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E-Commerce Provisions and Free Trade Agreements

Houssein Guimbard & Camilo Umana-Dajud

Highlights

- Since the early 2000s, trade agreements include provisions on electronic commerce (E.C.), which we call E-RTAs.
- RTAs that include e-commerce provisions are associated with about 22% less bilateral trade than RTAs without such provisions, once we control for the presence of an RTA.
- Neither the number of e-commerce provisions nor their legal bindingness (dispute settlement mechanism) affects this result.
- The negative average effect masks substantial heterogeneity: e-commerce provisions raise trade between country pairs whose combined development level is sufficiently high.

Abstract

Since 2001, 76 regional trade agreements (RTAs) have incorporated provisions on electronic commerce, representing 44% of all RTAs signed over the period. We build an original dataset identifying these agreements (which we call E-RTAs) using an algorithm that combines machine learning and text analysis to detect e-commerce provisions in 449 trade agreement texts. We document that E-RTAs are geographically concentrated among a handful of developed economies and that signatory pairs trade less and are farther apart than pairs linked by other RTAs. Using a gravity framework estimated via Poisson pseudomaximum likelihood (PPML), we find that E-RTAs increase trade by less than the average RTA: conditional on the standard RTA dummy, the E-RTA coefficient is -0.245, implying approximately 22 percent less trade. Neither the number of e-commerce provisions nor their legal bindingness affects this result. However, when we interact E-RTA status with a measure of the combined development level of the trading pair, the interaction coefficient is 0.134, and e-commerce provisions increase trade between sufficiently developed country pairs. These results are robust to alternative specifications, estimators, product-level disaggregation, services trade, and tariff controls.

Keywords

E-commerce, Regional Trade Agreements, Gravity Model, PPML, Digital Trade.

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F13, F14, F15, L81, O33.

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RESEARCH AND EXPERTISE
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E-Commerce Provisions and Free Trade Agreements

Houssein Guimbard* Camilo Umana-Dajud†

1 Introduction

More than 44 percent of regional trade agreements signed since 2001 contain provisions on electronic commerce, yet whether these provisions affect trade flows remains an open question. As RTAs have expanded beyond tariff liberalization to address digital trade, data flows, and electronic authentication, understanding the trade impact of these chapters has become a first-order policy question (Monteiro and Teh, 2017; Wu, 2017).

This paper examines how e-commerce provisions in RTAs affect bilateral trade. We first build an original dataset of 76 RTAs containing e-commerce provisions (E-RTAs) by applying an algorithm that combines text analysis and machine learning (Mayer et al., 2021a) to a corpus of 449 trade agreement texts (Alschner et al., 2017) covering 1957–2017. We then document the evolution and characteristics of E-RTAs before estimating their trade effects using a structural gravity framework.

Our main finding is that E-RTAs increase trade by less than the average RTA. In our preferred PPML specification with exporter-year and importer-year fixed effects, the standard RTA dummy yields a coefficient of 0.370, corresponding to a 45 percent increase in bilateral trade. By contrast, the incremental E-RTA coefficient is -0.245, implying that RTAs with e-commerce chapters are associated with approximately 22 percent less trade than RTAs without them. Neither the number of e-commerce provisions nor whether they are subject to dispute settlement mechanisms changes this result.

However, the average effect masks important heterogeneity by development level. When we interact E-RTA status with a "Pair World Bank Income Category Score" (the sum of ordinal income classifications for the exporter and importer) the interaction coefficient is 0.134. The E-RTA effect turns positive for country pairs whose combined income score reaches 5 or above, a threshold met, for instance, by a lower-middle-income country trading with a high-income partner. For pairs of two high-income countries (score = 8), the implied E-RTA effect is positive and economically meaningful. E-commerce provisions thus appear to increase trade only when both partners have sufficient digital infrastructure and regulatory capacity.

We subject these findings to extensive robustness checks. The null average effect holds across OLS specifications, alternative measures of agreement depth (DESTA database), economic integration indices (NSF-Kellogg), product-level disaggregation by Rauch classification, agricultural versus industrial goods, broad economic categories, trade in services, and specifications controlling for bilateral applied tariffs.

This paper makes three contributions. First, we construct a systematic, replicable dataset of e-commerce provisions in RTAs (2001-2017) using algorithmic detection. Monteiro and Teh (2017) provide a detailed legal taxonomy of e-commerce provisions, and Wu (2017) inventories

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digital trade rules with a legal emphasis. Our approach complements these qualitative analyses with an automated procedure that facilitates replication and updating. Second, we provide the first comprehensive gravity-based assessment of how e-commerce provisions affect trade flows. González et al. (2023) examine e-commerce chapters at the sectoral level; we extend this analysis to aggregate goods trade, services, and multiple product classifications. Related work by Lendle et al. (2016) and Freund and Weinhold (2004) studies the link between internet penetration and trade using gravity models, but does not examine the specific role of e-commerce provisions within RTAs. Third, we show that the trade effects of e-commerce provisions are conditional on development: they are effective only between partners with sufficient income and, presumably, digital infrastructure.

Our identification relies on cross-sectional bilateral variation in E-RTA status conditional on exporter-year and importer-year fixed effects, which absorb all country-specific time-varying determinants of trade including GDP, multilateral resistance, and trade policy stance. We do not include country-pair fixed effects in our preferred specification because E-RTA status exhibits limited within-pair variation over time, generating the sparsity problems analyzed in Umana-Dajud (2025): inflated estimator variance and breakdown of asymptotic approximations. We nonetheless report pair-FE specifications for transparency and discuss the endogeneity concerns associated with RTA formation (Baier and Bergstrand, 2007).

The remainder of the paper is organized as follows. Section 2 describes our algorithm and characterizes E-RTAs. Section 3 presents the data. Section 4 lays out the empirical strategy. Section 5 presents the results. Section 6 concludes.

2 E-commerce provisions in RTAs

2.1 Classification of RTAs

Trade agreements have grown dramatically in scope. The Canada–EU Comprehensive Economic and Trade Agreement (CETA), for instance, contains 30 chapters and hundreds of articles spanning investment, intellectual property, and digital trade.[1] Determining the content of such texts manually is impractical. We therefore implement the sequential text analysis procedure developed in Mayer et al. (2021a) to identify e-commerce provisions automatically.

The algorithm proceeds in two steps. First, it determines whether an RTA covers e-commerce by searching chapter titles for relevant keywords (Electronic, Digital, E-[a-zA-Z], Electrónico, Electronico). If a match is found, the algorithm searches the relevant chapter for dispute-related provisions; if no chapter title matches, it searches every article. Second, the algorithm classifies collected dispute sentences as including or excluding e-commerce from dispute settlement mechanisms, using a Naive Bayes classifier trained on manually labeled sentences.

We apply this procedure to the machine-readable corpus of 449 RTA texts provided by Alschner et al. (2017), covering agreements from 1957 to 2017.

2.2 The increasing number of E-RTAs

The number of RTAs containing e-commerce provisions has increased steadily since 2004, with entry into force peaking between 2011 and 2015 (Figure 1). By 2017, 76 E-RTAs were in force[2], representing 17% of all enforced RTAs but 44% of those signed since 2001 (Figure 2 and Table 13).

[1] CETA has been provisionally applied since September 2017.

[2] The European Union is treated as a single entity throughout, as trade policy is determined at the EU level.

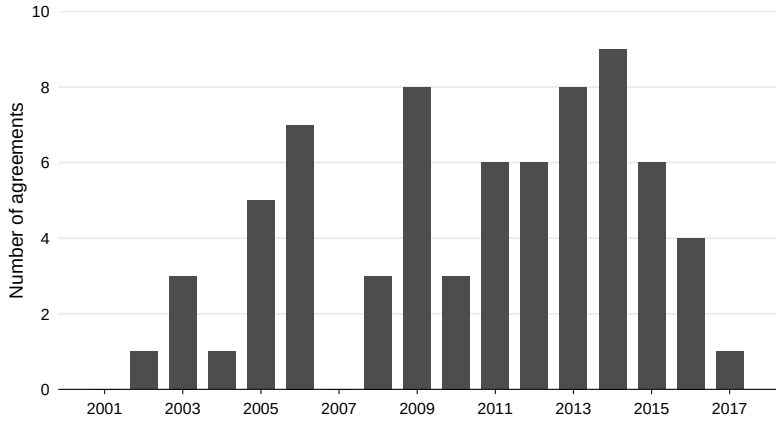

Figure 1: Number of RTAs containing e-commerce provisions entering into force each year (2001–2017)

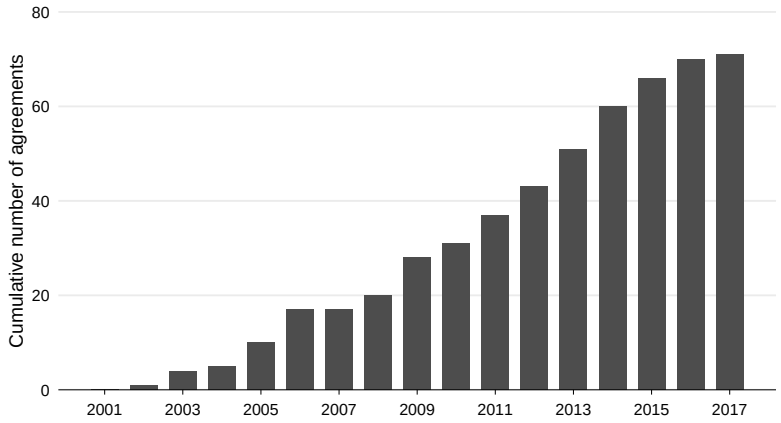

Figure 2: Cumulative number of RTAs containing e-commerce provisions in force (2001–2017)

2.3 Nature and depth of e-commerce provisions

Unlike tariff chapters, e-commerce provisions do not contain numerical commitments. Instead, they establish good practices for promoting digital trade: moratoriums on customs duties for electronic transmissions, consumer protection, electronic authentication, data protection, and paperless trading (Monteiro and Teh, 2017). These provisions may lower trade costs by reducing regulatory uncertainty and facilitating cross-border data flows (Wu, 2017).

The legal force of these provisions varies considerably. Many use permissive language ("may," "shall endeavor") rather than binding obligations. Burri and Polanco (2020) distinguish between soft, mixed, and hard commitments and conclude that "even on relatively simple issues (e.g., customs duty moratorium on electronic transmissions), there is a great variety of rules and formulations, possibly with differing legal effects." In our sample, more than 60% of E-RTAs

incorporate a dispute settlement mechanism covering e-commerce provisions.

Despite this heterogeneity in legal language, the substantive depth of e-commerce chapters has remained remarkably stable. Figure 3 shows that the average number of distinct e-commerce provisions per agreement has increased only slightly since the first E-RTAs (Australia–Singapore and Singapore–US), consistent with the regulatory convergence documented by Alschner et al. (2017).

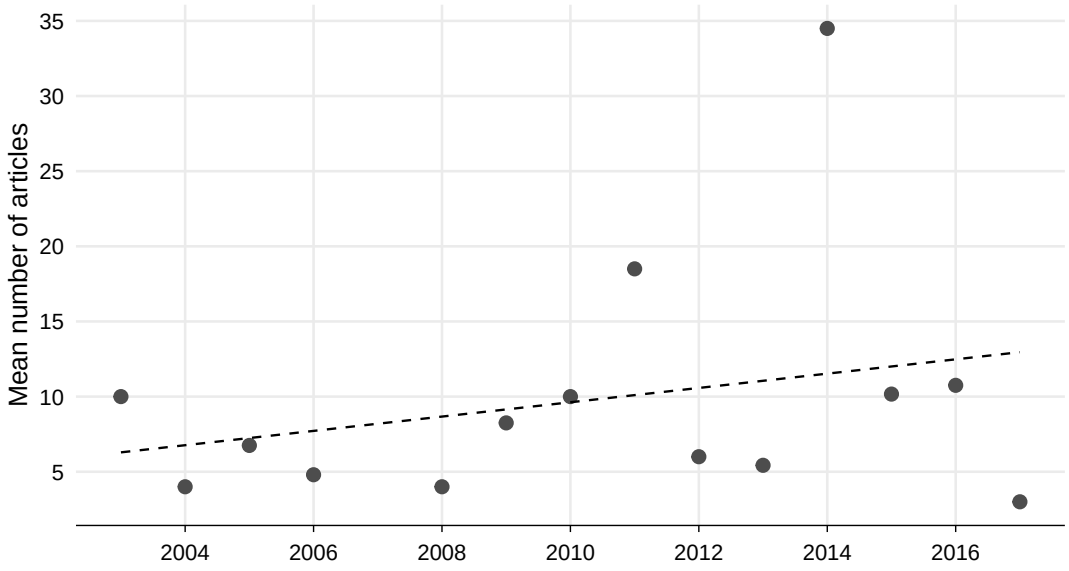

Figure 3: Average number of e-commerce articles in RTAs by year of signature

2.4 Characteristics of signatory countries

E-RTAs are predominantly bilateral: 60 of 76 (79%) involve exactly two signatories.[3] They are also geographically concentrated. Figure 4 shows that the main signatories are developed economies: the EU (12 E-RTAs), the US (10), South Korea (10), Singapore (10), and Japan (5). Latin American countries are also active, with Peru engaged in 10 E-RTAs, Colombia in 7, and Chile in 5, reflecting both regional agreements and deals with developed partners. Sub-Saharan African countries have no E-RTAs, consistent with their reliance on unilateral preferences (GSP, EBA, AGOA).[4]

[3] A few agreements involve many partners, such as the ASEAN–Australia–New Zealand FTA or the EU–CARIFORUM States EPA.

[4] GSP: Generalized System of Preferences; EBA: Everything But Arms; AGOA: African Growth and Opportunity Act.

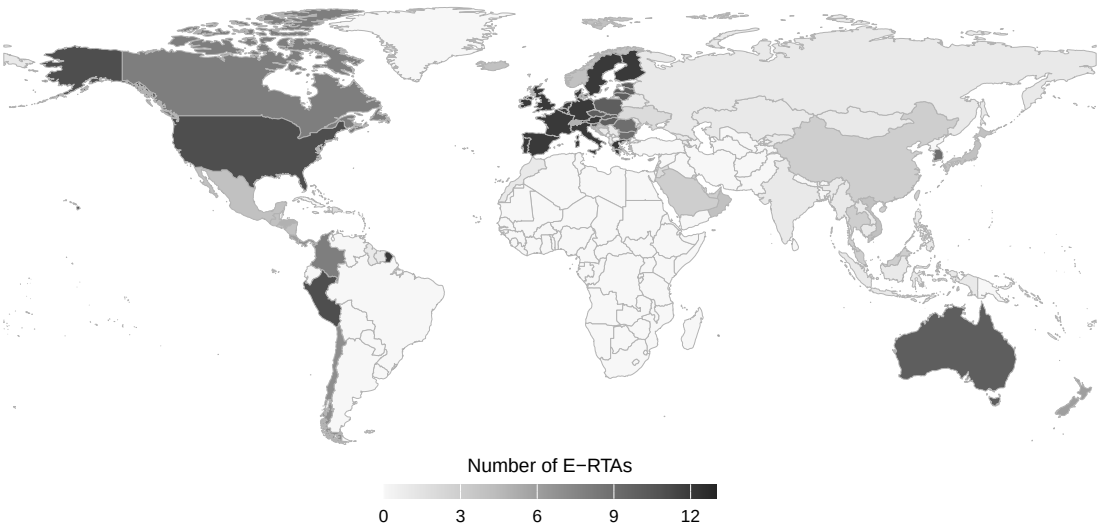

Figure 4: Number of RTAs in force containing e-commerce provisions by signatory country

Of the 76 E-RTAs, 92% include at least one high-income country, 35% are signed exclusively between high-income countries, and only 8% exclude high-income countries entirely.

Table 1 compares the characteristics of country pairs linked by E-RTAs versus other RTAs. E-RTA pairs have higher combined GDP, lower combined population, and higher GDP per capita. They also trade less between themselves (bilateral trade for E-RTA pairs is roughly one quarter of that for non-E-RTA pairs) and are geographically farther apart. These selection patterns are important for interpreting the gravity estimates that follow.

Table 1: Descriptive statistics for FTAs with and without E.C. provisions by pair of countries

Average value	**FTAs without E.C.**	**FTAs with E.C.**
Total GDP (mill. USD)	258,315.304	358,443.978
Pop. (mill.)	27.274	17.188
Per cap. GDP (USD)	13,718	15,040
Exports + Imports (mill. USD)	2,097.528	556.101
Distance between partners (km)	3,948.234	7,413.753

Author's calculations based on data from CEPII's Gravity Dataset, IMF's DOTS, and authors' database on e-commerce provisions.

3 Data

Our analysis draws on several data sources. Bilateral trade flows in goods come from the IMF Direction of Trade Statistics (DOTS) database, from which we use a balanced panel of aggregate

exports and imports covering 1960–2015; our regression sample is restricted to 1998–2015, the period over which e-commerce provisions in RTAs are observed. Trade in services comes from the World Bank's Trade in Services Database (Francois and Pindyuk, 2013). Product-level trade data at the HS6 level come from CEPII's BACI database (Gaulier and Zignago, 2010), and SITC four-digit flows from the World Bank's WITS database (UN COMTRADE).

Bilateral gravity variables (distance, contiguity, common language, and common currency) come from CEPII's GeoDist database (Mayer and Zignago, 2011) and Gravity dataset (Conte et al., 2022). RTA data are from the same sources supplemented with the E-RTA classification produced by our algorithm. World Bank income classifications are used to construct the development interaction variable. Bilateral applied tariffs at the HS two-digit level, used in a robustness check, come from UNCTAD TRAINS.

Trade agreement texts come from the ToTA corpus, "a machine-readable and annotated full text corpus of RTAs in XML format" (Alschner et al., 2017). The algorithm used to detect e-commerce provisions is documented in Mayer et al. (2021a).

4 Empirical strategy

We estimate the following gravity equation:

$$\begin{aligned} X_{i,j,t} = \exp\Big[&\beta_1 \cdot \text{RTA}_{i,j,t} + \beta_2 \cdot \text{E-RTA}_{i,j,t} + \beta_3 \cdot \text{E-RTA Disp. Settl.}_{i,j,t} \\ &+ \beta_4 \cdot \ln \text{Dist}_{i,j} + \beta_5 \cdot \text{Border}_{i,j} + \beta_6 \cdot \text{Language}_{i,j} + \beta_7 \cdot \text{Currency}_{i,j,t} \\ &+ \alpha_{i,t} + \gamma_{j,t}\Big] \times \varepsilon_{i,j,t} \end{aligned} \tag{1}$$

where $X_{i,j,t}$ is the trade flow from country i to country j in year t (IMF DOTS); $\text{RTA}_{i,j,t}$ equals 1 when an RTA is in force between i and j; $\text{E-RTA}_{i,j,t}$ equals 1 when that RTA contains e-commerce provisions; and $\text{E-RTA Disp. Settl.}_{i,j,t}$ equals 1 when those provisions are subject to dispute settlement. By construction, the E-RTA dummy is a subset of the RTA dummy, and the dispute settlement dummy is a subset of E-RTA. The bilateral controls (log distance, contiguity, common language, and common currency) come from CEPII's Gravity dataset (Conte et al., 2022).

We estimate equation (1) using Poisson pseudo-maximum likelihood (PPML), which provides consistent estimates under heteroskedasticity (Silva Santos and Tenreyro, 2006) and naturally accommodates zero trade flows. All specifications include exporter-year ($\alpha_{i,t}$) and importer-year ($\gamma_{j,t}$) fixed effects, which absorb all country-specific time-varying determinants of trade, including GDP, multilateral resistance terms (Anderson and van Wincoop, 2003), macroeconomic fluctuations, and unilateral trade policies. Standard errors are clustered at the country-pair level.

Choice of fixed effects. The structural gravity literature recommends country-pair fixed effects to control for unobserved bilateral heterogeneity and the endogeneity of RTAs (Baier and Bergstrand, 2007; Head and Mayer, 2014). However, pair fixed effects identify the E-RTA coefficient solely from within-pair changes over time. Because E-RTA status switches on for relatively few pairs in our sample, this generates severe regressor sparsity, which exacerbates the incidental parameter bias documented by Weidner and Zylkin (2021) for PPML with three-way fixed effects. Umana-Dajud (2025) shows more generally that sparse policy variables in gravity models suffer from inflated estimator variance and breakdown of standard asymptotic approximations, rendering both detection of true effects and calibration of inference unreliable.

For this reason, our preferred specification includes exporter-year and importer-year fixed effects but not pair fixed effects, following recent practice in settings with sparse policy variation (Anderson and Yotov, 2020; Mayer et al., 2021b). Identification therefore comes from bilateral cross-sectional variation across pairs, conditional on the full set of country-year fixed effects. We acknowledge that this specification does not control for time-invariant bilateral confounders (unobserved bilateral affinity, historical ties, etc.) that may correlate with both E-RTA adoption and trade levels. The selection patterns documented in Section 2 (E-RTA pairs are richer, farther apart, and trade less) are consistent with such confounding. Columns 5–8 of Table 2 report pair-FE estimates for comparison, and OLS results with and without pair fixed effects appear in Table 5 in the Appendix.

5 Results

5.1 Impact on goods trade

Table 2 reports our main PPML results. Column (1) estimates the standard gravity model with a single RTA dummy, yielding a coefficient of 0.370, which implies that RTAs increase bilateral trade by approximately $\exp(0.370) - 1 = 45$ percent, consistent with the gravity literature (Head and Mayer, 2014; Cipollina and Salvatici, 2010).

Column (2) replaces the RTA dummy with the E-RTA dummy. The coefficient is 0.100, positive but not statistically significant. Column (3) includes both RTA and E-RTA simultaneously: the RTA coefficient rises to 0.414, while the E-RTA coefficient is -0.245, significant at the 5% level. This implies that RTAs with e-commerce chapters are associated with approximately 22 percent less trade than RTAs without them. Adding the dispute settlement dummy in column (4) does not change this pattern: E-RTA remains negative at -0.210 and the dispute settlement coefficient is close to zero.

The sign reversal between columns (2) and (3) reflects the high correlation between the RTA and E-RTA dummies, since E-RTAs are a subset of RTAs. Without controlling for RTA status, the E-RTA coefficient captures the average RTA effect rather than the incremental contribution of e-commerce provisions.

Columns (5)–(8) add country-pair fixed effects. Both RTA and E-RTA coefficients become small and statistically insignificant, consistent with the sparsity-driven loss of power discussed above.

The finding that the inclusion of e-commerce provisions in RTAs is associated with a reduction in the positive trade impact of RTAs is, at first glance, counterintuitive. E-commerce chapters are typically designed to facilitate cross-border digital transactions through commitments such as paperless trading, recognition of electronic signatures, prohibition of customs duties on electronic transmissions, data flow facilitation, and cooperation on consumer protection and cybersecurity. WTO mappings of RTAs show that such provisions increasingly cover areas like electronic authentication, privacy rules, and digital trade facilitation measures, but remain highly heterogeneous in scope and depth across agreements (Monteiro and Teh, 2017). In principle, these rules should lower fixed and variable trade costs, thereby reinforcing the traditional trade-creating effects of RTAs captured in gravity models.

However, several mechanisms may rationalize a negative marginal effect. First, e-commerce provisions often reflect regulatory depth rather than pure liberalization. Many clauses, such as data localization rules, privacy constraints, or cybersecurity compliance requirements, can increase compliance costs for firms engaged in cross-border commerce, particularly in goods sectors that rely heavily on digital infrastructure (logistics coordination, platform intermediation, customs documentation systems). In our gravity framework, this can introduce new forms of

"regulatory distance" that may offset tariff reductions or traditional trade facilitation gains. Second, these provisions may be correlated with agreements among already highly integrated partners, where marginal gains from further liberalization are limited, while the inclusion of complex digital rules adds new frictions for certain sectors. This is consistent with broader evidence showing that deeper agreements may generate heterogeneous trade effects when they introduce complex regulatory obligations and compliance requirements. In particular, recent work on deep trade agreements finds that such provisions tend to benefit larger and globally integrated firms while smaller exporters may face higher adjustment and compliance costs (Neri-Lainé et al., 2023).

Table 2: Gravity Regression Results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RTA	0.370^a		0.414^a	0.416^a	-0.003		-0.018	-0.018
	(0.054)		(0.058)	(0.058)	(0.040)		(0.054)	(0.054)
E-RTA dummy		0.100	-0.245^b	-0.210		0.019	0.036	0.042
		(0.108)	(0.118)	(0.136)		(0.034)	(0.054)	(0.057)
E-RTA, Disp. Settlement				-0.004				-0.001
				(0.004)				(0.002)
Ln. Dist.	-0.770^a	-0.857^a	-0.755^a	-0.753^a				
	(0.033)	(0.028)	(0.033)	(0.033)				
Common border	0.384^a	0.429^a	0.381^a	0.383^a				
	(0.063)	(0.067)	(0.063)	(0.063)				
Common official language	0.144^b	0.176^a	0.148^a	0.148^a				
	(0.057)	(0.056)	(0.057)	(0.057)				
Common currency	0.014	0.043	0.007	0.006				
	(0.074)	(0.079)	(0.073)	(0.074)				
Pair Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes
Country-Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R2	0.941	0.940	0.941	0.941	0.993	0.993	0.993	0.993
Observations	501208	501178	501178	501178	493593	516087	493563	493563

Note: The dependent variable is the trade flow between origin and destination. Columns (1)-(4) include exporter-year and importer-year fixed effects. Columns (5)-(8) additionally include country-pair fixed effects. Standard errors in parentheses are robust and clustered at country pair level. Statistically significant at ^{c} 10% ^{b} 5% ^{a} 1%.

5.2 Depth of e-commerce provisions

Table 3 examines whether the depth of e-commerce commitments contained in trade agreements matters for bilateral trade flows. To capture this dimension, we replace the simple presence of an e-commerce chapter with a more detailed indicator measuring the logarithm of the number of distinct e-commerce provisions included in the agreement. These provisions cover a broad range of digital trade disciplines, such as, as said in previous section, electronic authentication, consumer protection, data flows, privacy protection, cybersecurity cooperation, and the prohibition of customs duties on electronic transmissions. The underlying hypothesis is that agreements containing a larger and more sophisticated set of digital trade rules should reduce transaction costs more effectively, improve regulatory certainty, and thereby foster greater cross-border trade.

The results do not support this expectation: Across all specifications, the estimated coefficient on the depth variable ranges from 0.051 to 0.111 and remains statistically insignificant. This suggests that the intensity or comprehensiveness of e-commerce chapters does not exert a measurable effect on trade flows once other determinants are controlled for. In other words, while

the existence of digital trade provisions may reflect a broader process of economic integration, increasing the number of provisions does not appear to generate additional effetct. One possible interpretation is that digital trade gains may operate through threshold effects: once a minimum regulatory framework is established, additional legal provisions yield diminishing marginal returns. Another explanation is that many e-commerce clauses remain relatively soft, declaratory, or weakly enforceable, limiting their practical impact on firms' trading behavior (Section 2.3).

These findings may also indicate that the effectiveness of digital trade agreements depends less on the quantity of provisions than on their quality, enforceability, and domestic implementation capacity. For instance, advanced rules on cross-border data flows or electronic signatures may only translate into higher trade volumes when countries possess adequate digital infrastructure, efficient payment systems, and compatible regulatory institutions. Consequently, counting the number of provisions may overestimate the true degree of policy integration in the digital economy. The absence of a significant relationship therefore suggests that deeper legal commitments alone are insufficient to stimulate trade unless accompanied by broader economic and institutional conditions supporting digital commerce.

Table 3: Gravity Regression Results. Number of E-commerce provisions

	(1)	(2)	(3)
RTA		0.420^a	0.420^a
		(0.058)	(0.058)
E-RTA dummy	0.204	-0.096	-0.058
	(0.259)	(0.266)	(0.450)
E-RTA, Disp. Settlement			0.001
			(0.013)
Ln. of # E.C. provisions	-0.051	-0.087	-0.111
	(0.092)	(0.089)	(0.266)
Ln. Dist.	-0.855^a	-0.751^a	-0.751^a
	(0.028)	(0.034)	(0.034)
Common border	0.430^a	0.382^a	0.382^a
	(0.067)	(0.063)	(0.063)
Common official language	0.177^a	0.149^a	0.149^a
	(0.056)	(0.057)	(0.057)
Common currency	0.046	0.012	0.012
	(0.079)	(0.074)	(0.074)
R2	0.940	0.942	0.942
Observations	498825	498825	498825

Note: The dependent variable is the trade flow between origin and destination. All estimations include exporter-year and importer-year fixed effects. Standard errors in parentheses are robust and clustered at country pair level. Statistically significant at ^{c} 10% ^{b} 5% ^{a} 1%.

5.3 Heterogeneity by development level

The negative average coefficient associated with E-RTAs may partly reflect the selection patterns discussed above: country pairs signing these agreements are typically richer, geographically more

distant, and already trade less on average.

Hence, another explanation of this negative coefficient may lie in heterogeneous effects across country groups, particularly across income levels. E-commerce provisions are likely to generate stronger benefits in economies with advanced digital infrastructure, efficient logistics systems, and firms capable of leveraging platform-based trade. High-income countries are generally better equipped to comply with and benefit from digital trade facilitation measures - such as interoperable customs systems, secure payment infrastructures, and robust data governance frameworks - which can translate into net trade gains.

By contrast, low- and middle-income countries may face substantial compliance and adaptation costs, including investments in Information and Communication Technology infrastructure, legal reforms, and cybersecurity systems, that can outweigh short-run gains, especially in trade in goods. In addition, if e-commerce provisions reinforce digital substitution or increase platform concentration, they may disproportionately favor exporters from technologically advanced economies, potentially crowding out exports from less digitally integrated partners. As a result, aggregate gravity estimations may produce a negative average effect even if the impact is positive among high-income countries.

To examine whether the effectiveness of e-commerce provisions depends on the level of development of trading partners, we construct a "Pair World Bank Income Category Score." Each World Bank income group is assigned an integer value (Low = 1, Lower-middle = 2, Upper-middle = 3, High = 4), and the exporter and importer scores are summed to obtain a bilateral indicator ranging from 2 to 8. The underlying hypothesis is that higher-income country pairs benefit more from e-commerce provisions because they possess more advanced digital infrastructure, stronger regulatory frameworks, and greater digital readiness.

Table 4 reports the results. In column (1), the E-RTA coefficient is -0.629 and the interaction with the income score is 0.134, statistically significant at the 1% level. The E-RTA effect turns positive when the income score reaches 5 or above: $-0.629 + 0.134 \times 5 = 0.041$, a threshold met by, for example, a lower-middle-income country paired with a high-income partner, or two upper-middle-income countries. For two high-income countries (score = 8), the implied effect is positive and economically meaningful. Column (2) adds the dispute settlement dummy and column (3) controls for the log of combined GDP per capita. The interaction coefficient remains stable across all three specifications (0.134, 0.129, and 0.123).

5.4 Robustness

We present additional analyses in the Appendix. In each case, the average E-RTA effect remains insignificant or negative, reinforcing the baseline finding. Table 6 controls for overall agreement depth using the DESTA database; Table 7 controls for economic integration levels using the NSF-Kellogg index. Neither changes the E-RTA coefficient. Table 8 tests for differential effects across product types using Rauch's (1999) classification; the E-RTA interaction with differentiated goods is insignificant. Tables 9 and 10 disaggregate by agricultural versus industrial goods and by broad economic categories, with no significant E-RTA heterogeneity. Table 11 replaces goods trade with services trade; E-RTAs show no significant effect. Table 12 controls for bilateral applied tariffs at the HS two-digit level; the E-RTA coefficient remains insignificant. Finally, Table 5 reports OLS estimates with and without pair fixed effects, yielding qualitatively similar results: OLS without pair FE produces an E-RTA coefficient of -0.539, larger in magnitude than PPML, consistent with the known upward bias of OLS in gravity models (Silva Santos and Tenreyro, 2006).

Table 4: Gravity Regression Results

	(1)	(2)	(3)
RTA	0.421^a	0.421^a	0.428^a
	(0.058)	(0.058)	(0.059)
E-RTA dummy	-0.629^b	-0.593^b	-0.601^b
	(0.244)	(0.281)	(0.245)
E-RTA, Disp. Settlement		-0.003	
		(0.004)	
E-RTA dummy × WB Inc. category score	0.134^a	0.129^b	0.123^b
	(0.050)	(0.054)	(0.051)
Ln. Dist.	-0.749^a	-0.748^a	-0.748^a
	(0.034)	(0.034)	(0.034)
Common border	0.384^a	0.386^a	0.394^a
	(0.063)	(0.063)	(0.061)
Common official language	0.154^a	0.154^a	0.150^a
	(0.056)	(0.056)	(0.056)
Common currency	0.007	0.006	0.012
	(0.074)	(0.074)	(0.074)
$\ln(GDP/Pop\_o + GDP/Pop\_d)$			0.090
			(0.070)
R2	0.941	0.941	0.941
Observations	494043	494043	464462

Note: The dependent variable is the trade flow between origin and destination. All estimations include exporter-year and importer-year fixed effects. Standard errors in parentheses are robust and clustered at country pair level. Statistically significant at ^{c} 10% ^{b} 5% ^{a} 1%.

6 Conclusion

In this paper, we construct a dataset of 76 regional trade agreements containing e-commerce provisions, document their rapid proliferation and geographic concentration, and estimate their impact on bilateral trade. Three findings stand out.

First, the average E-RTA increases trade by less than the typical RTA. Conditional on a standard RTA dummy, the E-RTA coefficient is -0.245 in our preferred PPML specification. This does not imply that e-commerce provisions reduce trade in an absolute sense, but rather that RTAs with these chapters are associated with less bilateral trade than RTAs without them, likely reflecting the selection of country pairs into E-RTAs. Also, while e-commerce chapters are designed to reduce trade costs through digital facilitation (e.g., paperless trade, electronic signatures, data flow provisions), they may also introduce new forms of regulatory burden. In particular, provisions related to data governance, privacy, or cybersecurity can increase compliance costs for firms, thereby generating a form of "regulatory distance" that may offset traditional trade-facilitating gains within the gravity framework.

Second, the depth and legal enforceability of e-commerce provisions do not matter for trade outcomes. Neither the number of provisions nor the presence of dispute settlement mechanisms produces a statistically significant effect in any specification. This result is consistent with the interpretation that the effectiveness of digital trade rules depends less on their formal quantity than on their economic relevance, enforceability, and implementation. It also aligns with the idea that many provisions may be relatively soft or declaratory, limiting their ability to generate measurable reductions in trade costs.

Third, development level is a critical moderator. E-commerce provisions increase trade between country pairs whose combined World Bank income score reaches 5 or above, with the effect growing in the level of development. This heterogeneity is in line with the fact that the gains from e-commerce provisions are likely to be concentrated among countries with higher levels of digital readiness. High-income economies are better able to comply with and benefit from digital trade facilitation measures due to stronger ICT infrastructure, more efficient logistics systems, and more advanced regulatory frameworks. By contrast, low- and middle-income countries may face substantial adjustment costs—such as investments in digital infrastructure, legal reforms, and cybersecurity capacity—that can outweigh short-run gains. As a result, aggregate estimates may mask positive effects within more developed country pairs.

These findings have implications for digital trade policy. The mere inclusion of e-commerce chapters in trade agreements does not appear sufficient to increase trade flows. Instead, the effectiveness of these provisions depends on the complementary infrastructure, regulatory capacity, and digital readiness of both trading partners. In addition, the negative or muted average effects observed in the data suggest that digital trade provisions may simultaneously reduce trade frictions for some firms while increasing compliance costs for others, particularly through regulatory heterogeneity and uneven implementation capacity across countries. This suggests that e-commerce provisions may be most effective when accompanied by investments in digital infrastructure and institutional capacity, particularly in developing countries.

Our analysis has limitations. The identification strategy relies on cross-sectional bilateral variation without pair fixed effects, leaving the estimates vulnerable to omitted bilateral confounders. The data end in 2015, before the rapid expansion of digital trade accelerated by the COVID-19 pandemic and before recent comprehensive digital trade agreements (e.g., the Digital Economy Partnership Agreement). Furthermore, aggregate trade flows may mask heterogeneous effects across specific digital products and services that are most directly affected by e-commerce provisions. Future work with more granular data on digital trade flows, combined with the post-2017 expansion of E-RTAs, may allow for pair-FE identification as the policy variation becomes

less sparse.

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Appendix

A.1 OLS estimations

Table 5 presents OLS estimates of equation (1). Columns (1)–(4) include exporter-year and importer-year fixed effects; columns (5)–(8) add pair fixed effects. The results are qualitatively consistent with the PPML estimates.

Table 5: Gravity Regression Results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RTA	0.489^a		0.577^a	0.577^a	0.034		0.147^a	0.147^a
	(0.035)		(0.039)	(0.039)	(0.023)		(0.028)	(0.028)
E-RTA dummy		-0.111^b	-0.539^a	-0.552^a		-0.164^a	-0.270^a	-0.269^a
		(0.052)	(0.060)	(0.063)		(0.034)	(0.042)	(0.044)
E-RTA, Disp. Settlement				0.003				-0.000
				(0.003)				(0.002)
Ln. Dist.	-1.629^a	-1.723^a	-1.612^a	-1.612^a				
	(0.019)	(0.018)	(0.019)	(0.019)				
Common border	0.661^a	0.755^a	0.654^a	0.654^a				
	(0.093)	(0.094)	(0.093)	(0.093)				
Common official language	0.966^a	1.007^a	0.962^a	0.961^a				
	(0.035)	(0.035)	(0.035)	(0.035)				
Common currency	0.307^a	0.392^a	0.255^b	0.255^b				
	(0.101)	(0.101)	(0.101)	(0.101)				
Pair Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes
Country-Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R2	0.742	0.741	0.742	0.742	0.897	0.896	0.897	0.897
Observations	418001	417971	417971	417971	416044	434267	416014	416014

Note: The dependent variable is the trade flow between origin and destination. All estimations include exporter-year and importer-year fixed effects. Standard errors in parentheses are robust and clustered at country pair level. Statistically significant at ^{c} 10% ^{b} 5% ^{a} 1%.

A.2 Agreement depth

Table 6 adds a measure of overall agreement depth constructed from the World Bank's Content of Deep Trade Agreements (DTA) database. The depth measure is positive and significant, indicating that deeper agreements increase trade, but the E-RTA coefficient is unchanged.

A.3 Economic integration index

Table 7 controls for the level of economic integration using the NSF-Kellogg Institute Economic Integration Index (ranging from 0 for no agreement to 6 for economic union).

A.4 Differentiated versus homogeneous products

Table 8 tests whether E-RTAs have a larger effect on differentiated goods using Rauch's (1999) classification. Differentiated goods trade more overall, but the interaction with E-RTA is not statistically significant.

Table 6: Gravity Regression Results controlling for the agreement's depth

	(1)	(2)	(3)	(4)
RTA	0.152		0.151	0.169^{c}
	(0.095)		(0.096)	(0.097)
E-RTA dummy		-0.021	-0.009	0.020
		(0.074)	(0.074)	(0.078)
E-RTA, Disp. Settlement				-0.008^{b}
				(0.003)
LnDepthMeasure	0.077^{a}	0.123^{a}	0.078^{a}	0.074^{b}
	(0.027)	(0.018)	(0.029)	(0.029)
Ln. Dist.	-0.778^{a}	-0.789^{a}	-0.778^{a}	-0.770^{a}
	(0.033)	(0.031)	(0.033)	(0.034)
Common border	0.385^{a}	0.388^{a}	0.384^{a}	0.390^{a}
	(0.064)	(0.064)	(0.064)	(0.064)
Common official language	0.153^{a}	0.160^{a}	0.153^{a}	0.155^{a}
	(0.058)	(0.058)	(0.058)	(0.059)
Common currency	-0.006	-0.008	-0.003	-0.013
	(0.073)	(0.073)	(0.073)	(0.074)
R2	0.941	0.941	0.941	0.941
Observations	501208	501178	501178	501178

Note: The dependent variable is the trade flow between origin and destination. All estimations include exporter-year and importer-year fixed effects. Standard errors in parentheses are robust and clustered at country pair level. Statistically significant at ^{c} 10% ^{b} 5% ^{a} 1%.

Table 7: Gravity Regression Results controlling for the degree of integration of the agreement

	(1)	(2)	(3)	(4)
Eco. integration index	0.112^a		0.119^a	0.119^a
	(0.017)		(0.018)	(0.018)
Ln. Dist.	-0.742^a	-0.857^a	-0.733^a	-0.733^a
	(0.036)	(0.028)	(0.036)	(0.036)
Common border	0.440^a	0.429^a	0.438^a	0.439^a
	(0.066)	(0.067)	(0.066)	(0.066)
Common official language	0.205^a	0.176^a	0.212^a	0.213^a
	(0.058)	(0.056)	(0.056)	(0.056)
Common currency	-0.180^b	0.043	-0.197^b	-0.197^b
	(0.076)	(0.079)	(0.076)	(0.076)
E-RTA dummy		0.100		
		(0.108)		
E-RTA dummy=1			0.108	0.161
			(0.095)	(0.104)
E-RTA dummy=1 × Eco. integration index			-0.110^c	-0.124^b
			(0.062)	(0.051)
E-RTA, Disp. Settlement				-0.002
				(0.004)
R2	0.943	0.940	0.943	0.943
Observations	395070	501178	395046	395046

Note: The dependent variable is the trade flow between origin and destination. All estimations include exporter-year and importer-year fixed effects. Standard errors in parentheses are robust and clustered at country pair level. Statistically significant at ^{c} 10% ^{b} 5% ^{a} 1%.

Table 8: Gravity Regression Results. Rauch's product classification

	(1)	(2)
RTA	0.463^a	0.463^a
	(0.060)	(0.060)
E-RTA dummy	-0.310^b	-0.285^b
	(0.124)	(0.139)
Differentiated product dummy	0.638^a	0.639^a
	(0.058)	(0.059)
E-RTA dummy × Differentiated product dummy		-0.038
		(0.155)
Ln. Dist.	-0.693^a	-0.693^a
	(0.034)	(0.034)
Common border	0.396^a	0.396^a
	(0.062)	(0.062)
Common official language	0.140^b	0.140^b
	(0.056)	(0.056)
Common currency	-0.001	-0.001
	(0.069)	(0.069)
R2	0.891	0.891
Observations	889824	889824

Note: The dependent variable is the trade flow between origin and destination. All estimations include exporter-year and importer-year fixed effects. Standard errors in parentheses are robust and clustered at country pair level. Statistically significant at ^{c} 10% ^{b} 5% ^{a} 1%.

A.5 Agricultural versus industrial goods

Table 9 distinguishes agricultural goods (HS2 chapters 01–24) from industrial goods (chapters 25–97) using CEPII's BACI database (Gaulier and Zignago, 2010). The E-RTA interaction is not significant for either sector.

Table 9: Gravity Regression Results. Agriculture vs Industrial Goods.

	(1)	(2)
Free Trade Agreement	0.468^a	0.468^a
	(0.062)	(0.062)
E-RTA dummy	-0.292^a	-0.311^a
	(0.110)	(0.115)
Agricultural product dummy	-2.455^a	-2.461^a
	(0.044)	(0.045)
E-RTA dummy × Agricultural product dummy		0.216
		(0.138)
Ln. Dist.	-0.707^a	-0.707^a
	(0.035)	(0.035)
Common border	0.424^a	0.424^a
	(0.066)	(0.066)
Common official language	0.078	0.078
	(0.069)	(0.069)
Common currency	-0.082	-0.082
	(0.071)	(0.071)
R2	0.931	0.931
Observations	1277654	1277654

Note: The dependent variable is the trade flow between origin and destination. All estimations include exporter-year and importer-year fixed effects. Standard errors in parentheses are robust and clustered at country pair level. Statistically significant at ^{c} 10% ^{b} 5% ^{a} 1%.

A.6 Broad economic categories

Table 10 disaggregates trade by BEC categories (capital, intermediate, and consumption goods) across agricultural, energy, and industrial sectors.

A.7 Trade in services

Table 11 replaces goods trade with bilateral services trade from the World Bank's Trade in Services Database (Francois and Pindyuk, 2013). E-RTAs show no statistically significant effect on services trade.

A.8 Controlling for bilateral applied tariffs

Table 12 adds bilateral applied tariffs at the HS two-digit level to the baseline specification.

Table 10: Gravity Regression Results. BEC 1

	(1)	(2)
RTA	0.468^a	0.468^a
	(0.062)	(0.062)
E-RTA dummy	-0.292^a	-0.101
	(0.110)	(0.133)
Bec1==Ag_KG	-6.541^a	-6.535^a
	(0.126)	(0.129)
Bec1==Ag_int	-0.621^a	-0.621^a
	(0.051)	(0.053)
Bec1==Na_KG	1.162^a	1.165^a
	(0.062)	(0.063)
Bec1==Na_fin	0.919^a	0.931^a
	(0.077)	(0.078)
Bec1==Na_int	2.242^a	2.247^a
	(0.044)	(0.045)
Bec1==En_int	1.032^a	1.036^a
	(0.081)	(0.083)
Ln. Dist.	-0.707^a	-0.707^a
	(0.035)	(0.035)
Common border	0.424^a	0.424^a
	(0.066)	(0.066)
Common official language	0.078	0.078
	(0.069)	(0.069)
Common currency	-0.082	-0.082
	(0.071)	(0.071)
TopicXAgricultureCapitalGoods		-0.190
		(0.301)
TopicXAgricultureIntermediary		0.017
		(0.134)
TopicXIndustryCapitalGoods		-0.121
		(0.182)
TopicXIndustryFinal		-0.492^a
		(0.159)
TopicXIndustryIntermediary		-0.194
		(0.156)
TopicXEnergyIntermediary		-0.147
		(0.204)
R2	0.864	0.864
Observations	4471789	4471789

Note: The dependent variable is the trade flow between origin and destination. All estimations include exporter-year and importer-year fixed effects. Standard errors in parentheses are robust and clustered at country pair level. Statistically significant at ^{c} 10% ^{b} 5% ^{a} 1%.

Table 11: Gravity Regression Results. Trade in Services.

	(1)	(2)	(3)	(4)
RTA	0.186^a		0.223^a	0.222^a
	(0.071)		(0.079)	(0.079)
E-RTA dummy		0.003	-0.191	-0.213
		(0.112)	(0.134)	(0.140)
E-RTA, Disp. Settlement				0.006
				(0.007)
Ln. Dist.	-0.632^a	-0.689^a	-0.621^a	-0.622^a
	(0.033)	(0.025)	(0.035)	(0.035)
Common border	0.175^b	0.175^b	0.171^b	0.170^b
	(0.078)	(0.079)	(0.077)	(0.077)
Common official language	0.335^a	0.328^a	0.343^a	0.343^a
	(0.066)	(0.065)	(0.065)	(0.065)
Common currency	0.092	0.119	0.085	0.085
	(0.079)	(0.081)	(0.079)	(0.079)
R2	0.925	0.925	0.926	0.926
Observations	52761	52562	52562	52562

Note: The dependent variable is the trade in services flow between origin and destination. Standard errors in parentheses are robust and clustered at country pair level. Statistically significant at ^{c} 10% ^{b} 5% ^{a} 1%.

Table 12: Gravity Regression Results with Applied Tariffs

	(1)	(2)	(3)	(4)
RTA	0.300^a		0.345^a	0.345^a
	(0.060)		(0.063)	(0.063)
E-RTA dummy		0.001	-0.226^c	-0.201
		(0.118)	(0.127)	(0.143)
E-RTA, Disp. Settlement				-0.004
				(0.004)
Ln. Dist.	-0.760^a	-0.796^a	-0.749^a	-0.747^a
	(0.034)	(0.031)	(0.034)	(0.034)
LnTariffs	-2.374^a	-5.160^a	-2.176^b	-2.179^b
	(0.851)	(0.873)	(0.849)	(0.849)
Common border	0.371^a	0.393^a	0.367^a	0.368^a
	(0.064)	(0.067)	(0.064)	(0.064)
Common official language	0.146^b	0.173^a	0.149^a	0.149^a
	(0.058)	(0.057)	(0.058)	(0.058)
Common currency	0.013	0.022	0.008	0.007
	(0.074)	(0.076)	(0.074)	(0.074)
R2	0.940	0.940	0.940	0.940
Observations	127440	127430	127430	127430

Note: The dependent variable is the trade flow between origin and destination. All estimations include exporter-year and importer-year fixed effects. Bilateral applied tariffs (MAcMap-HS6, ITC-CEPII) are available every three years (2001, 2004, 2007, 2010, 2013, 2016), so the estimation sample is restricted to those years. Standard errors in parentheses are robust and clustered at country pair level. Statistically significant at ^{c} 10% ^{b} 5% ^{a} 1%.

A.9 List of E-RTAs

Table 13: List of trade agreements containing E.C. provisions

Name	Signature	Inforce
Gulf Cooperation Council (GCC)	2001	2003
EU - Croatia	2001	2002
EU - Chile	2002	2003
US - Singapore	2003	2004
Singapore - Australia	2003	2003
Jordan - Singapore	2004	2005
CAFTA-DR	2004	2006
US - Morocco	2004	2006
Thailand - Australia	2004	2005
US - Australia	2004	2005
Trans-Pacific Strategic Economic Partnership	2005	2006
India - Singapore	2005	2005
US - Bahrain	2005	2006
Korea, Republic of - Singapore	2005	2006
Thailand - New Zealand	2005	2005
Panama - Singapore	2006	2006
EU - Albania	2006	2006
US - Peru	2006	2009
US - Oman	2006	2009
Chile - Colombia	2006	2009
US - Colombia	2006	2012
Nicaragua - Chinese Taipei	2006	2008
US - Panama	2007	2012
Korea, Republic of - US	2007	2012
Colombia - Northern Triangle (El Salvador, Guatemala, Honduras)	2007	2009
Australia - Chile	2008	2009
Canada - Colombia	2008	2011
EFTA - Colombia	2008	2011
Peru - Singapore	2008	2009
EU - Bosnia and Herzegovina	2008	2008
EU - CARIFORUM States EPA	2008	2008
Canada - Peru	2008	2009
EU - Serbia	2008	2010
Gulf Cooperation Council (GCC) - Singapore	2008	2013
Japan - Switzerland	2009	2009
ASEAN - Australia - New Zealand	2009	2010
EFTA - GCC	2009	2014
Canada - Jordan	2009	2012
Peru - China	2009	2010
EU - Korea, Republic of	2010	2011
EFTA - Peru	2010	2011
Hong Kong, China - New Zealand	2010	2011
Canada - Panama	2010	2013
Costa Rica - Singapore	2010	2013
Peru - Korea, Republic of	2011	2011
Costa Rica - Peru	2011	2013
Panama - Peru	2011	2012
Mexico - Central America	2011	2012
Malaysia - Australia	2012	2013
EU - Central America	2012	2013
EU - Colombia and Peru	2012	2013
Hong Kong, China - Chile	2012	2014
Korea, Republic of - Colombia	2013	2016

EFTA - Central America (Costa Rica and Panama)	2013	2014
New Zealand - Chinese Taipei	2013	2013
Singapore - Chinese Taipei	2013	2014
Canada - Honduras	2013	2014
Canada - Rep. of Korea	2014	2015
Japan - Australia	2014	2015
Korea, Republic of - Australia	2014	2014
EU - Ukraine	2014	2014
Mexico - Panama	2014	2015
EU - Georgia	2014	2014
EU - Rep. of Moldova	2014	2014
Pacific Alliance	2014	2016
Australia - China	2015	2015
China - Rep. of Korea	2015	2015
Rep. of Korea - Viet Nam	2015	2015
Japan - Mongolia	2015	2016
Eurasian Economic Union (EAEU) - Viet Nam	2015	2016
Canada - Ukraine	2016	2017
Trans-Pacific Partnership	2016	