

Digital trade, data protection and the EU adequacy club

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Abstract

Between 2000 and 2020, the EU granted 14 so-called adequacy decisions, permitting EU citizens' personal data to flow freely between the EU and the respective trading partners, including among the countries accorded adequacy. Most adequacy decisions are unilateral, complementing the more commonly observed and analysed mutual recognition arrangements for technical regulations. Using structural gravity to assess the relationship between EU adequacy decisions and digital trade, and applying different approaches to define digital trade, we find that adequacy increases bilateral digital trade between the EU and the adequate countries by 7–9% compared to non-digital trade. We also provide evidence of a 'club effect,' with digital trade increasing between countries that have been granted adequacy, but only to the extent that the USA is part of the club. Using synthetic control methods, we show that the magnitude of the club effect varies across countries.

KEYWORDS

clubs, data protection, digital trade, recognition, trade costs

JEL CLASSIFICATION

D18; F13; F14; K24; L88; O38

1 | INTRODUCTION

Between 2005 and 2022, exports of digitally delivered services expanded by an average of 8.1% annually, the fastest growing category in global trade (World Trade Organization (WTO) 2023). Such services often utilize personal data at multiple stages of the value chain, including research and development, product design, marketing, and sales. As the extensive use of personal data

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gives rise to privacy concerns (Zuboff 2019), many governments regulate how personal data is used and shared, seeking to balance the promotion of digital trade with the protection of individual privacy. Such regulation may facilitate digital trade by fostering trust in the digital economy, but may also increase trade costs. Much of the extant literature highlights the trade-offs between the free flow of personal data and privacy protection of citizens in the economy (Acquisti *et al.* 2016). Empirical studies have found that more restrictive data policies negatively impact trade in information and communication technology (ICT) goods and digitally deliverable services.¹

The European Union (EU) has been a leader in this area, with its General Data Protection Regulation (GDPR).² In addition to establishing rights for EU citizens and regulating data processing, the GDPR also sets conditions for firms to transfer personal data outside the EU. These conditions include obtaining consent from the data subject or the use of firm-specific contractual mechanisms to ensure data privacy protection in third countries, measures that are generally associated with additional costs for firms.³ To facilitate data transfers to non-EU countries deemed to provide a level of personal data protection equivalent to that of the EU, the European Commission may accord a so-called adequacy decision to a foreign country. An adequacy determination allows companies located in the 'adequate' country to freely transfer EU citizens' personal data to and from the EU, dispensing with the need for costly firm-specific contractual obligations to assure compliance with the GDPR.

Adequacy decisions function akin to recognition arrangements that are commonly used by countries to reduce the trade costs associated with differences in national regulatory standards for health and product safety. Such arrangements may involve unilateral determinations that another jurisdiction's regulatory system is equivalent to the national one, or comprise reciprocal, mutual recognition arrangements.⁴ An adequacy decision not only allows companies to freely transfer data between the EU and the country concerned, but also establishes the right to transfer personal data of EU citizens among all countries accorded adequacy by the EU. This latter dimension creates a potential additional indirect benefit of adequacy: reducing digital trade costs among the 'club' of all jurisdictions granted adequacy.⁵

The adoption of such recognition mechanisms generally relies on the premise that a technical and institutional determination that regulatory regimes are effectively equivalent will lower trade costs. It is important to note that this does not imply that adequacy is endogenous in the sense that countries can self-select into adequacy by deciding to adopt EU-type data protection regimes. Regulatory determinations reflect political as well as legal considerations, such as a desire to offer preferential treatment to political allies. Adequacy decisions have been accorded to only a small subset of the many countries that have adopted national personal data protection frameworks that are broadly aligned with the GDPR. Conversely, they have been granted to the USA, which does not have GDPR-like legislation.⁶

The fact that adequacy is granted selectively raises the question of the magnitude of the direct trade benefits of the associated preferential access to markets that is implied, as well as the potential indirect benefits that accrue due to membership of the club. In this paper, we use structural gravity modelling and synthetic control methods to assess the relationship between EU adequacy decisions and digital trade, distinguishing between EU–US adequacy frameworks and all other adequacy decisions.⁷

We extend previous analyses of the trade effects of personal data protection (Spiezia and Tscheke 2020; Wu *et al.* 2023; Ma *et al.* 2023) by estimating the impact of unilaterally determined EU adequacy decisions on digital trade, controlling for regulatory data agreements and trade agreements that include data privacy provisions that might also influence digital trade outcomes. We identify both a positive bilateral digital trade impact and an adequacy club effect, thereby contributing to the literature assessing the economic effects of discriminatory international cooperation to lower the costs of regulatory heterogeneity. To the best of our knowledge, ours is the first empirical study to examine the digital trade impacts of

GDPR adequacy decisions by focusing on both (i) bilateral digital trade between the EU and partner countries, and (ii) digital trade between countries accorded an EU adequacy decision, that is, the potential club effect associated with recognition of national data protection regulations.

We employ different approaches to define digital trade, using both sectoral classifications of digital trade and data intensity measures that capture the dependence of sectors on data flows. Our baseline methodology builds on a standard structural gravity model to estimate the effect of adequacy decisions on aggregate bilateral digital trade with the EU and on digital trade between jurisdictions accorded adequacy. This is supplemented by a pooled product-level gravity model across all industries and sectors using data intensity measures. Because the bilateral structural gravity framework and set of fixed effects preclude evaluation of the country-specific impact of adequacy on overall digital trade, we complement the gravity-based analysis with a synthetic control approach to assess the heterogeneity of both the bilateral and club effects of adequacy decisions on digital trade.

Our baseline analysis focusing on aggregate digital trade provides evidence for a statistically significant effect of adequacy decisions on digital trade between the EU and the USA as well as between the USA and the club of adequate countries. We do not find any significant increase in aggregate digital trade between the EU and the other countries that received adequacy. Moving beyond the aggregate trade focus to exploit variation across different digital and non-digital sectors in the intensity of use of data using a pooled product-level gravity model, we find a positive effect of adequacy decisions on digital trade between the EU and all adequate countries, with an increase of 7–9% in bilateral digital trade compared to non-digital trade. This model confirms that the club effect is driven by the presence of the USA, with an increase in digital trade of up to 9% between the USA and other adequate countries, despite the bilateral ‘hub and spoke’ nature of adequacy decisions. This dynamic has not previously been analysed in the literature. The synthetic control analysis confirms the presence of a club effect, highlighting the heterogeneous impact across countries and instances where digital trade increases with the club of countries accorded adequacy, excluding the USA.

The paper proceeds as follows. Section 2 provides background information on the EU GDPR and the process involved in obtaining an adequacy decision for personal data protection regimes. Section 3 discusses the gravity model framework that we use to estimate bilateral adequacy and club effects on digital trade, and presents initial findings for aggregate digital trade. Section 4 reports the results of applying a more detailed empirical strategy, pooling across all industries and sectors, and using different measures of data intensity. Section 5 analyses specific instances of adequacy decisions using synthetic control methods. Section 6 concludes.

2 | THE GDPR, ADEQUACY DECISIONS AND DIGITAL TRADE

In 1998, the EU implemented the Data Protection Directive governing the treatment of personal data of citizens from the European Economic Area.⁸ This directive permitted personal data to be freely transferred to third countries if the EU determined that the receiving country provided an adequate level of personal data protection. It was replaced by the GDPR in 2018. The GDPR lays out specific conditions under which personal data can flow to countries in the absence of an adequacy decision.⁹ These conditions entail the use of contractual mechanisms, including binding corporate rules and standard contractual clauses.¹⁰ The former provide a legal basis for transferring data within a multinational company and apply only to intra-firm data transfers; the latter are legal templates defined by the European Commission for transferring data to a firm located outside the EU.

These contractual mechanisms enable companies to certify compliance with EU regulations for transferring personal data abroad. They are costly for firms due to the burdensome approval

procedures involved (Cory *et al.* 2020). The associated costs are both fixed and variable: in addition to fulfilling the contractual arrangements required to use these model documents, firms may need to hire data specialists and specialized consultancy firms for data mapping, management and third-party auditing services. The costs will vary based on the number of countries, the type of data transfer, and the processing activity involved. Thus standard contractual clauses must be drafted every time personal data processing activities change (Chivot and Cory 2020). For binding corporate rules, the Data Protection Authority of the EU Member States where the firm or its subsidiary operates must approve the rules before the transfers take place, and ensure ongoing compliance. The fixed costs of using these legal templates will place a relatively larger burden on small and medium-sized enterprises.¹¹

When an adequacy decision is implemented, companies no longer need to rely on binding corporate rules, standard contractual clauses or other derogations because the regulatory regime in the recipient countries is deemed ‘essentially equivalent’ to that of the EU. The equivalence in the level of data protection refers not only to the substance of the data protection rules, but includes multiple other factors, including respect for the rule of law and human rights, access of public authorities to personal data, and existence and effective functioning of independent supervisory authorities (GDPR, art. 45). In practice, the process for deciding whether to pursue a dialogue on adequacy with a third country is discretionary. The willingness of the EU to engage in adequacy discussions will reflect political considerations, consistent with the theory of discriminatory clubs developed by Davis (2023).¹²

Between 2000 and 2023, the EU granted adequacy 17 times (see Appendix Table A1). In our empirical analysis, we focus on 14 adequacy decisions agreed up to 2020, the last year for which we have trade as well as input–output data to calculate our data intensity measures. Except for the USA, all adequacy decisions require countries to have a comprehensive data privacy protection framework. In an adequacy decision, the European Commission certifies that the data protection regime of the trading partner is essentially equivalent in providing the same level of data protection as in the EU. In the case of the USA, which does not have a comprehensive national data protection regime, adequacy decisions are based on a specific framework agreement governing data flows. As such, the adequacy decisions for the USA certify the equivalence of the specific framework and not the data protection regime in the USA. A consequence is that adequacy status is granted only to companies that self-certify compliance with specific requirements that ensure that personal data protection meets EU standards.

The first EU–US framework agreement for personal data flows was the Safe Harbour Privacy Principles, signed in 2000. This permitted US companies to voluntarily comply with seven basic privacy principles and several associated requirements. Any US business or organization subject to regulation by the Federal Trade Commission that self-certified compliance could apply to participate. Over 4500 US companies relied on this mechanism to transfer EU citizens’ personal data between the EU and the USA. In 2015, the Court of Justice of the European Union (CJEU) invalidated the agreement, following a complaint brought by privacy activist Max Schrems against Facebook.¹³ The Court ruled that Safe Harbour did not sufficiently limit the potential for US authorities to access EU citizens’ personal data, and therefore did not guarantee the protection of the fundamental right to privacy. Companies utilizing the framework were given a grace period of four months to revert to alternative mechanisms (i.e. individual contract-specific measures) for data transfers whilst the EU and USA negotiated a new agreement. In 2016, a substantially more detailed Privacy Shield framework was agreed. This clarified responsibility for compliance with EU data protection standards, and included assurances from the US authorities regarding the treatment of complaints and redress possibilities. Over 5300 companies signed up to the Privacy Shield framework. In 2020, the framework was invalidated by a second ruling of the CJEU.¹⁴ To address the ruling, in 2023 the Commission replaced Privacy Shield with the EU–US Data Privacy Framework (DPF) (European Commission 2023).

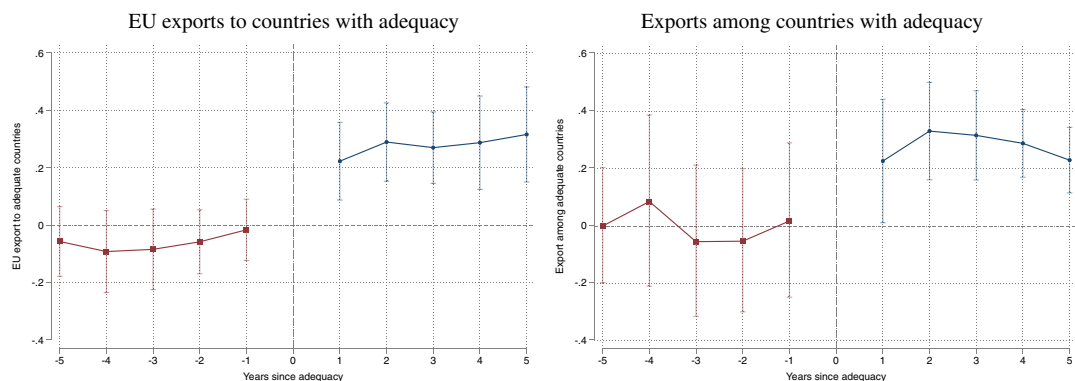


FIGURE 1 Event study of bilateral digital trade among countries with adequacy. *Notes:* The plots report the point estimates of a simple event study regression taking the form: $X_{ijt} = \alpha + \sum_{l=1}^5 \beta_w \text{Lag}_{w+l} + \sum_{l=1}^5 \beta_k \text{Lead}_k + \beta' \text{GRA}_{ijt} + \alpha_i + \gamma_j + \lambda_t + \varepsilon_{ijt}$, where X_{ijt} are digital trade exports, GRA_{ijt} are standard gravity controls, α_i , γ_j and λ_t are exporter, importer and time fixed effects, respectively, and ε_{ijt} is an error term. Definitions of these variables are discussed in Section 3. The left-hand panel plots point estimates for digital trade between EU members and all partner countries with an adequacy decision. The right-hand panel plots estimates for digital trade between countries with EU adequacy. *Source:* OECD TiVA database.

2.1 | Exploratory analysis

A basic event study estimating the impact of the 14 EU adequacy decisions implemented up to 2020 on bilateral digital trade provides the initial motivation for our empirical analysis. Digital trade in this exercise spans digital services (audiovisual, telecommunications and IT services) and associated ICT goods and equipment. Figure 1 plots the five-year period preceding and following an adequacy decision, set at $t = 0$, for digital trade between the EU and adequacy-granted partner countries (left-hand panel) and between partner countries that have an adequacy decision (right-hand panel). The latter captures what we call the ‘club effect’ of EU adequacy decisions.

Prior to an adequacy decision, both panels of Figure 1 show no significant difference in digital trade compared to countries that did not receive adequacy during the sample period. A positive gap emerges following an adequacy decision, with coefficient estimates that are statistically significant at the 1% level in the second and subsequent years following the adequacy decision.¹⁵ The event study estimates plotted in the right-hand panel are suggestive of a club effect associated with decisions enabling the onward transfer of EU personal data among the set of countries with an adequacy decision.

3 | GRAVITY-BASED ANALYSIS OF ADEQUACY

The gravity model is a widely used empirical framework to assess the determinants of bilateral trade flows, including policy variables (Head and Mayer 2014).¹⁶ In our case, the policy of interest is an EU adequacy decision, which is expected to reduce bilateral trade costs. Trade costs τ_{ijk} comprise two elements:

$$\tau_{ijkt} = T_{ijkt}(1 + t_{ijkt}), \quad (1)$$

where T_{ijk} are the (iceberg) transfer costs incurred by firms in origin country i when exporting to destination country j in digital sectors k and year t , and t_{ijk} denotes the *ad valorem* tariff on imports of ICT goods applied by destination country j from origin i . These may vary over time,

reflecting, for example, changes in policies. Since tariffs do not apply to digital services, and most ICT goods covered by our definition of digital trade have zero import duties due to the WTO International Technology Agreement (ITAs), in our empirical analysis we focus on T_{ijkt} , the transaction costs that firms in origin country i incur when exporting to destination country j .¹⁷ These will be determined by standard gravity variables such as bilateral distance, participation in trade agreements or shared language, as well as policy frictions, including differences in regulatory regimes that increase the marginal cost for a firm trading across borders. In our setting, such costs include the need for individual contract-specific measures to safeguard data privacy each time a firm engages in cross-border data transfers with the EU.¹⁸ Therefore T_{ijkt} will incorporate the effects of cross-border data frameworks that remove the need for firms to incur such costs, attenuating policy frictions between country pairs i and j for trade in digital sectors k .¹⁹

3.1 | Empirical specification

Our baseline empirical gravity equation is derived directly from Anderson *et al.* (2018) and takes the form

$$X_{ijt}^{dig} = \exp(\tau_{ijt}\varphi + \alpha_{it} + \gamma_{jt} + \delta_{ij})e_{ijt}, \quad (2)$$

where $X_{ijt}^{dig} = \sum_{k=1}^d X_{ijk}$, the aggregate digital trade between country i and country j , with the superscript *dig* denoting one of the two definitions of digital trade described in Subsection 3.2, summing over sectors k for year t . The term τ_{ijt} is a vector that captures all observable trade costs relevant for digital trade as described above, with φ being the associated vector of coefficients. The terms α_{it} , γ_{jt} and δ_{ij} correspond to exporter, importer and bilateral fixed effects; e_{ijt} is the error term.²⁰

As is standard in the gravity literature (i.e. Santos Silva and Tenreiro 2006; Woolridge, 2023), we use Poisson pseudo maximum likelihood (PPML) to estimate equation (2) as follows:

$$X_{ijt}^{dig} = \exp\{\beta ADQ_{ijt} + \phi GRA_{ijt} + \alpha_{it} + \gamma_{jt} + \delta_{ij}\} + \varepsilon_{ijt}, \quad (3)$$

where ADQ_{ijt} captures the existence of bilateral adequacy decisions between EU members and partner countries, and GRA_{ijt} refers to all other elements of τ_{ijkt} , reflecting all standard dyadic time-varying covariates typically used in gravity models (discussed further in Subsection 3.2). Equation (3) includes the three sets of fixed effects. Given the difference between the Safe Harbour and Privacy Shield frameworks for the USA and other adequacy decisions, in most of the analysis we split the term ADQ_{ijt} into two components. One captures whether the EU has granted adequacy to any country other than the USA. We label this as ‘regular’ adequacy decisions ($RADQ_{ijt}$). The second component captures whether the Safe Harbour/Privacy Shield (SH/PS) frameworks between the EU and the USA were in place (SH/PS_{ijt}). Both terms are represented as a dummy variable that assumes value 1 in every period following the determination of adequacy for the partner country.

3.1.1 | Club effect

The potential effects of adequacy decisions are not limited to digital trade between the EU and the partner countries granted adequacy. Because the European Commission permits onward transfers of EU citizens’ personal data to any country accorded adequacy, this potentially reduces bilateral trade costs among members of the ‘adequacy club’. We therefore distinguish between the direct effect of an adequacy decision on trade between the EU and an adequacy receiving

country (ADQ_{ijt}) and the potential indirect ‘club effect’ of adequacy (CLB_{ijt}) that may enhance bilateral digital trade between country pairs that have been accorded adequacy decisions. The CLB_{ijt} parameter therefore captures whether and to what extent adequacy induces an additional bilateral trade cost reduction within the club of adequacy countries.

To explore the potential club effect, we modify equation (3) as.

$$X_{ijt}^{dig} = \exp \{ \beta ADQ_{ijt} + \lambda CLB_{ijt} + \phi GRA_{ijt} + \alpha_{it} + \gamma_{jt} + \delta_{ij} \} + \varepsilon_{ijt}, \quad (4)$$

where ADQ_{ijt} is a dummy variable equal to 1 starting in the year when the EU accords adequacy to a partner country, and CLB_{ijt} is a dummy variable equal to 1 in year t when countries i and j both have adequacy status. In doing so, we again distinguish between regular adequacy decisions (ADQ_{ijt}^{club}) and the specific adequacy frameworks with the USA (SH/PS_{ijt}^{club}).²¹ If an adequacy decision sufficiently lowers policy frictions between third countries that have been granted adequacy, reducing trade costs, then we expect a positive coefficient estimate for this club term. The vector GRA_{ijt} and the three sets of fixed effects are the same as in equation (3).

3.2 | Dependent and explanatory variables

3.2.1 | Defining digital trade

The dependent variable X_{ijt}^{dig} measures digital trade. Given that there is no commonly accepted definition of digital trade, we need to select sectors that qualify as digital and that rely on cross-border data transfers. To determine this, we draw on information provided by firms under the EU–US cross-border data transfer frameworks. To be able to utilize these frameworks, the US Department of Commerce requires participating firms to report their sector of activity and to justify why they want to use the data transfer agreement. A text analysis algorithm applied to the purpose descriptions under the 2023 EU–US DPF reveals that words such as ‘goods’, ‘devices’, ‘electronics’ and ‘equipment’ are mentioned by almost half of the companies that have self-certified their compliance with the framework.²² Appendix Table A2 lists the top 10 sectors represented by firms participating in this arrangement, accounting for about 95% of all registered firms. Companies active in ICT services, and business and professional services, frequently mention ICT goods in their purpose descriptions. Firms in industries such as education technology, biopharmaceuticals and computer-aided activities also subscribe extensively to the framework. This mix of sectors indicates complementarity between ICT products and firms providing digital services and engaging in cross-border data flows.²³

We use two sectoral definitions of digital trade in our empirical analysis. The first comprises what the OECD (2023) classifies as core digital sectors. This narrow definition of digital trade includes ICT goods needed to provide digital services, and spans publishing, audiovisual and broadcasting, telecommunications, information technology services, and computer, electronic and optical equipment. A second broader definition adds other digitally deliverable services, such as business, financial, health and education services, following the approach suggested in the *Handbook on Measuring Digital Trade* (IMF *et al.* 2023), and several sectors that rely on personal data transfers and thus may be affected by cost frictions related to data protection regulations.²⁴ For example, the pharmaceutical sector, while not digital, relies on data transfers for medical research and clinical trials, and as such is affected by the GDPR (Bentzen *et al.* 2023). The biopharmaceutical sector is one of the top sectors participating in the 2023 EU–US Data Protection Framework (see Appendix Table A2). We therefore include this sector in our broader definition of digital trade. Appendix Table A5 provides a list of the 2-digit ISIC sectors that are included in the narrow and broad definitions of digital trade.

In both cases, the associated bilateral gross trade values for the included sectors are sourced from the OECD Trade in Value-Added (TiVA) dataset.²⁵ An advantage of using TiVA is that data for trade in goods and services are reported in a consistent manner from 1995 to 2020 for the ISIC Rev. 4 sectoral classification, well before the EU started to grant adequacy in 2000.²⁶ As the database records trade data in squared balanced format across exports and imports, results are similar for both types of flows. We choose to use exports.

In the pooled gravity regressions reported in what follows, we complement these sectoral definitions of digital trade with a measure that captures the intensity of use of data across all sectors $k = 1, \dots, K$, to consider the possibility that non-digital industries may also be affected by adequacy agreements that reduce the cost of cross-border personal data flows.

3.2.2 | Explanatory variables

Given the stringent set of fixed effects, we need to control only for dyadic covariates that vary by country pairs over time. We incorporate a dummy variable capturing whether countries in a dyad are members of a preferential trade agreement (PTA) during our sample period, and another dummy variable indicating whether partner countries are WTO members, sourced from Egger and Larch (2008) and Gurevich and Herman (2018), respectively.²⁷ We refine the PTA variable to include only agreements with binding provisions on data protection contained in an e-commerce chapter ($PTA - DP$).²⁸ Not controlling for PTAs with such provisions could bias our adequacy estimates upwards, given potential overlap of partner countries that have both a PTA with data protection provisions and adequacy. Moreover, our adjusted PTA variable is likely to better capture the effect on digital trade given the focus on activities that rely on data protection, that is, digital trade sectors. We use data from the (Burri and Polanco 2020) Trade Agreements Provisions on Electronic-commerce and Data database, which records all types of binding and non-binding digital provisions in PTAs. We check all PTAs in this dataset, and cross-reference them with the Egger and Larch (2008) database. If they match, then we create a PTA variable indicating whether it contains legally binding data protection provisions in a specific e-commerce chapter.

Additionally, we include several data-related dyadic controls. First, we have a variable capturing whether a country is subject to the 1995 EU Data Protection Directive 95/46/EC. As discussed above, this precursor to the GDPR mandates the protection of citizens when transferring and processing personal data.²⁹ Second, we consider membership in the 1981 Council of Europe Convention for the Protection of Individuals regarding Automatic Processing of Personal Data. This agreement safeguards individuals' right to privacy, and sets certain limits and exceptions for cross-border data flows among signatory countries. A third control is whether a country adheres to the APEC Cross-Border Privacy Rules system, an agreement involving Canada, Japan, Mexico, Korea, Singapore and the USA that addresses cross-border data flows.³⁰ Finally, we control for EU membership given that adequacy decisions are issued by the EU and apply to all EU members.³¹

The three sets of fixed effects α_{it} , γ_{jt} and δ_{ij} control for exporter–year, importer–year and bilateral specific shocks, respectively. Other standard gravity variables, such as distance, are collinear with this set of fixed effects, and are therefore dropped from our regressions. Appendix Tables A3 and A4 provide details on these variables and their sources. Standard errors are clustered by country pair and time, following Egger and Tarlea (2015). In addition, to control for the likelihood that adequacy decisions between country pairs are signed when cross-border data flows are trending upwards, we also add a linear country-pair-specific time trend. This captures any common linear trend specific to a given country pair due to other digital integration factors, such as cross-border data flows in our case. By controlling for this trend, the identification comes solely from above average changes in bilateral digital trade during the sample period relative to countries

TABLE 1 Baseline results, exports.

	EXP (1)	EXP (2)	EXP (3)	EXP (4)	EXP (5)	EXP (6)	EXP (7)
ADQ_{ijt}	0.048* (0.055)	0.054** (0.043)					
ADQ_{ijt}^{club}		0.062** (0.018)					
$RADQ_{ijt}$			0.002 (0.959)	0.001 (0.985)	0.024 (0.471)	0.023 (0.501)	0.002 (0.973)
SH/PS_{ijt}			0.070** (0.036)	0.070** (0.037)	0.078** (0.023)	0.078** (0.024)	0.096** (0.010)
$RADQ_{ijt}^{club}$				−0.044 (0.473)		−0.039 (0.546)	0.026 (0.605)
SH/PS_{ijt}^{club}					0.081*** (0.001)	0.080*** (0.001)	0.071** (0.014)
Digital trade definition	Narrow	Narrow	Narrow	Narrow	Narrow	Narrow	Broad
All controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	143,901	143,901	143,901	143,901	143,901	143,901	146,751
R ²	0.80	0.80	0.80	0.80	0.80	0.80	0.82
Fixed effects pair	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects export–year	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects import–year	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Trend effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Two-way cluster	Pair & Year	Pair & Year	Pair & Year	Pair & Year	Pair & Year	Pair & Year	Pair & Year

Notes: Dependent variable: digital exports (EXP). Numbers in parentheses are *p*-values.

*, **, *** indicate 10%, 5%, 1% significance levels, respectively.

without adequacy. The inclusion of these time trends further mitigates the potential endogeneity of adequacy decisions.

The inclusion of country, time and pair fixed effects, along with the pair trend effects, removes much of the variation in the data, raising the bar for finding statistically significant relationships between digital trade and adequacy decisions. In principle, assuming that GRA_{ijt} , together with the set of fixed effects, accounts for all data regulation-related time-varying trade frictions, the estimated coefficients can be recovered without bias.

3.3 | Baseline results

Table 1 presents the results of PPML estimation of equations (3) and (4) for both the narrow (columns (1)–(6)) and broader (column (7)) definitions of digital trade. Only the results for the adequacy variables are presented. The control variables for each column are reported in Appendix Table A7. The results in Table 1 distinguish between regular adequacy decisions granted to non-US partner countries ($RADQ_{ijt}$), and those pertaining to the USA (SH/PS_{ijt}). Columns (1) and (2) first report results for the narrow definition of digital trade for all adequacy decisions taken together, that is, without distinguishing between regular decisions and those for the USA. Results indicate a statistically significant relationship between adequacy and bilateral digital trade between the EU and countries with adequacy, and between countries with

adequacy, that is, a positive club effect. Given the differences between regular adequacy decisions and the frameworks put in place for personal data flows between the EU and the USA, in the remainder of this paper we focus on results that differentiate between the two types of frameworks.

Using the narrow definition of digital trade, we find a significant effect for the transatlantic data agreements, but not for regular adequacy decisions; see column (3) of Table 1.³² Columns (4) and (5) consider the potential club effect of adequacy decisions, again distinguishing between the Safe Harbour/Privacy Shield frameworks for the USA and regular adequacy agreements. Column (4) captures the club effect among adequate countries excluding the USA, while column (5) considers the potential club effect among all countries with adequacy. There is no relationship between regular adequacy decisions and digital trade among adequate countries. Conversely, there is a positive association between EU–US adequacy arrangements and digital trade among the club of adequate countries, with coefficient estimates that are significant at the 1% level. Column (6) includes all variables. The EU–US framework agreements remain positive and significant for both the direct and club effects, whereas coefficient estimates for the other adequacy decisions remain statistically insignificant. Column (7) replicates the analysis using the broad definition of digital trade, and the results remain similar.

Arguably, the adequacy variables may correlate with our PTA control variable. Although adequacy decisions are developed independently from trade agreements, in practice the benefits of a PTA might partly depend on whether adequacy has been granted or on other political economy considerations. This is particularly relevant because our regressions include PTAs with data protection provisions. As reported in Appendix Table A7, the PTA control variable is not significant. Applying a lead of 2 years, and lags of 2 as well as 1 and 3 years for the PTA variable, does not affect the significance of the coefficient estimates for the adequacy variables.³³

4 | POOLING ACROSS ALL INDUSTRIES

The results in Table 1 suggest that digital trade is positively associated with adequacy decisions that involve the USA. These findings are premised on identifying the effect of adequacy on aggregate digital trade using the time variation in adequacy status across countries. Specifically, this identifies the effect of adequacy agreements based on deviation from a pair-specific linear trend. This approach has been extensively applied in the empirical trade literature, and we report it to facilitate direct comparison with prior empirical works. However, insofar as changes in trade costs, prices and demand are product- or sector-specific, our estimates may conceal substantial heterogeneity. Moreover, as already mentioned, a range of industries and sectors beyond those that we characterize as digital may rely on cross-border data transfers.

To address this possibility, we follow French and Zylkin (2024) and extend the gravity analysis by pooling across all industries. In doing so, we correct for potential aggregation bias among the treated sectors, and control for any bilateral time-variant unobserved factors that influence bilateral digital trade using fixed effects. At the same time, pooling across sectors enables us to exploit not only the variation over time in adequacy status, but also the variation in digital trade induced by adequacy decisions across all sectors and industries. The approach is akin to estimating an average treatment effect (ATE) on a sector-by-sector basis as opposed to estimating an average treatment effect on the treated sectors (ATT), as we did before.³⁴

We re-estimate the effects of adequacy and associated potential club effects by modifying equation (4) to interact the ADQ_{ijt} and CLB_{ijt} dummy variables with sector-weighted proxies of data intensity I_k ³⁵:

$$X_{ijkt} = \exp \left\{ \beta ADQ_{ijt} * I_k + \lambda CLB_{ijt} * I_k + \alpha_{ikt} + \gamma_{jkt} + \delta_{ijt} + \psi_{ijk} \right\} + \varepsilon_{ijkt}, \quad (5)$$

where X_{ijkt} represents exports of goods and services belonging to sector k between origin country i and destination country j in year t , where $k = 1, \dots, d, \dots, K$ spans all industries, that is, both digital and non-digital. The terms α_{ikt} and γ_{jkt} correspond to exporter–sector–time and importer–sector–time fixed effects, respectively, each incorporating the sector-level dimension, while δ_{ijt} and ψ_{ijk} correspond to exporter–importer–time and exporter–importer–sector fixed effects. The term δ_{ijt} controls for all standard gravity controls and therefore replaces the vector GRA_{ijt} used in the aggregate gravity regressions. It also captures the linear country-pair-specific time trends. All regressions again apply two-way clustering by country pair and year.

To define the term I_k , we define two dummy variables following the narrow and broad definitions of digital trade as reported in Appendix Table A5. This is equivalent to assigning a weight equal to 1 to digital sectors only, those that should benefit most from adequacy. In Subsection 4.2, we augment this strategy with several continuous measures reflecting the dependence on data across all sectors, that is, both digital and non-digital.

The rationale for interacting the adequacy and club variables with a measure of data intensity is to capture how different sectors respond to adequacy decisions based on how much they are potentially affected by data-related cost frictions, something our baseline aggregate gravity estimates cannot capture. The pooled specification assumes pair-specific parallel trends in digital and non-digital industries, and identifies the effect of adequacy decisions based on deviation from pair-specific industry trends. By applying industry-level fixed effects, this specification controls for any time-varying industry-specific heterogeneity. The difference between the two approaches is that the aggregate specification measures the effect of adequacy within country pairs for the treated sectors themselves, compared to those that have no adequacy, whereas the pooled specification measures the effects of adequacy on the basis of differences across sectors within each country-pair–industry combination, with digital sectors experiencing different trade growth compared to non-digital sectors.

4.1 | Pooled gravity estimates

We first estimate equation (5) using dummy variables for the narrow and broad definitions of digital trade as interaction terms. These estimates differ from our baseline aggregate gravity results because we now include the full set of industries while controlling for all time-varying pair-specific factors at the sector level by including the appropriate set of fixed effects. The inclusion of all sectors implies that identification comes from within pair–time–product variation in trade flows, rather than pair–time variation only. Thus the estimation assesses how exports in digital sectors are affected because of adequacy relative to non-digital sectors.

Table 2 reports the results. When using the narrow definition of digital trade, regular adequacy decisions are statistically significant in all specifications (columns (1)–(4)). The EU–US framework agreements are significant only at the 10% level. The significance of the regular adequacy decisions becomes stronger, however, when including the club variables (columns (3) and (4)). Estimates for the SH/PS club effect are positive and statistically significant at the 5% level. As in the aggregate analysis, estimates of the club effect for regular adequacy decisions remain insignificant. Moreover, we no longer find any significant relationship between adequacy and our broad definition of digital trade (column (5)), supporting the presumption that adequacy should matter more for digital activities. Table 2 also reports estimates of the effects of trade agreements with binding provisions on data protection, which are found to be strongly associated with digital trade flows.

While the aggregate results in Table 1 highlight the significance of the EU–US adequacy framework for digital trade, the pooled gravity regression results suggest that although the club effect remains significant, its coefficient is estimated less precisely than in the aggregate specification. Conversely, the coefficient estimates for regular adequacy decisions become statistically

TABLE 2 Pooled gravity estimates.

	EXP (1)	EXP (2)	EXP (3)	EXP (4)	EXP (5)
$RADQ_{ijt} * I_k$	0.059* (0.096)	0.059* (0.078)	0.081** (0.034)	0.083** (0.025)	0.030 (0.317)
$SH/PS_{ijt} * I_k$	0.069* (0.095)	0.069* (0.094)	0.080* (0.066)	0.081* (0.066)	-0.010 (0.657)
$RADQ_{ijt}^{club} * I_k$		0.009 (0.909)		0.031 (0.700)	-0.022 (0.684)
$SH/PS_{ijt}^{club} * I_k$			0.084** (0.020)	0.085** (0.019)	0.069* (0.090)
$PTA - DP * I_k$	0.329*** (0.000)	0.329*** (0.000)	0.328*** (0.000)	0.328*** (0.000)	0.285*** (0.000)
Digital trade dummy	Narrow	Narrow	Narrow	Narrow	Broad
Controls	Subsumed	Subsumed	Subsumed	Subsumed	Subsumed
Observations	4,911,529	4,911,529	4,911,529	4,911,529	4,911,529
R ²	0.71	0.71	0.71	0.71	0.71
Fixed effects pair-year	Yes	Yes	Yes	Yes	Yes
Fixed effects pair-industry	Yes	Yes	Yes	Yes	Yes
Fixed effects exports-industry-year	Yes	Yes	Yes	Yes	Yes
Fixed effects imports-industry-year	Yes	Yes	Yes	Yes	Yes
Two-way cluster	Pair & Year	Pair & Year	Pair & Year	Pair & Year	Pair & Year

Notes: Numbers in parentheses are *p*-values. The dummy I_k is an indicator that takes value 1 if industry k is included in the definition of digital industries as per Appendix Table A.5.

*, **, *** indicate 10%, 5%, 1% significance levels, respectively.

significant. These two results do not necessarily contradict each other, because they are not directly comparable due to differences in their reference units, as explained above. The baseline results measure the increase in the aggregate volume of trade for the selected digital trade sectors (i.e. the treated units), whereas the pooled gravity model exploits sectoral variation across all sectors. As such, the latter comprises a different sample, including both digital and non-digital sectors. This distinction also matters for the interpretation of the pooled results. Specifically, the significance of the adequacy variables indicates that trade in sectors classified as digital expands more, on average, than trade in non-digital sectors in response to adequacy. In Table 1, no such distinction between the two groups is made for the outcome variable.

4.2 | Robustness: data-intensity-based measures of digital trade

To assess the robustness of our results using sectoral definitions of digital trade, we construct three different continuous data intensity measures. The first measure is based on firm-level information associated with participation in the EU–US Data Protection Framework. As discussed, the US Department of Commerce maintains a list of self-certified companies that includes data on each company's primary sector of activity. Using web scraping, we retrieved data on all 2675 companies certified under this framework, including their primary and subsector activities, as well as the stated purpose for which firms use the adequacy agreement. We use this information to create an indicator of data intensity based on the share of listed firms in each sector.³⁶

Two other data intensity measures are derived from national input–output tables provided by the OECD for 1995–2020. These are based on the 2-digit International Standard Industrial Classification (ISIC) (Revision 4), which aligns with our trade data and defines data intensity in terms of usage of upstream digital services and goods by firms operating in a given downstream sector.³⁷ The first measure, domestic input elasticities of digital sectors, refers to the input–output coefficients of digital inputs sourced domestically. The second measure, cross-border input elasticities, refers to the input–output coefficients of imported digital inputs. The rationale for these two measures is that even non-digital downstream sectors might be affected by an adequacy decision due to their digital input usage, which we expect to be a good proxy of data intensity.

To compute these data intensity measures, consistent with our narrow definition of digital trade (see Appendix Table A5), we select the digital sectors that sell to other downstream sectors in the economy: Computer, Electronic and Optical Equipment (ISIC D26), Publishing, Audio-Visual and Broadcasting (ISIC D58T60), Telecom (ISIC D61), and Information Technology and Other Information Services (ISIC D62T63). For each downstream sector, we calculate the proportion of inputs from these digital sectors relative to the sector's total input usage (total intermediate consumption at purchasers' prices). Since the OECD provides values for inputs sourced from a country's domestic market as well as imported inputs, we can compute the coefficients for both sets of inputs, which sum to the total value of digital inputs used by each downstream sector.³⁸

Our preferred measure is the import input elasticity, which is consistent with the input–output coefficient used in Frey and Presidente (2024). However, as this data intensity measure may suffer from endogeneity because trade is our dependent variable, we also use domestic input elasticities as an additional robustness check. To further reduce endogeneity concerns, we compute the average across all countries covered in the input–output tables for the year 2006, approximately the midpoint of our period. Appendix Table A6 presents the summary statistics for all three digital intensity measures. Appendix Figure A1 shows that they are strongly correlated.

Table 3 reports results from estimating equation (5) on bilateral trade for all sectors, where I_k is now one of the three continuous digital intensity measures. Results are in line with those reported in Table 2. When using the sectoral share of firms registered under the EU–US data framework to identify data-intensive sectors, we obtain significant results for both regular adequacy decisions and the club effect for the EU–US agreements (column (1)). In our preferred specification, using cross-border input elasticities (column (2)), we obtain similar results. When using domestic input elasticities, the result for regular adequacy decisions is highly significant, whereas the results for the SH/PS data frameworks become significant, with the club effect increasing in magnitude as well as significance (column (3)). The $PTA - DP$ control variable is again positive, large and statistically significant at the 1% level in all columns.

We implement two additional robustness checks. First, following Cheng and Wall (2005), Baier and Bergstrand (2007) and Bergstrand *et al.* (2015), we re-estimate equation (5) using 3-year intervals with our preferred cross-border input elasticity measure. The results, reported in column (4) of Table 3, show that the coefficients remain significant for the regular adequacy decisions as well as for the club effect of the two EU–US data frameworks. Second, to address any remaining concerns about identification, we also apply leads of all our independent variables. This serves as a type of placebo test for a potential implicit parallel trend assumption in cases where we find statistically significant coefficient estimates, and also allows us to examine if there are anticipation effects present in a country being granted adequacy. Consistent with empirical gravity research (e.g. Larch *et al.* 2019; Yotov *et al.* 2016), we apply a 4-year lead using cross-border input elasticities. The results, reported in column (5), show that the main results hold whereas the lead effects remain largely insignificant, except for *SH/PS*, which is negative and significant.³⁹

TABLE 3 Results of pooled gravity regressions using data intensity measures.

	EXP	EXP	EXP	EXP	EXP
	(1)	(2)	(3)	Interval	Placebo
	(1)	(2)	(3)	(4)	(5)
$RADQ_{ijt} * DI_k$	0.172** (0.045)	0.358** (0.019)	0.767*** (0.003)	0.695*** (0.003)	0.797*** (0.002)
$SH/PS_{ijt} * DI_k$	0.137 (0.133)	0.263 (0.159)	0.922** (0.031)	0.366 (0.496)	0.973*** (0.010)
$RADQ_{ijt}^{club} * DI_k$	0.041 (0.820)	0.165 (0.566)	0.552 (0.130)	0.152 (0.704)	0.482 (0.182)
$SH/PS_{ijt}^{club} * DI_k$	0.216** (0.022)	0.396* (0.057)	0.657** (0.024)	0.913* (0.050)	0.721*** (0.007)
$PTA - DP * DI_k$	0.749*** (0.000)	1.607*** (0.000)	1.972*** (0.000)	2.018*** (0.002)	1.929*** (0.000)
$RADQ_{ijt} * DI_k(t + 4)$					0.141 (0.506)
$SH/PS_{ijt} * DI_k(t + 4)$					-1.136*** (0.000)
$RADQ_{ijt}^{club} * DI_k(t + 4)$					0.310 (0.503)
$SH/PS_{ijt}^{club} * DI_k(t + 4)$					0.105 (0.654)
Digital variable	DPF	I/O imports	I/O domestic	I/O imports	I/O imports
Controls	Subsumed	Subsumed	Subsumed	Subsumed	Subsumed
Observations	4,581,963	4,911,529	4,911,529	1,272,015	4,911,529
R ²	0.71	0.71	0.71	0.71	0.71
Fixed effects pair-year	Yes	Yes	Yes	Yes	Yes
Fixed effects pair-industry	Yes	Yes	Yes	Yes	Yes
Fixed effects exports-industry-year	Yes	Yes	Yes	Yes	Yes
Fixed effects imports-industry-year	Yes	Yes	Yes	Yes	Yes
Two-way cluster	Pair & Year	Pair & Year	Pair & Year	Pair & Year	Pair & Year

Notes: Numbers in parentheses are *p*-values. All adequacy variables are interacted with DI_k , which refers to the measure of digital intensity used in each interaction term, respectively: (1) DPF; (2) I/O imports, i.e. I/O coefficients of imported digital inputs; (3) I/O domestic, i.e. I/O coefficients for digital inputs sourced domestically.

*, **, *** indicate 10%, 5%, 1% significance levels, respectively.

Overall, using the most conservative estimates from our narrow digital dummy variable in Table 2 (column (4))—which arguably provides the strongest empirical approach—the results suggest that regular adequacy decisions increase digital trade by about 7–9% relative to non-digital trade, whereas the two EU–US framework agreements increase digital trade by around 8%, computed as $\exp(\beta \text{RADQ}/(\text{SH}/\text{PS})) - 1$. Considering the club effect associated with the two transatlantic data agreements, countries within the adequacy club experience a digital trade increase of around 9%. The first estimate pertains to trade between the EU and countries granted adequacy status, while the second applies to trade among the adequate countries themselves. These findings apply only to the pooled estimates, and must be benchmarked against non-digital trade. In the aggregate estimates, regular adequacy decisions have no significant effect; adequacy impacts trade only under the two EU–US data flow agreements.

5 | SYNTHETIC CONTROL ANALYSIS

The relationship between adequacy decisions and digital trade is likely to be influenced by country characteristics. A gravity model approach is not well suited for identifying idiosyncratic effects of adequacy on a country's digital trade. To consider the potential role of country-specific factors, we turn to a synthetic control approach. Synthetic control methods involve comparing the performance of a country granted adequacy with that of a synthetically constructed counterfactual unit, which approximates how the country obtaining adequacy would have performed had it never received adequacy status. Pre-adequacy differences between a country receiving adequacy and a constructed counterfactual are minimized by aggregating the pool of potential untreated control units, based on their individual performance with respect to both the outcome of interest (digital trade) and the variables used for matching purposes (Abadie *et al.* 2015). Provided that a set of pseudo-identifying assumptions hold, the difference between the treated and the synthetic control in the post-adequacy period can be attributed to being granted adequacy.⁴⁰

Our objective here is twofold: first, to assess whether the effects of adequacy decisions are homogeneous irrespectively of the country that benefits from such decisions; second, if the response is heterogeneous, to understand the pattern of responses. We consider three distinct adequacy decisions, for Argentina, Israel and New Zealand. The motivation for focusing on these three countries is that they obtained adequacy at different points in time (2003, 2011 and 2013, respectively) and are located in different parts of the world. Their geographic dispersion may drive idiosyncratic responses to an adequacy decision, associated with a country's integration into different regional digital markets. Each of the three countries also has distinct features as regards digital trade. Argentina, a middle-income country, saw digital exports expand substantially during the period of analysis.⁴¹ Argentina is also the only Latin American Spanish-speaking country with EU adequacy in our sample, and it is located in the same time zone as the USA.⁴² Israel differs from the other countries because of its relatively close geographic proximity to the EU, strong comparative advantage in ICT/high-tech industries that rely on cross-border data flows, and deep economic ties with the USA. Finally, New Zealand is English-speaking, is among the most geographically remote countries, located in a time zone many hours ahead of/behind the EU and USA, the two largest digital services traders (WTO 2023), and has strong historical connections to Europe.⁴³ New Zealand's remoteness from the EU and all other countries accorded EU adequacy is salient in evaluating whether adequacy is indeed effective in promoting digital trade, and creates a club effect with other adequate partners, notwithstanding its remoteness compared to other adequate countries.

5.1 | Methodology

Following Hollingsworth and Wing (2022), we use a matching algorithm that relies on the least absolute shrinkage and selection operator (Lasso) for the selection of the optimal mix of matching variables and pre-adequacy lags for the dependent variable. The synthetic control estimator of the ATT of adequacy, $\widehat{\beta}_{st}$, can be described as

$$\widehat{\beta}_{st} = Y_{0t'} - Y_t^* = Y_{0t'}(1) - \sum_{s=1}^S Y_{st'} \pi_s, \quad (6)$$

where $Y_t^* = \sum_{s=1}^S Y_{st'} \pi_s$ is a weighted combination of control units, and $Y_{0t'}(1)$ is the post-adequacy performance of a 'treated' country (Argentina, Israel or New Zealand) with

respect to the outcome of interest.⁴⁴ The parameter π_s is the weight attached to each country in the donor pool, and it captures the similarity of a potential control country to the one of interest. This in turn depends on the set of matching variables considered, and their trends in the pre-adequacy period. The pool of potential controls (donor pool) for each case study is restricted as follows: for Argentina, we only consider other Spanish-speaking countries in Latin America; for New Zealand, we consider all English-speaking countries in the Indo-Pacific found in TiVA, excluding the USA and Canada given that both were granted adequacy and are located in a very different time zone; for Israel, we cover all English-speaking countries in the dataset, irrespectively of the time zone and location, excluding the USA and Canada.⁴⁵

To illustrate the role of the matching variables, the estimator can be rewritten as.

$$\widehat{\beta}_{st} = \underset{\beta}{\operatorname{argmin}} \left\| X_T^{pre} - \beta X_S^{pre} \right\| = \sqrt{\sum_p \left(X_{t,p}^{pre} - \sum_{i \in S} \beta_p X_{c,p}^{pre} \right)^2}, \quad (7)$$

that is, as an optimization problem minimizing the distance between all the observable characteristics of the control units ($X_c, c = 1, \dots, C$) and the country obtaining adequacy (X_T).⁴⁶ Consistent with the empirical literature, our matching variables include different lags of our dependent variable (pre-adequacy digital trade in logs), total trade (all three variables in logs), the ratio of digital trade to total trade, per capita GDP (in logs), plus a set of country fixed effects to absorb all country-specific characteristics, such as time zone and geographic location, that do not vary over time.

5.2 | Synthetic control estimates

We estimate the effect of adequacy on digital trade with the club of adequate countries using our preferred narrow definition of digital trade. Results for the three countries are reported in Figures 2–4. Each panel compares the performance of the country of interest (the solid line labelled ‘Real’) with that of its synthetic control (the dashed line) with respect to digital trade. The year the adequacy decision was granted by the EU is indicated by the vertical dashed line: 2003 for Argentina, 2013 for New Zealand, and 2011 for Israel. Part (a) of each figure reports results for digital trade with all partners irrespectively of whether they have been granted adequacy; part (b) restricts the dependent variable to digital trade with the club of countries granted adequacy by the EU; part (c) reports results for digital trade with the USA; and part (d) reports results for digital trade with the club of adequate countries, excluding the USA. This analysis allows an assessment of heterogeneity of the club effect found in the gravity results.

The plots in Figures 2–4 are largely consistent with our gravity estimates, revealing that adequacy matters for digital trade. The three cases also highlight the prevalence of heterogeneity, reflected in the large differences in the estimated effects across the four scenarios. The estimates for Argentina in Figure 2 suggest that receiving adequacy did not expand total digital trade compared to the counterfactual scenario—that is, absent the adequacy decision—but Argentina’s digital trade with adequate countries other than the USA (Argentina’s main digital trade partner) continuously increased following the adequacy decision, suggesting potential trade diversion from the USA to the EU and other adequate countries. (Results do not change if we consider digital trade with all countries except the USA.) This is consistent with the synthetic counterfactual in Figures 2(b) and 2(c), which initially increased before respectively declining or stabilizing. The estimates for New Zealand in Figure 3 reveal a different pattern. Digital trade increases only marginally relative to the donor pool (Figure 3(a)), while we find a larger increase in trade with countries accorded adequacy *other* than the USA and trade with the USA. Finally, the case

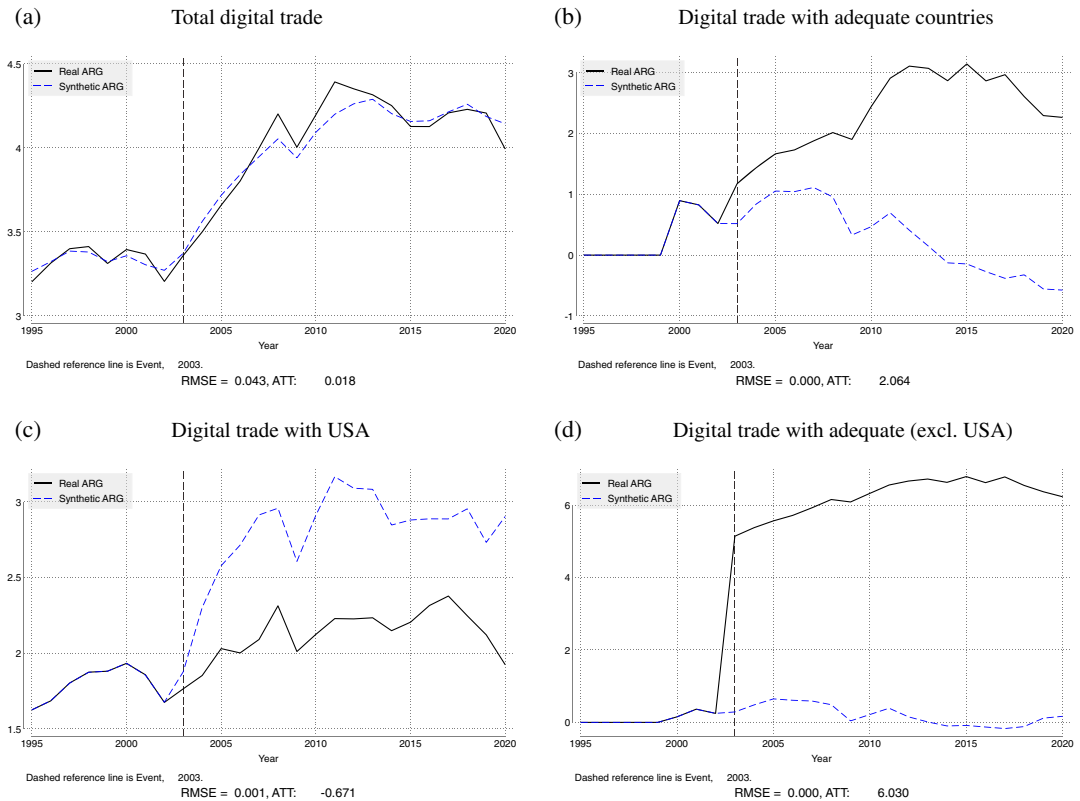


FIGURE 2 Synthetic control estimates: Argentina. *Notes:* Outcome variable is the narrow definition of digital trade as defined in Appendix Table A5.

of Israel in Figure 4 is most clear-cut, with significant increases in digital trade across all four scenarios following adequacy.⁴⁷

Overall, the case studies for Argentina and New Zealand indicate that adequacy was associated with a reallocation of digital trade flows, with both countries substantially increasing digital trade with the EU and with other adequate countries as compared to the counterfactual. This contrasts with Israel, where the synthetic control exercise indicates that adequacy not only redirected existing trade, but generated new digital trade growth overall. Taken together, these findings suggest that adequacy decisions affect digital trade among members of the club of adequate countries heterogeneously. While the gravity estimates indicate that the club effect is statistically significant only when the USA has an adequacy agreement, these results point to a club effect for the three countries analysed even when we do not consider the USA. These findings suggest that the average effect in our aggregate gravity estimates may mask significant differences in how digital trade responds to obtaining adequacy.

In addition to the stacked plots for each of the four scenarios defined above, we report the related ‘spaghetti plots’ in Appendix C, Figures A2–A4. These additional results refer to the in-space placebo tests obtained by randomly assigning adequacy to any of the potential control units in each of the three case studies discussed. By assigning a fictitious adequacy status to countries that did not actually receive adequacy, the test can validate our main results: if the identification strategy is sound, then these placebo treatments should yield substantially smaller effects than our main adequacy treatment. The plots in Appendix C provide a basic form of

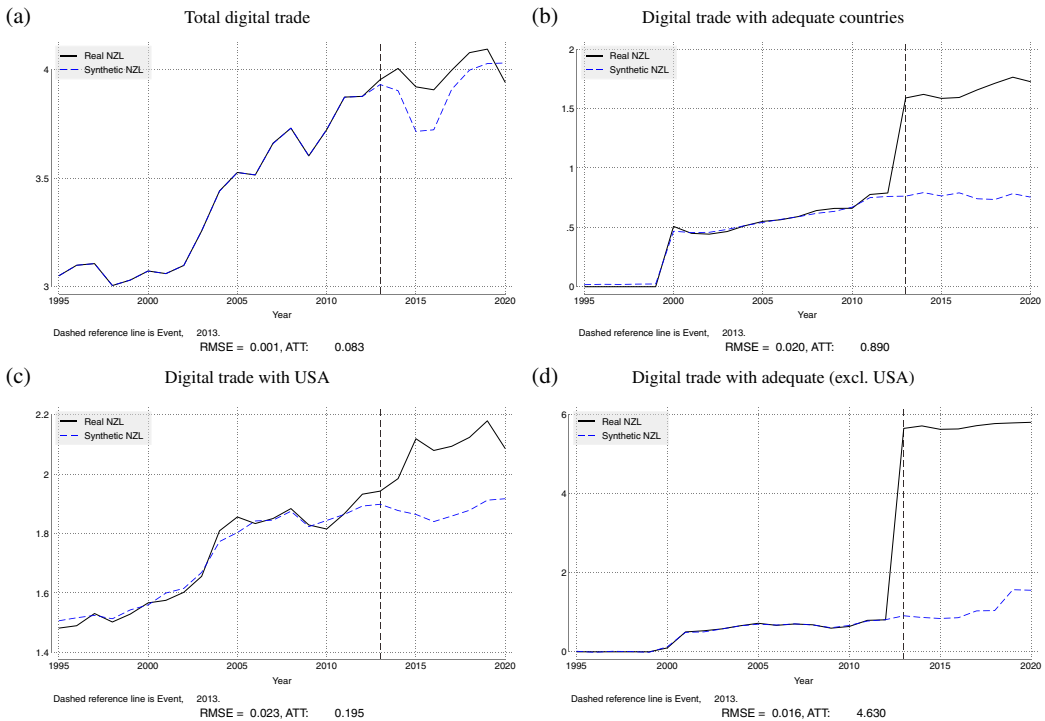


FIGURE 3 Synthetic control estimates: New Zealand. *Notes:* Outcome variable is the narrow definition of digital trade as defined in Appendix Table A5.

robustness. They support the conclusion that the effects that we identify can be attributed to adequacy and not to any country-specific trend. Appendix Table A8 reports all the estimated ATTs and the related root mean square errors, as well as their robustness according to the placebo test.

6 | CONCLUSION

Regulation of cross-border data flows and differences in national regulatory regimes generates costs for firms that engage in digital trade. Recognition agreements are a potential instrument to reduce such trade costs. In our analysis, we distinguish between regular adequacy decisions and the two data agreements for data transfers between the EU and the USA, the Safe Harbour and Privacy Shield frameworks. Overall, adequacy decisions positively affect bilateral digital trade. Our baseline model, which assesses the relationship between adequacy and aggregate exports of selected digital sectors, finds a significant effect only for the two transatlantic data agreements between the EU and the USA, but no statistically significant effect for adequacy decisions accorded to other countries. When we exploit the variation across digital and non-digital sectors using a pooled product-level gravity framework, we find that regular adequacy decisions increase digital trade by 7–9% relative to non-digital trade.

We also examine whether adequacy decisions affect digital trade among adequate countries. Both gravity models point to a positive club effect, driven primarily by the presence of the USA in the club. The magnitude of the effect is substantial, with an estimated 9% increase in digital trade relative to non-digital trade. A possible explanation is that US companies are best positioned

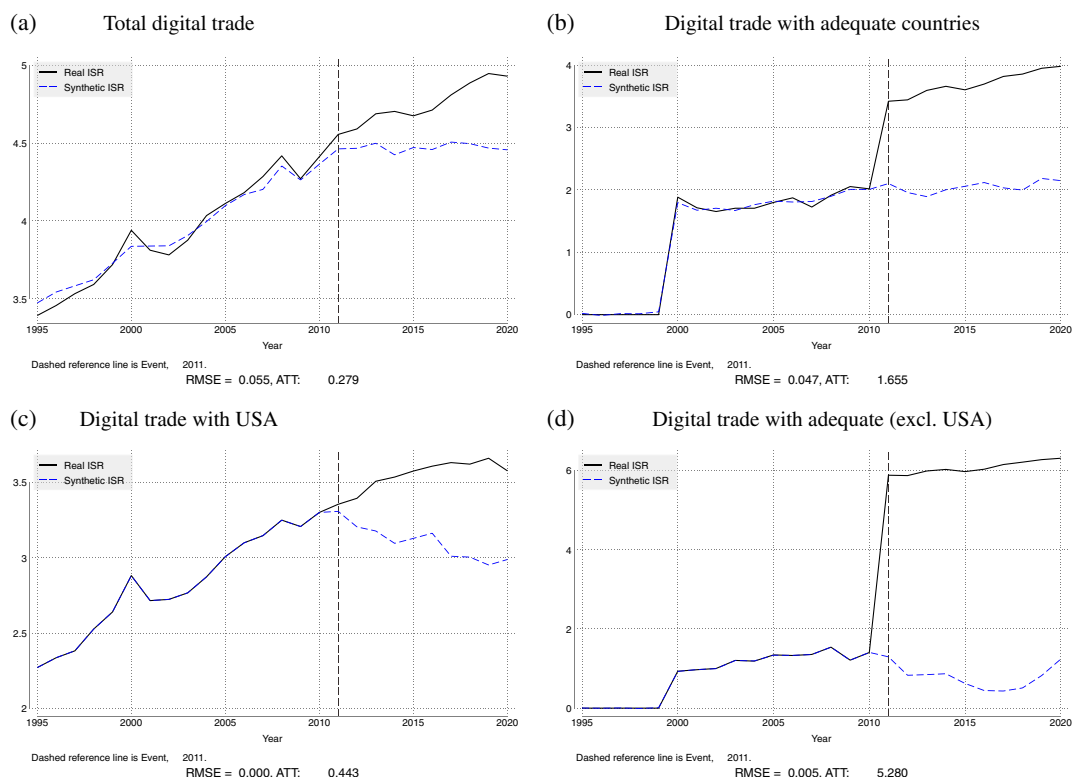


FIGURE 4 Synthetic control estimates: Israel. *Notes:* Outcome variable is the narrow definition of digital trade as defined in Appendix Table A5.

to benefit from adequacy decisions, given their capacity to adjust supply chains and exploit the advantages of adequacy decisions.

The synthetic control analysis reveals that the average effects on digital trade of adequacy decisions found in the gravity regression analysis mask considerable heterogeneity at the country level. The three country case studies confirm the positive relationship between digital trade and adequacy and the club effect. In contrast to the gravity finding that the inclusion of the USA in the adequacy club drives the positive club effect, the synthetic control analysis reveals instances where digital trade between countries with adequacy decisions increases even if trade with the USA is disregarded.

Data constraints precluded inclusion in the analysis of adequacy decisions agreed after 2020. Assessing the impacts of more recent arrangements is presently not possible because insufficient time has passed to generate the required trade and trade in value-added data. Future research will be important to deepen understanding of the economic implications of adequacy decisions and their benefits to the countries that are able to join the EU adequacy club.

ACKNOWLEDGMENTS

We are grateful to the two anonymous reviewers, Ingo Borchert, Mira Burri, Elisabeth Christen, Paola Conconi, Mattia Di Ubaldo, Javier Lopez-Gonzalez, Peter Herman, Richard Kneller, Douglas Nelson, Hildegunn Nordås, Sarah Oliver, Hein Roelfsema, Maarja Saluste, Rohit Ticku, Jan Tscheke, Alan Winters, and participants in workshops and seminars at the EUI, the

University of Florence, Örebro University, USITC, University of Sussex and the 2024 International Political Economy Society conference for comments and suggestions on earlier drafts. Elena Sisto and Lars Vandelaar provided excellent research assistance.

This work was supported by the Centre for Inclusive Trade Policy, Economic and Social Research Council (UK), grant number ES/W002434/1 (Santi) and the European Research Council, grant no. 101142666-PIANO-ERC-2023-ADG (Hoekman).

Data statement: The data used in the analysis undertaken in this study are open access.

Conflict of interest statement: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. Open access publishing facilitated by Università degli Studi di Bologna, as part of the Wiley - CRUI-CARE agreement.

ENDNOTES

- ¹ See Ferracane and van der Marel (2021) and Sun and Trefler (2023). Other studies assessing economic impacts of the GDPR focus on online outcomes or welfare rather than trade. Recent research in this vein includes Goldfarb and Trefler (2018), Goldberg *et al.* (2023) and Aridor *et al.* (2023).
- ² EU Regulation on the Protection of Natural Persons with Regard to the Processing of Personal Data and on the Free Movement of Such Data (27 April 2016) Regulation (EU) 2016/679 (GDPR) and Repealing Directive 95/46/EC (repealed 24 May 2018) OJ L 119/1.
- ³ Frey and Presidente (2024) find that the GDPR reduces profits by about 8% and sales by 2%, driven by compliance costs for firms in handling European personal data.
- ⁴ See, for example, De Brito *et al.* (2016) and Pelkmans (2023).
- ⁵ The network of EU adequacy decisions is an example of the type of discriminatory club analysed by Davis (2023).
- ⁶ Adequacy decisions are determined not by DG Trade, but by DG Justice and the European Data Protection Board, which are effectively insulated from trade-related business lobbying. The role of political and foreign policy considerations in the process of granting adequacy therefore reduces any endogeneity concerns.
- ⁷ As discussed below, adequacy decisions granted to the USA are *sui generis*.
- ⁸ The European Economic Area comprises the EU countries plus Norway, Iceland and Lichtenstein.
- ⁹ The GDPR only marginally changed the framework for personal data transfers compared to the 1995 Data Protection Directive, but it significantly raised the stakes of violating these rules, by introducing fines of up to 4% of the total worldwide annual turnover of an undertaking for the preceding financial year.
- ¹⁰ In addition to these contractual mechanisms, firms seeking to transfer EU personal data can also use certain derogations, such as the consent of the data subject for every cross-border transfer of personal data. These derogations are considered restrictive by the European Data Protection Board, especially for large-scale transfers of data (Saluste 2021). Surveys have shown that both binding corporate rules and standard contractual clauses are widely used by European companies to transfer personal data abroad in the absence of an adequacy decision (Business Europe *et al.* 2020).
- ¹¹ Firms trading services are typically smaller on average, as shown by Bento and Restuccia (2021) and Breinlich and Criscuolo (2011).
- ¹² The criteria for adequacy include 'the overall political relationship with the third country in question, in particular with respect to the promotion of common values and shared objectives at international level' (European Commission 2017, p. 6).
- ¹³ CJEU, Case C-362/14, Maximillian Schrems v Data Protection Commissioner, ECLI:EU:C:2015:650 (Schrems I).
- ¹⁴ CJEU, C-311/18, Data Protection Commissioner v Facebook Ireland Ltd, Maximillian Schrems, ECLI:EU:C:2020:559 (Schrems II).
- ¹⁵ A test of the equality of coefficients one year before and one year after adequacy rejects the null hypothesis (no difference between the two), with p -values 0.0004 or smaller.
- ¹⁶ Gravity models for services trade have been developed by Anderson *et al.* (2018) and Reverdy (2023). Yotov (2024) discusses the current standard in gravity estimation.
- ¹⁷ The ITA eliminated tariffs on most ICT products; see Gnutzmann-Mkrtchyan and Henn (2018).
- ¹⁸ Since our interest is in examining the effect of adequacy on digital trade between the EU and specific partners granted adequacy, we do not include intra-EU digital trade. Moreover, including EU members as adequacy granted countries could bias our results as they are adequate by definition.
- ¹⁹ The specification in equation (1) captures the presence of fixed trade costs. Following Anderson (2011, p. 139): 'The iceberg metaphor still applies when allowing for a fixed cost, as if a chunk of the iceberg breaks off from the mother glacier. Mathematically, the generalized iceberg trade cost is linear in the volume shipped.' Arkolakis *et al.* (2012) demonstrate how fixed trade costs can enter the trade cost function multiplicatively in models with monopolistic competition.

- ²⁰ The selected set of fixed effects also controls for any changes in domestic data protection regulatory regimes, including possible changes that are implemented by a country to ensure convergence with EU norms.
- ²¹ By construction, the four adequacy variables are dummies and are mutually exclusive within any given country dyad. Practically, this means that the four dummies will be assigned value 1 in the following bilateral country cases: (i) EU-ADQ, (ii) ADQ-ADQ, (iii) EU-US, (iv) US-ADQ, where EU are EU members, and ADQ are the adequacy-granted countries other than the USA. In equation (4), case (i) is captured by the term $RADQ_{ijt}$, case (ii) by $RADQ\ Club_{ijt}$, case (iii) by SH/PS_{ijt} , and case (iv) by $SH/PS\ Club_{ijt}$. For all other bilateral combinations, the four dummies will be set to zero.
- ²² This number is derived by taking the total number of times such words are mentioned in the purpose description divided by the total number of firms that are listed, i.e. $(1217/2675) \times 100 = 45.5\%$.
- ²³ This pattern is consistent with research highlighting the complementarity between goods and services trade (e.g. Ariu *et al.* 2019).
- ²⁴ Given the difficulty of estimating the volume of digitally delivered services, statistics on digital services trade include all services that are *potentially* deliverable, providing an upper-bound estimate of digitally delivered trade. Services related to goods trade such as transport, processing of physical inputs owned by others, maintenance and repair, travel, and construction are not included in the IMF *et al.* (2023) definition of digitally deliverable services as they are not provided over digital networks. They are therefore not part of our definition of digital sectors that are heavily reliant on cross-border data flows.
- ²⁵ Other sources that record trade in services, such as the International Trade and Production Database for Estimation (Borchert *et al.* 2022) and the OECD-WTO Balanced Trade in Services dataset, do not distinguish between the digital services sectors that are part of our narrow definition.
- ²⁶ This period enables us to incorporate most adequacy decisions, with the exception of the most recent decisions for Korea (in 2021) and the UK (in 2021). TiVA does not report trade data for Uruguay and the five micro-states of Guernsey, Isle of Man, Jersey, Andorra and the Faroe Islands.
- ²⁷ Since the latter dataset ends in 2019, we fill in missing information for 2020 using data from the WTO.
- ²⁸ We only include binding provisions on data protection within a specific e-commerce chapter in a PTA. Even though some PTAs include data-related provisions for specific sectors outside an e-commerce chapter, we do not include them because data protection provisions outside a specific e-commerce chapter are less meaningful. Including them in our assessment may potentially bias our results. We thank Mira Burri for this insight.
- ²⁹ The Data Protection Directive entered into force in 1998 for the EU15. For other European countries, it applied in 2004, 2007 or 2013, depending on the date of EU accession. The adoption of the GDPR in 2018 does not affect this control variable, as both the Directive and the Regulation cover a similar set of countries.
- ³⁰ These rules have some similarity with the EU–US adequacy agreements in that companies voluntarily subscribe to it, but differ by relying on qualified accountability agents, recognized by the participating economies, who certify the policies and practices with which a company must comply for data protection.
- ³¹ The controls discussed here are meant to reduce the bias arising from omitting relevant co-determinants of digital trade. Since their magnitude, sign and significance are consistent with the extant literature, we do not report the coefficients in the results tables. These are reported in Appendix Table A7.
- ³² In the baseline analysis, we apply a one-year gap between Safe Harbour and Privacy Shield frameworks during which there was no data flow agreement between EU members and the USA, i.e., the SH/PS dummy is set at zero for 2015. We do the same for the club variables.
- ³³ The $PTA - DP$ variable is generally insignificant, except with 1- and 3-year lags. Using the full PTA dummy yields a negative and insignificant coefficient, and does not affect the significance of the adequacy variable. Results available upon request.
- ³⁴ Note that although the results in Table 1 are based on aggregate trade flows, pooling across digital sectors only—as is done in this section—and applying similar three-way fixed effects yields exactly the same results, as found in French and Zylkin (2024).
- ³⁵ This approach builds on a long-standing stream of research initiated by Rajan and Zingales (1998). See Ciccone and Papaioannou (2023) for a literature review of this approach.
- ³⁶ Sectors of activity were manually concorded to the ISIC. If a firm's primary sector is not mentioned but subsector activities are reported, then we use the latter for our analysis. Appendix Table A2 shows the top 10 sectors that rely most on the adequacy framework, covering about 95% of all firms.
- ³⁷ The OECD inter-country input–output tables report data for 44 sectors. We exclude agriculture and mining, as well as utilities and construction, leaving 35 sectors.
- ³⁸ This is akin to the shift-share approach commonly applied in the empirical economic literature. When the intensity measures are interacted with our adequacy and club effect dummies, the 'shift' component is represented by the adequacy and club effect, reflecting shifts that are common to all units, whereas the 'share' component comprises the exposure shares that vary across units (sectors in our case). Similar to analyses applying a shift-share approach, the latter component sums to 1 for each unit, i.e. across sectors for each country, and is therefore a weighted average. See Borusyak *et al.* (2024).
- ³⁹ Note, however, that the first transatlantic adequacy framework (Safe Harbour) was applied in 2000, which leaves one year of identification for our lead variable. Moreover, the negative effect may be driven by the drop in digital exports

following the repeal of this arrangement in 2015, which was followed by a recovery in the following year with the adoption of the Privacy Shield framework.

- ⁴⁰ Hollingsworth and Wing (2022) summarize the set of ‘pseudo-identifying’ assumptions and identify a series of threats to the validity of estimates. The assumptions are: (i) no spillover effects (or no interference between units); (ii) factor structure model (performance of unexposed countries is driven by a set of common factors that vary over time but is constant across countries); (iii) performances of unexposed units are allowed to vary due to an idiosyncratic exogenous shock; (iv) no pre-period perfect multicollinearity of common factors; and (v) existence of weights such that a synthetic counterfactual exists. The five assumptions ensure that a synthetic counterfactual can be constructed and used for causal inference. Assumption (i) hinges on the process leading to an adequacy decision, specifically that obtaining adequacy is largely independent of a country’s domestic data protection policy. This is reflected by the fact that the prospect of obtaining adequacy is not necessarily enhanced because a country adopts a GDPR-compliant regulation. As noted, many countries that have adopted the GDPR have not been granted adequacy, while the USA, which does not have a GDPR-type regulation, has repeatedly been accorded adequacy. Thus obtaining adequacy is unlikely to influence the opportunities of other partner countries that could be considered as potential controls to obtain adequacy themselves in the period considered, even if these countries adopt the GDPR. Assumption (v) holds because we were able to generate a synthetic counterfactual, implying the existence of such weights. The remaining three assumptions rely on unobserved factors, but the restrictions imposed on the donor pool for the three case studies provide confidence that all control units respect them. See Abadie (2021) for discussion of threats to validity in a synthetic control setting.
- ⁴¹ This reflects the rapid growth of companies such as MercadoLibre, which has become the largest online e-commerce platform in Latin America, and has developed a variety of payment services to complement its e-commerce activities.
- ⁴² Uruguay, the other Latin American country with EU adequacy, is not included in the TiVA database.
- ⁴³ Trade in services is sensitive to time zones, as shown by Head *et al.* (2009).
- ⁴⁴ We consider $s = 0, \dots, n$ countries, where $s = 0$ is the treated country, and $s = 1, \dots, n$ is the donor pool.
- ⁴⁵ Due to its geographic remoteness from the EU, South Africa is included in the donor pool in the New Zealand case. Being part of the donor pool does not automatically imply that a country is part of the synthetic control. See, for example, Abadie (2005) for a discussion on this issue.
- ⁴⁶ Abadie (2021) shows that the synthetic control estimator is biased, although bounded and decreasing provided that the underlying identifying assumptions are valid. As noted, the set of identifying assumptions holds in both our exercises, although the pre-adequacy period for the Argentina case is relatively short.
- ⁴⁷ For a clearer comparison, all the estimated ATTs for the three case studies are also reported in Appendix Table A8, where the same exercise is replicated considering a broader definition of trade.

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How to cite this article: Ferracane, M. F., Hoekman, B., van der Marel, E. and Santi, F. (2025). Digital trade, data protection and the EU adequacy club. *Economica*, 1–30. <https://doi.org/10.1111/ecca.70016>

APPENDIX A

A.1 Descriptive and additional explanatory tables and figure

TABLE A1 Adequacy decisions, 2000–2023.

Adequacy agreement	Year	Of relevance for the European Economic Area	Notes
EU–Switzerland	2000	Yes	
EU–US (SH)	2000	Yes	Up to 2014 (repealed in 2015)
EU–Canada	2002	No	20 December 2001
EU–Argentina	2003	Yes	
EU–Guernsey	2003	Yes	
EU–Isle of Man	2004	Yes	
EU–Jersey	2008	Yes	
EU–Andorra	2010	Yes	
EU–Faroe Islands	2010	Yes	
EU–Israel	2011	Yes	
EU–Uruguay	2012	Yes	
EU–New Zealand	2013	Yes	19 December 2012
EU–US (PS)	2016	Yes	Up to 2019 (repealed in 2020)
EU–Japan	2019	Yes	
EU–UK	2021	Yes	
EU–South Korea	2021	Yes	
EU–US (DPF)	2023	Yes	

TABLE A2 Share of firms by sector and number of mentions of ICT goods notified under the EU–US DPF.

Sector	No. of firms	Share	Product	Electronics	Goods	Device	Equipment
ICT	1245	57.19%	404	1	32	125	14
Business and Professional Services	400	18.37%	86	0	21	28	1
Healthcare/Biopharmaceuticals	123	5.65%	38	0	10	17	1
Financial Services	65	2.99%	12	0	0	2	1
Education	62	2.85%	15	0	0	3	0
Media and Entertainment	57	2.62%	20	0	1	9	0
Travel and Tourism	34	1.56%	10	0	0	3	0
Consumer Goods	32	1.47%	17	2	3	8	4
Distribution and Logistics	25	1.15%	3	0	8	1	0
Equipment and Machinery	18	0.83%	14	1	1	2	0

TABLE A3 Description and interpretation of all adequacy variables.

Variable	Unit	Interpretation	Source
$RADQ_{ijt}$	0–1	Takes value 1 if there is an adequacy decision between EU and partner country j ($j \neq$ USA), i.e. for all EU member states i and country j	European Commission
SH/PS_{ijt}	0–1	Takes value 1 if there is an adequacy framework between EU and USA	European Commission
$RADQ_{ijt}^{club}$	0–1	Takes value 1 if countries i and j have adequacy status ($j \neq$ USA)	European Commission
SH/PS_{ijt}^{club}	0–1	Takes value 1 if pair involves USA and any country that has been granted adequacy	European Commission
I_k	0–1	Takes value 1 if industry k is included in definition of digital trade	Own calculations using DPF and OECD (2023)
DI_k	$R > 0$	Data intensity of industry k	OECD ICIO tables

Notes: Dummies are mutually exclusive. Definitions of dummy variables are provided in Subsection 3.2 and Table A5. Digital intensity measures are discussed in Subsection 4.2 and summarized in Table A6.

TABLE A4 Gravity controls.

Variable	Description	Source
PTA	Preferential trade agreement (includes customs unions, free trade agreements, partial scope agreements, economic integration agreements (services))	Regional Trade Agreements Database (Egger and Larch 2008)
PTA-DP	Preferential Trade Agreement with binding data-related provisions related to data protection	Regional Trade Agreements Database (Egger and Larch 2008); Trade Agreements Provisions on Electronic-commerce and Data database (Burri and Polanco 2020)
WTO	World Trade Organization	WTO and Dynamic Gravity Database
DPD	Data Protection Directive	EU
CON 118	Council of Europe Protocol no. 8 to the Convention for the Protection of Human Rights and Fundamental Freedoms (Treaty no. 118)	Spiezia and Tscheke (2020); Council of Europe
CBPR	APEC Cross-Border Privacy Rules System	Spiezia and Tscheke (2020); APEC (apec.org)
EU	European Union	Dynamic Gravity Database

TABLE A5 Narrow and broad sectoral definitions of digital trade.

TiVA code	Industry	ISIC Rev. 4	Narrow definition	Broad definition
C21	Pharmaceuticals, medicinal chemical and botanical products	21		✓
C26	Computer, electronic and optical equipment	26	✓	✓
J58T60	Publishing, audiovisual and broadcasting activities	58, 59, 60	✓	✓
J61	Telecommunications	61	✓	✓
J62_63	IT and other information services	62, 63	✓	✓
K	Financial and insurance activities	64, 65, 66		✓
M	Professional, scientific and technical activities	69–75		✓
N	Administrative and support services	77–82		✓
P	Education	85		✓
Q	Human health and social work activities	86, 87, 88		✓

TABLE A6 Summary statistics, data intensity measures.

	Observations	Average	S.D.	Max	Min
Percentage of firms (DPF)	32	0.07681	0.15339	0.46542	0.00075
I/O coefficient imports (2006)	35	0.01333	0.03029	0.18053	0.00016
I/O coefficient domestic (2006)	35	0.07357	0.09711	0.49304	0.00078

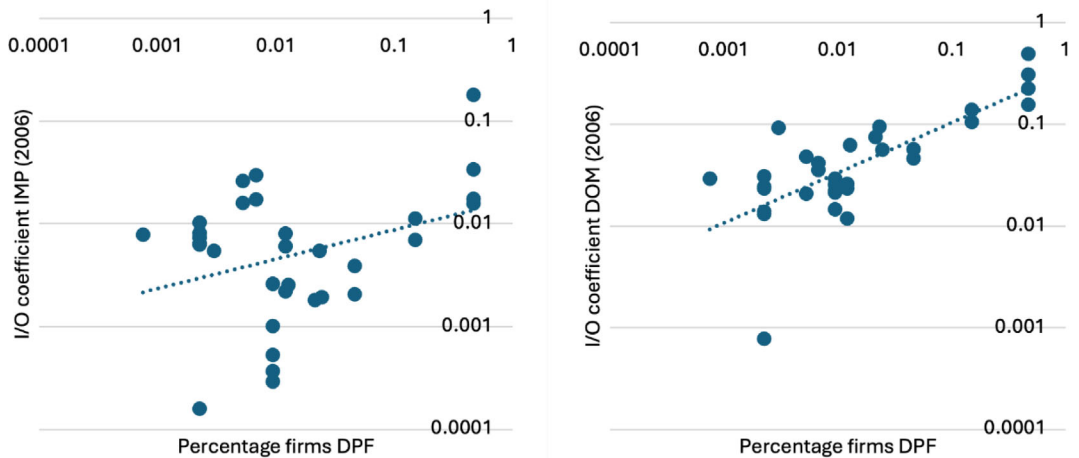


FIGURE A1 Correlations between data intensity measures (log scale).

A.2 Control variables

TABLE A7 Control variables for regressions reported in Table 1.

	EXP (1)	EXP (2)	EXP (3)	EXP (4)	EXP (5)	EXP (6)	EXP (7)
RTA DP	0.002 (0.983)	0.002 (0.982)	0.002 (0.980)	0.003 (0.979)	0.003 (0.978)	0.003 (0.977)	0.016 (0.819)
WTO	−0.397*** (0.000)	−0.397*** (0.000)	−0.394*** (0.000)	−0.393*** (0.000)	−0.393*** (0.000)	−0.393*** (0.000)	−0.450*** (0.001)
DPD	−0.063 (0.197)	−0.062 (0.205)	−0.054 (0.263)	−0.055 (0.260)	−0.053 (0.271)	−0.054 (0.268)	−0.055 (0.233)
CON 181	−0.007 (0.783)	−0.007 (0.776)	−0.007 (0.764)	−0.007 (0.770)	−0.008 (0.756)	−0.007 (0.761)	−0.001 (0.948)
CBPR	0.068 (0.142)	0.071 (0.125)	0.065 (0.159)	0.065 (0.159)	0.069 (0.136)	0.069 (0.136)	0.042 (0.400)
EU	0.041 (0.684)	0.042 (0.681)	0.038 (0.706)	0.038 (0.706)	0.039 (0.697)	0.039 (0.697)	0.107 (0.126)
Digital dummy	Narrow	Narrow	Narrow	Narrow	Narrow	Narrow	Broad

Notes: Dependent variable: digital exports (EXP). Numbers in parentheses are *p*-values. Variable definitions described in Table A3. Further details on these regressions are provided in Table 1.

*, **, *** indicate 10%, 5%, 1% significance levels, respectively.

A.3 Additional synthetic control exhibits and robustness tests

This subsection provides additional results for the synthetic control exercises discussed in Subsection 5.2. Table A8 summarizes the average effect of treatment on the treated (ATT), while Figures A2–A4 report the graphical outcome from the in-space placebo tests for the main results reported in Figures 2–4. The purpose is to provide a test for the main synthetic control results. The test involves reassigning adequacy status iteratively to all countries in the pool of potential controls, then averaging the discrepancy that is recorded post-adequacy between each of these additional ‘placebo’ synthetic controls. Visually, this is reflected in the black dashed line in each panel in Figures A2–A4, with the light grey lines representing the individual synthetic control analysis run on the countries in the control group. The solid black line in each graph refers to the effect of adequacy on the country being considered, and is the same as reported in the plots in the main text (Section 5).

TABLE A8 Summary of all synthetic difference-in-differences estimates.

	Argentina		New Zealand		Israel	
	ATT	RMSE	ATT	RMSE	ATT	RMSE
Digital services and goods						
Total digital trade	0.018	0.043	0.083*	0.001	0.279*	0.055
Digital trade with adequate countries	2.064*	0.000	0.890*	0.020	1.655*	0.047
Digital trade with USA	−0.671*	0.001	0.195*	0.023	0.443*	0.000
Digital trade excluding USA	6.030*	0.000	4.630*	0.016	5.280*	0.005

Notes: ATT means average effect of treatment on the treated. RMSE means root mean square error. See Table A5 for the definitions of digital services and related ICT goods.

* indicates significance based on the placebo test, and does not denote any particular significance level.

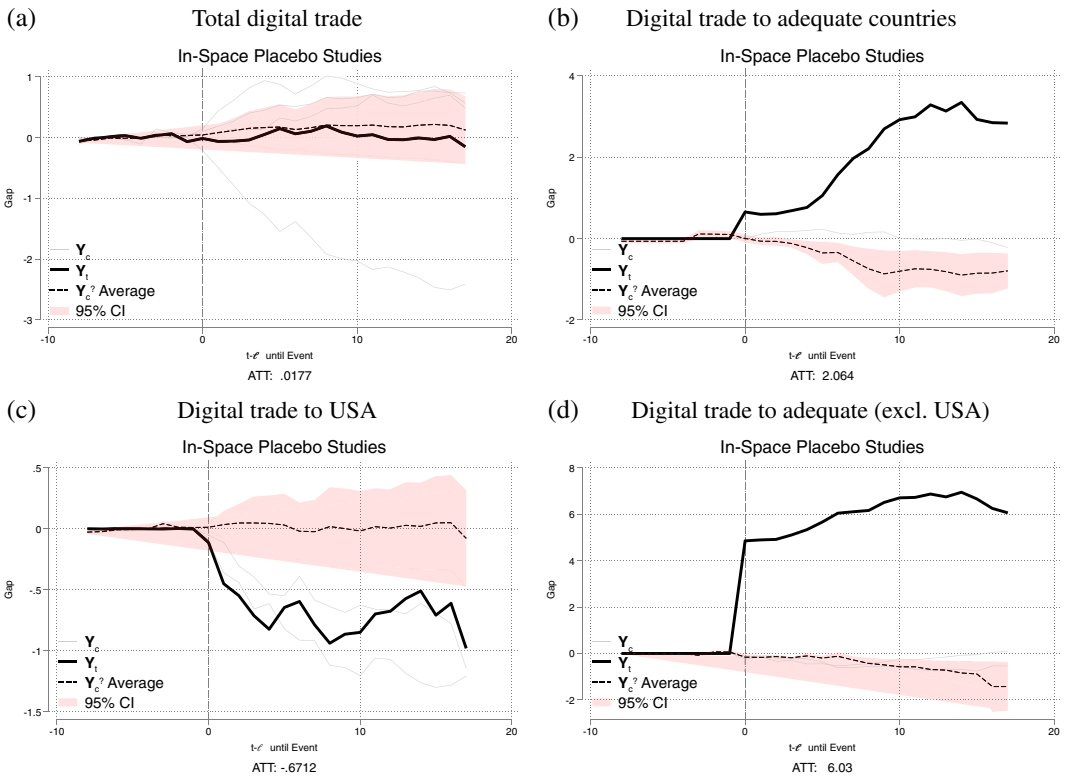


FIGURE A2 In-space placebo synthetic control estimates for Argentina. *Notes:* Outcome variable is the narrow definition of digital trade as defined in Appendix Table A5.

Comparing the solid line (our main result) with the dashed line and the red ribbon indicating the 95% confidence interval for the average effect on the control group provides an indication of how much of the digital trade performance of a country can be attributed to the effect of adequacy. Visually, this is verified when the solid line extends beyond the 95% confidence interval once adequacy has been obtained.

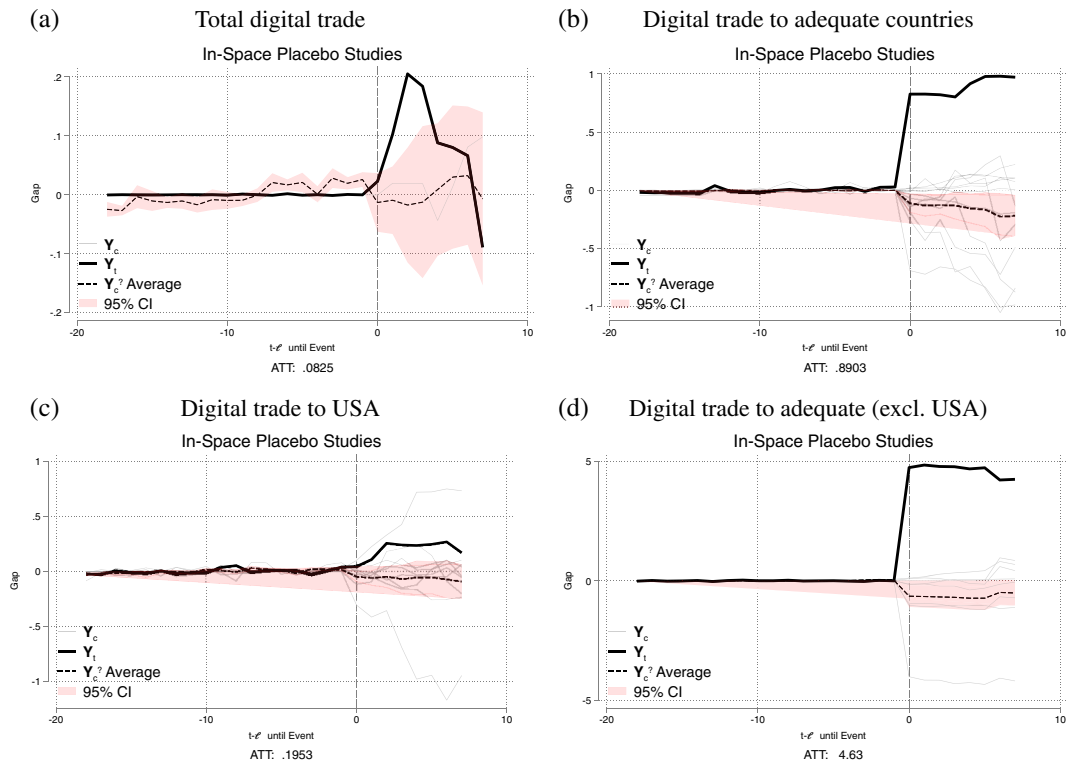


FIGURE A3 In-space placebo synthetic control estimates for New Zealand. *Notes:* Outcome variable is the narrow definition of digital trade as defined in Appendix Table A5.

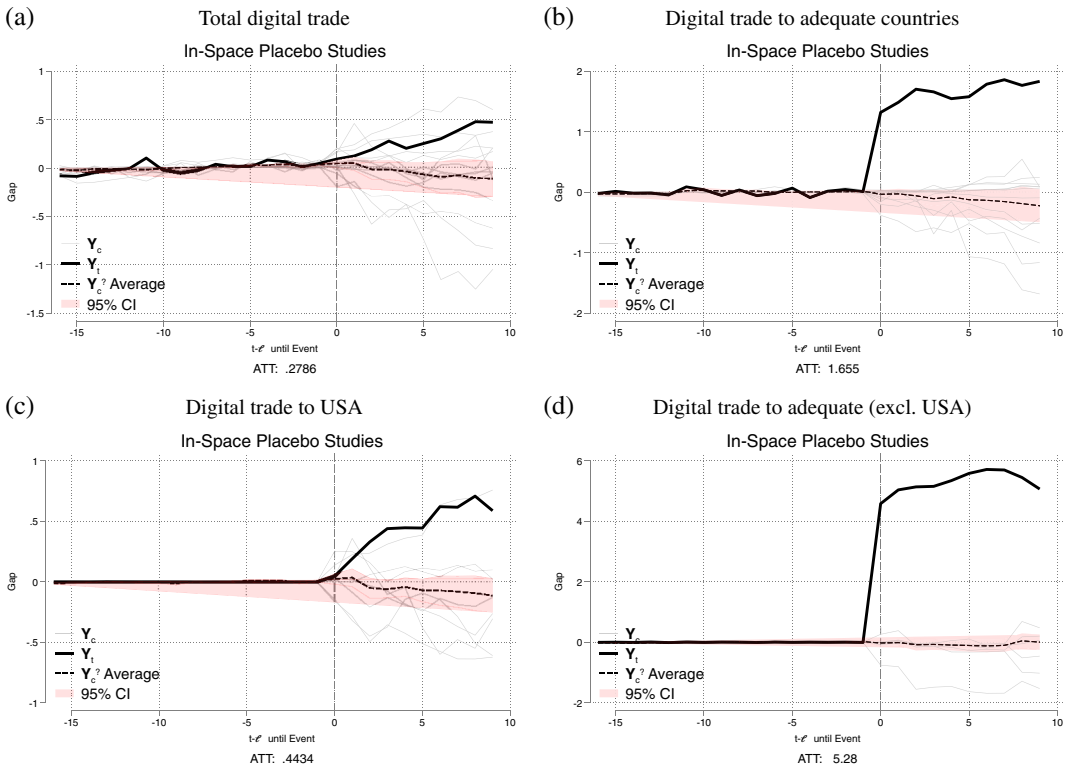


FIGURE A4 In-space placebo synthetic control estimates for Israel. *Notes:* Outcome variable is the narrow definition of digital trade as defined in Appendix Table A5.