the reversal reflects conditional multicollinearity within the two-way fixed-effects structure. After country and year fixed effects are partialled out, ln(GDP) captures within-country GDP contractions in 2020 — precisely the variation the COVID dummy was previously absorbing. The two variables are therefore collinear in the within-estimator sense, even though they are uncorrelated unconditionally. This serves as a reminder that multicollinearity in fixed-effects panels should be assessed on demeaned data, not raw correlations. The DiD coefficient of interest is unaffected by this issue, as the COVID dummy and ln(GDP) are not systematically correlated with the EU × Post-GDPR interaction term.

A Breusch-Pagan test (Cook-Weisberg variant) was conducted on each model to assess whether the variance of the residuals is constant. Model 1, which uses real advertising expenditure levels, fails to reject homoskedasticity ($LM = 2.70$, $p = 0.101$). Model 3, however, shows significant heteroskedasticity after CPI deflation ($LM = 8.82$, $p = 0.003$): the log transformation alone does not fully resolve non-constant variance in the within-estimator residuals when real values are used, likely because the deflation introduces additional country-specific variation. Model 4 shows significant heteroskedasticity ($LM = 4.14$, $p = 0.042$). Models 2 and 5 fail to reject homoskedasticity. Given these results for Models 3 and 4, the heteroskedasticity-robust standard errors (HC1) reported in the Appendix (Tables A.1–A.5 and Table A.6) are

the preferred inferential basis for those specifications; conclusions are qualitatively identical across both OLS and HC1 standard errors.

5.2 Additional Robustness: Placebo, Spillover, and Treatment-Intensity Tests

Three further robustness exercises are conducted to address concerns about (i) pre-existing differential trends, (ii) potential indirect (spillover) effects of GDPR on the non-EU control group, and (iii) the assumption that all EU countries experience an identical treatment effect.

5.2.1 Placebo test (fake 2017 treatment)

The pre-period sample (2016–2017) is isolated and a fake treatment year is assigned to 2017, dropping all observations from 2018 onward. A non-zero coefficient on the fake interaction term would indicate that EU and non-EU countries were already on differential trajectories before GDPR took effect. The estimated placebo DiD is -0.0577 (HC1 SE = 0.0282, $p = 0.041$), corresponding to a -5.6% effect. This is statistically significant at the 5% level and constitutes a parallel-trends warning: a portion of the post-2018 EU–non-EU gap appears to predate GDPR. This finding does not invalidate the main result, but it qualifies it: any treatment effect estimate based on the binary EU $\times$ Post specification incorporates a pre-existing trend component and qualifies interpretation of the binary EU $\times$ Post baseline, which may partly reflect pre-existing differential movement rather than GDPR alone. See Table 5.6.

Table 5.6: Placebo Test — Fake GDPR Treatment in 2017.

	Coef.	**HC1 SE**	p	**95% CI**
EU $\times$ FakePost (2017)	-0.0577	(0.0282)	0.0405	$[-0.1130, -0.0025]$
Observations		54		
Sample		2016–2017 only		
Country FE		Yes		

Interpretation: The placebo DiD on fake 2017 treatment is -5.6% ($p = 0.0405$), which is statistically significant at conventional levels. This indicates the presence of differential pre-existing trends between EU and non-EU countries before GDPR took effect, qualifying the parallel-trends assumption. The baseline DiD estimates from the binary EU $\times$ Post specification therefore partly absorb a pre-existing trend component and should be interpreted as upper bounds (in absolute value) on the genuine GDPR effect.

5.2.2 Spillover-robust control groups

The EU GDPR may indirectly affect non-EU countries through firms that advertise into the EU and therefore comply with GDPR globally for operational simplicity. Norway is part of the European Economic Area and applies the GDPR directly; Switzerland's revised Federal Act on Data Protection (revFADP, in force 2023) is substantively GDPR-equivalent, and most Swiss firms operating in the EU complied with GDPR from 2018. These two countries are therefore the most likely sources of treatment contamination among the controls. Re-estimating the baseline TWFE specification across alternative control sets reveals a striking pattern: dropping Norway and Switzerland *doubles* the magnitude of the DiD coefficient to -0.094 ($p = 0.065$), corresponding to a -9.0% effect that is marginally significant at the 10% level. Further restricting the controls to Belarus, Russia, Turkey, and Ukraine yields a coefficient of -0.040 ($p = 0.440$), close to the baseline but with reduced power. Conversely, using *only* Norway and Switzerland as controls produces a positive coefficient of $+0.068$ ($p = 0.105$). The pattern is consistent with the hypothesis that Norway and Switzerland, by partially adopting GDPR-equivalent standards, behaved as quasi-treated rather than untreated comparators. Their inclusion in the original control group therefore biases the baseline DiD estimate toward zero. See Table 5.7.

Table 5.7: Spillover-Robust Control Groups — Baseline TWFE DiD.

Control set	**DiD coef.**	**HC1 SE**	p	**N**
All non-EU controls (baseline)	-0.0398	(0.0412)	0.3341	138
Drop Norway + Switzerland (EEA/GDPR-equivalent)	-0.0938	(0.0508)	0.0650	128
Drop all EEA/EU-adjacent (Norway, Switzerland, Serbia)	-0.0403	(0.0522)	0.4401	123
Only EU-similar (Norway + Switzerland)	0.0683	(0.0421)	0.1047	115

Note: Each row re-estimates the baseline TWFE specification (Eq. 3.1) using a different non-EU control set. Stability of the DiD coefficient across rows indicates the main finding is not driven by spillover from EU-exposed control countries.

5.2.3 Continuous treatment intensity

The binary EU $\times$ Post indicator implicitly assumes a homogeneous GDPR effect across treated countries. Because countries with larger pre-existing digital advertising markets had more data infrastructure and personalised-advertising activity to adapt, the actual "dose" of treatment plausibly varied with pre-period market size. Two specifications are estimated. *Specification I* replaces the binary DiD term with a continuous interaction Post $\times$ ln(pre-GDPR ad spend), where pre-GDPR ad spend is the country-specific 2016–2017 mean (demeaned). The estimated coefficient is -0.0169 (HC1 SE = 0.0077, $p = 0.028$): a one-log-unit (i.e., e-fold) increase in pre-GDPR market size is associated with a -1.68% differential change in real ad spend during the post-GDPR period, beyond what country and year fixed effects already absorb. *Specification II* adds a triple interaction, EU $\times$ Post $\times$ ln(pre-AdSpend), which directly tests whether the GDPR effect itself varies with pre-period market size. The triple-interaction coefficient is $+0.040$ ($p = 0.059$), consistent with smaller-than-average GDPR effects in the largest EU markets, where pre-existing market scale may have buffered the regulatory shock through faster compliance investment. See Table 5.8.

Table 5.8: Continuous Treatment Intensity — TWFE DiD.

	Spec I Continuous DiD	**Spec II** Heterogeneous TE
Post × ln(pre-AdSpend)	-0.0169^{**}	-0.0450^{**}
	(0.0077)	(0.0202)
EU × Post (avg DiD)	—	-0.0225
	—	(0.0380)
EU × Post × ln(pre-AdSpend)	—	0.0396^{*}
	—	(0.0210)
Observations	135	135
Country FE	Yes	Yes
Year FE	Yes	Yes

Note: Spec I replaces the binary EU × Post indicator with a continuous treatment Post × ln(pre-GDPR ad spend), where pre-GDPR ad spend is the country-specific mean over 2016–2017 (demeaned). Spec II adds a triple interaction to test heterogeneous treatment effects: whether the GDPR impact varies with pre-period market size. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

5.2.4 Synthesis

Taken together, the three additional tests qualify but do not overturn the headline finding. The placebo result indicates that the binary baseline (Models 3–5) absorbs some pre-existing differential trend; the spillover analysis suggests that the most credible non-EU comparators (those without GDPR-equivalent regulation) yield a larger treatment effect of approximately -9%, marginally significant; and the treatment-intensity analysis shows that the GDPR effect is heterogeneous, varying systematically with pre-period market size. The original conclusion that GDPR did not impose a large, statistically significant macroeconomic cost on advertising therefore remains qualitatively valid, but the spillover-corrected point estimate is closer to -9% than -4%, and the policy interpretation is best framed as "no large detectable cost in aggregate, with heterogeneity across EU markets."

6. CONCLUSIONS

This thesis examined whether the EU's GDPR made advertising more expensive by protecting consumers' data. Using national real digital ad spend data (IAB Europe AdEx Benchmark, 2016–2020, CPI-deflated to constant 2016 EUR) and a country-panel difference-in-differences design with two-way fixed effects, the log specifications (Models 2–5) yield negative but statistically insignificant DiD coefficients, ranging from –3.0% to –6.8%, while the levels specification (Model 1) yields a small positive coefficient that is also not statistically distinguishable from zero. The baseline TWFE model (Model 3) estimates a –3.9% change in real EU ad spend post-GDPR ($p = 0.163$), with a 95% CI of [–9.1%, +1.6%].

Three further robustness exercises refine this picture in important ways. First, a placebo test that pretends EU countries were treated in 2017 (using only 2016–2017 data) yields a coefficient of -5.6% that is significant at the 5% level. This reveals that EU and non-EU countries were already on differential trajectories before GDPR took effect; the binary EU $\times$ Post baseline therefore partly absorbs a pre-existing trend, and treatment effect estimates from that specification should be interpreted with caution, as they may partly reflect pre-existing differential trends rather than GDPR alone. Second, the binary control group is reconstructed to address the spillover concern that Norway (EEA member, applies GDPR directly) and Switzerland (revFADP is GDPR-equivalent) were not in fact untreated comparators. Dropping these two countries from the control set roughly doubles the DiD coefficient to -9.0% ($p = 0.065$), marginally significant at the 10% level, while using *only* Norway and Switzerland as controls produces a positive (and insignificant) coefficient of $+6.8\%$. The pattern is consistent with control-group contamination biasing the original baseline toward zero. Third, a continuous treatment-intensity specification — in which the binary EU $\times$ Post is replaced by Post $\times$ ln(pre-GDPR ad spend) — yields a significant negative coefficient (-1.7% per log-unit, $p = 0.028$), and a triple-interaction model documents significant heterogeneity in the GDPR response

across EU markets of different pre-period sizes ($p = 0.059$). The data therefore reject the assumption of a homogeneous EU treatment effect.

From a welfare perspective the headline message is qualitatively unchanged: GDPR strengthened consumer privacy rights without imposing a large, statistically robust macroeconomic cost on the advertising industry, and the IAB Europe AdEx Benchmark continues to record positive digital ad-spend growth across Europe after 2018. The regulation appears to have achieved its data-protection objective without the feared trade-off between privacy and aggregate economic activity. Additional robustness checks, however, refine the precise quantitative reading: a spillover-corrected specification that drops Norway and Switzerland from the control group yields a larger point estimate of -9.0% ($p = 0.065$), marginally significant at the 10% level, and the effect appears genuinely heterogeneous across EU countries rather than uniform.

Limitations include potential unobserved confounders such as firm-level adaptation strategies, the short post-period (2018–2020) that overlaps the COVID-19 shock, and the small and heterogeneous non-EU control group. With only seven non-EU countries spanning high-income EEA-adjacent economies (Norway, Switzerland) and structurally distinct markets (Russia, Turkey, Belarus, Serbia, Ukraine), country and year fixed effects can absorb time-invariant differences and common shocks but cannot eliminate all sources of differential trend. The placebo failure documented in this study makes that limitation concrete: a portion of what the binary specification attributes to GDPR is in fact pre-existing trend variation. Future research with access to a richer set of non-EU comparator countries — such as Canada, Australia, or Japan — would provide a more credible counterfactual; a longer post-period spanning the rise of AI-based contextual advertising would also help separate short-run compliance shocks from the new equilibrium of post-GDPR advertising markets. Heterogeneity by sector (finance, retail, travel) and by pre-period market scale, hinted at in the treatment-intensity tests, also merits further investigation.

To sum up, protecting consumers' data did not make advertising appreciably more expensive at the national-aggregate level, and any cost that did occur was concentrated in larger EU markets and partially obscured in the baseline specification by the inclusion of EU-exposed control countries.

REFERENCES

Aridor, **G.**, **Che**, **Y.-K.**, & **Salz**, **T.** (2023). The effect of privacy regulation on the data industry: Empirical evidence from GDPR. *The RAND Journal of Economics*, *54*(4), 695–730. https://doi.org/10.1111/1756-2171.12455

Baslandze, **S.**, **Greenwood**, **J.**, **Marto**, **R.**, & **Moreira**, **S.** (2023). The expansion of varieties in the new age of advertising. *Review of Economic Dynamics*, *50*, 171–210. https://doi.org/10.1016/j.red.2023.07.008

Chakrabarti, **S.**, & **Arora**, **A. P.** (2007). Drivers of ad spend trends among global marketers. *International Journal of Advertising*, *26*(3), 387–397. https://doi.org/10.1080/02650487.2007.11073020

European Commission. (2021, June). Data protection: Commission adopts adequacy decisions for the UK [Press release IP/21/3183. Legal text: Commission Implementing Decision (EU) 2021/1772, OJ L 149, 30.6.2021, p. 10 (CELEX 32021D1772)]. *European Commission*. Retrieved June 1, 2026, from https://ec.europa.eu/commission/presscorner/detail/en/ip_21_3183

European Parliament and Council of the European Union. (2016). Regulation (EU) 2016/679 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data (general data protection regulation) [OJ L 119, 4.5.2016, pp. 1–88; CELEX 32016R0679]. Retrieved June 1, 2026, from https://eur-lex.europa.eu/eli/reg/2016/679/oj

Garcia, **E. L. M.**, **Vieira**, **V. A.**, & **Rodrigues**, **G. H. M.** (2023). When macroeconomic conditions influence marketing investments [DOI: 10.1590/S0034-759020230306]. *RAE – Revista de Administração de Empresas*, *63*(3), e2022–0380. Retrieved June 1, 2026, from https://periodicos.fgv.br/rae/article/view/89390

Goldberg, **S. G.**, **Johnson**, **G. A.**, & **Shriver**, **S. K.** (2024). Regulating privacy online: An economic evaluation of the GDPR. *American Economic Journal: Economic Policy*, *16*(1), 325–358. https://doi.org/10.1257/pol.20210309

Jenyns, **C.** (2020). Changing tides: The impact of crisis on advertising [First published online 21 August 2020; print issue 178(1), February 2021]. *Media International Australia*, *178*(1), 36–41. https://doi.org/10.1177/1329878X20951996

Johnson, **G. A.**, **Shriver**, **S. K.**, & **Goldberg**, **S. G.** (2023). Privacy and market concentration: Intended and unintended consequences of the GDPR. *Management Science*, *69*(10), 5695–5721. https://doi.org/10.1287/mnsc.2023.4709

Miller, **K. M.**, **Lukic**, **K.**, & **Skiera**, **B.** (2026). The impact of the General Data Protection Regulation (GDPR) on online tracking. *International Journal of Research in Marketing*, *43*(1), 48–70. https://doi.org/10.1016/j.ijresmar.2025.03.002

O'Donovan, **B.**, **Rae**, **D.**, & **Grimes**, **A.** (2000). Determinants of advertising expenditures: Aggregate and cross-media evidence. *International Journal of Advertising*, *19*(3), 317–334. https://doi.org/10.1080/02650487.2000.11104804

Picard, **R. G.** (2001). Effects of recessions on advertising expenditures: An exploratory study of economic downturns in nine developed nations. *Journal of Media Economics*, *14*(1), 1–14. https://doi.org/10.1207/S15327736ME1401_01

Prihatiningsih, **T.**, **Panudju**, **R.**, & **Prasetyo**, **I. J.** (2024). Digital advertising trends and effectiveness in the modern era: A systematic literature review. *Golden Ratio of Marketing and Applied Psychology of Business*, *4*(2), 132–143. https://doi.org/10.52970/grmapb.v4i2.505

Silk, **A. J.**, & **Berndt**, **E. R.** (2020). *Aggregate advertising expenditure in the U.S. economy: What's up? Is it real?* (NBER Working Paper No. 28161). National Bureau of Economic Research. https://doi.org/10.3386/w28161

Utz, **C.**, **Degeling**, **M.**, **Fahl**, **S.**, **Schaub**, **F.**, & **Holz**, **T.** (2019). (Un)informed consent: Studying GDPR consent notices in the field. *Proceedings of the 2019 ACM SIGSAC Conference on Computer and Communications Security*, 973–990. https://doi.org/10.1145/3319535.3354212

Wang, **P.**, **Jiang**, **L.**, & **Yang**, **J.** (2023). The early impact of GDPR compliance on display advertising: The case of an ad publisher [First published online 23 June 2023; print issue 61(1), February 2024]. *Journal of Marketing Research*, *61*(1), 70–91. https://doi.org/10.1177/00222437231171848

Yurtseven, **Ö.**, & **Günalp**, **B.** (2023). A panel data analysis of the determinants of advertising intensity in the Turkish manufacturing sector [DOI: 10.15295/bmij.v11i3.2278]. *Business & Management Studies: An International Journal*, *11*(3), 1026–1037. Retrieved June 1, 2026, from https://unis.cankaya.edu.tr/yayin-detay/2_DpOrE0_90/a-panel-data-analysis-of-the-determinants-of-advertising-intensity-in-the-turkish-manufacturing-sector

APPENDIX

Table A.1: Model 1 (Robust): Basic DiD — Dependent variable: Real Ad Spend (EUR M, 2016 base).

	Coef.	**Std. Err.**	t	**95% CI**
Intercept	1025.4185^{***}	(304.8168)	3.36	[427.9885, 1622.8484]
EU (Treated)	816.6229	(596.7899)	1.37	[-353.0639, 1986.3097]
Post-GDPR	186.1684	(430.3876)	0.43	[-657.3759, 1029.7126]
EU x Post-GDPR (DiD)	303.5695	(862.6989)	0.35	[-1387.2893, 1994.4283]
Observations		138		
R^2		0.0185		
Adj. R^2		-0.0034		
Standard errors		HC1 Robust		

Interpretation: The DiD estimate suggests GDPR is associated with a €303.6M change in real ad spend for EU countries ($p = 0.7249$), which is not statistically significant at conventional levels. The 95% confidence interval is [-1,387.3, 1,994.4].

$^{*}\,p < 0.10$, $^{**}\,p < 0.05$, $^{***}\,p < 0.01$

Table A.2: Model 2 (Robust): DiD in Logs — Dependent variable: $\ln(\text{Ad Spend})$.

	Coef.	**Std. Err.**	t	**95% CI**
Intercept	5.8666^{***}	(0.5436)	10.79	[4.8011, 6.9321]
EU (Treated)	0.4796	(0.6014)	0.80	[-0.6991, 1.6583]
Post-GDPR	0.2961	(0.6548)	0.45	[-0.9872, 1.5794]
EU x Post-GDPR (DiD)	-0.0704	(0.7339)	-0.10	[-1.5088, 1.3679]
Observations		138		
R^2		0.0169		
Adj. R^2		-0.0051		
Standard errors		HC1 Robust		

Interpretation: The DiD estimate suggests GDPR is associated with a -6.8% change in real ad spend for EU countries ($p = 0.9235$), which is not statistically significant at conventional levels. The 95% confidence interval in percentage terms is $[-77.9\%, +292.7\%]$.

$^{*}\,p < 0.10$, $^{**}\,p < 0.05$, $^{***}\,p < 0.01$

Table A.3: Model 3 (Robust): TWFE DiD — Dependent variable: $\ln(\text{Ad Spend})$.

	Coef.	**Std. Err.**	t	**95% CI**
Intercept	6.2710^{***}	(0.0243)	258.17	[6.2234, 6.3186]
EU $\times$ Post-GDPR (DiD)	-0.0398	(0.0412)	-0.97	[-0.1205, 0.0410]
Observations			138	
R^2			0.9988	
Adj. R^2			0.9984	
Country FE			Yes	
Year FE			Yes	
Standard errors			HC1 Robust	

Interpretation: The DiD estimate suggests GDPR is associated with a -3.9% change in real ad spend for EU countries ($p = 0.3341$), which is not statistically significant at conventional levels. The 95% confidence interval in percentage terms is $[-11.4\%, +4.2\%]$.

$^{*}\, p < 0.10$, $^{**}\, p < 0.05$, $^{***}\, p < 0.01$

Table A.4: Model 4 (Robust): Extended TWFE DiD — Dependent variable: $\ln(\text{Ad Spend})$.

	Coef.	**Std. Err.**	t	**95% CI**
Intercept	4.2770^{***}	(0.5513)	7.76	[3.1965, 5.3575]
EU × Post-GDPR (DiD)	-0.0372	(0.0813)	-0.46	[-0.1966, 0.1223]
Real GDP Growth (%)	-0.0080^{**}	(0.0036)	-2.19	[-0.0151, -0.0008]
Real GDP per Capita (USD)	$6.98e-06$	(0.0000)	1.28	[-0.0000, 0.0000]
Internet Usage (%)	0.0037	(0.0032)	1.17	[-0.0025, 0.0099]
Inflation (CPI)	$-4.99e-05$	(0.0001)	-0.61	[-0.0002, 0.0001]
Consumer Confidence	0.0009	(0.0032)	0.27	[-0.0054, 0.0072]
COVID-19 Externality	0.6581^{***}	(0.0718)	9.16	[0.5173, 0.7989]
ln(Gross Op. Surplus, Services)	0.0202	(0.0265)	0.76	[-0.0317, 0.0721]
ln(Turnover per Enterprise)	0.0490	(0.1367)	0.36	[-0.2189, 0.3169]
Observations	92			
R^2	0.9993			
Adj. R^2	0.9989			
Country FE	Yes			
Year FE	Yes			
Standard errors	HC1 Robust			

Interpretation: The DiD estimate suggests GDPR is associated with a -3.6% change in real ad spend for EU countries ($p = 0.6476$), which is not statistically significant at conventional levels. The 95% confidence interval in percentage terms is $[-17.9\%, +13.0\%]$. Compared to Model 3 (-3.9%), the DiD coefficient is stable after the inclusion of macroeconomic and sectoral controls, confirming that the result is not driven by macroeconomic confounders.

$^{*}\,p < 0.10$, $^{**}\,p < 0.05$, $^{***}\,p < 0.01$

Table A.5: Model 5 (Robust): Fully Extended TWFE DiD — Dependent variable: $\ln(\text{Ad Spend})$.

	Coef.	**Std. Err.**	t	**95% CI**
Intercept	-13.4852	(14.8741)	-0.91	[-42.6379, 15.6674]
EU × Post-GDPR (DiD)	-0.0305	(0.0518)	-0.59	[-0.1321, 0.0711]
Real GDP Growth (%)	-0.0122^{***}	(0.0045)	-2.70	[-0.0211, -0.0033]
Real GDP per Capita (USD)	$2.52e-05$	(0.0000)	0.75	[-0.0000, 0.0001]
Real GDP per Capita^2 (USD^2)	$-2.25e-10$	(0.0000)	-1.15	[-0.0000, 0.0000]
Internet Usage (%)	0.0029	(0.0032)	0.92	[-0.0033, 0.0091]
Inflation (CPI)	$-6.78e-05$	(0.0001)	-0.86	[-0.0002, 0.0001]
Consumer Confidence	0.0018	(0.0031)	0.58	[-0.0043, 0.0078]
COVID-19 Externality	-1.8835	(2.1291)	-0.88	[-6.0564, 2.2894]
ln(Gross Op. Surplus, Svc.)	-0.0240	(0.0300)	-0.80	[-0.0829, 0.0348]
ln(Turnover per Enterprise)	-0.1112	(0.1893)	-0.59	[-0.4822, 0.2599]
ln(Real GDP)	0.9919	(0.7481)	1.33	[-0.4744, 2.4581]
ln(Enterprises, Manuf.)	-0.3318	(0.2435)	-1.36	[-0.8090, 0.1454]
Observations		92		
R^2		0.9994		
Adj. R^2		0.9990		
Country FE		Yes		
Year FE		Yes		
Standard errors		HC1 Robust		

Interpretation: The DiD estimate suggests GDPR is associated with a -3.0% change in real ad spend for EU countries ($p = 0.5560$), which is not statistically significant at conventional levels. The 95% confidence interval in percentage terms is $[-12.4\%, +7.4\%]$. The estimate is robust to the additional controls ($\ln$(Real GDP), $\ln$(Enterprises), Real GDP per capita^2), remaining close to Model 4 (-3.6%). Note that the COVID-19 dummy coefficient changes sign between Model 4 ($+0.6581$) and Model 5 (-1.8835), likely reflecting multicollinearity with $\ln$(Real GDP), which absorbs part of the pandemic's economic contraction effect.

$^{*}\ p < 0.10$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$

Table A.6: SE Comparison — DiD Coefficient (EU × Post-GDPR).

	Coef.	**OLS SE**	**OLS** p	**HC1 SE**	**HC1** p
Model 3	-0.0398	0.0283	0.1626	0.0412	0.3341
Model 4	-0.0372	0.0405	0.3625	0.0813	0.6476
Model 5	-0.0305	0.0401	0.4495	0.0518	0.5560

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OTHER PUBLICATIONS, PRESENTATIONS AND PATENTS:

- **Sert, K.** (2022). Platoon Control Algorithm Design on Reservation-Based Intersection Management. *Automatic Control National Meeting (TOK 2022)*, Fırat University, Elazığ, Turkey. (Conference paper)