Do Trade Agreements Actually Reduce Trade Volatility?

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Abstract

A frequently stated objective of regional and multilateral trade agreements is to stabilize trade and reduce volatility in trade flows. We examine whether trade agreements accomplish this goal. Using a structural gravity approach we identify two potential channels through which international trade institutions may influence the volatility of bilateral trade flows: by affecting the variance of trade barriers and by affecting the covariance of economic outcomes between the trading partners. We then use a panel of bilateral industry-level trade data to empirically examine the effects of regional trade agreements and GATT/WTO membership on export earnings volatility. We find some evidence that joining a multilateral trade agreement such as the GATT does make export earnings less volatile. However, regional trade agreements increase measured volatility in bilateral exports, and this rise in volatility increases as the agreement becomes deeper and more integrated.

Keywords: Export earnings volatility, structural gravity model, regional trade agreements, deep trade agreements.

JEL Classification Numbers: F13, F14, F15.

1 Introduction

Although much empirical attention has been paid to the second part of the World Trade Organization's (WTO) mandate, "to ensure that trade flows as ... freely as possible", less attention has been paid to the first part of that mandate, "to ensure that trade flows as smoothly (and) predictably ... as possible". Indeed, it is immediately apparent that creating conditions for a stable and predictable business environment is considered vital to the mission of not only the WTO, but also the vast majority of regional trade agreements (RTAs). References to creating "stability" or "predictability" or reducing "uncertainty" abound on the WTO webpage and also appear in the objective statements of most RTAs.[1] Indeed, institutions such as the WTO are not viewed simply as providing a forum for negotiated tariff concessions, but also increasing the security and stability of the international trading system by securing those market access commitments against unilateral infringement.[2] However, this raises an empirical question of whether countries that join a trade agreement in fact experience more stability in their trade relations (measured by reduced trade flow volatility). In this paper, we conduct a large-scale empirical test of this question using industry-level bilateral trade flow data and a gravity specification approach.

Two recent events have focused attention on the ability of trade agreements to provide more stability in trade relationships. The first event was China's ascension into the WTO and the subsequent explosion in Chinese exports. As many researchers have noticed (e.g., see [Feng et al., 2017]) China was already afforded most-favored nation (MFN) status by many WTO members, including the United States, prior to their entry into the WTO. Thus, their entry into the WTO was not accompanied by much change in the de facto tariffs faced by Chinese exporters. As a result, the large increase in Chinese exports has been attributed primarily to China obtaining access to the WTO's mechanisms for providing stability and

[1] Both [Mansfield and Reinhardt, 2008] and [Rose, 2005] provide numerous examples of the stated intentions of trade agreement being to stabilize trade flows.

[2] For example see [Bagwell and Staiger, 2001] and [Bagwell et al., 2002] which lay out how the legal framework of the GATT/WTO achieves secure market access.

certainty in trade relationships. Indeed, [Handley and Limao, 2017] estimates that one-third of the export growth between the U.S. and China can be attributed to greater certainty about U.S. trade policy. The second event was the trade collapse during the global recession (i.e., the almost unprecedented fall in the global volume of trade that far outweighed the fall in global output), which sparked a large literature on its causes[3] and generated interest in the potential role of the WTO and other trade institutions as a force for trade stability. In addition to several theoretical and empirical investigations of the link between the policy certainty generated by trade agreements and various economic outcomes (e.g., see [Handley, 2014] and [Limao and Maggi, 2015]), a recent study, [Jakubik and Piermartini, 2019], found that WTO accession reduced the probability that import shocks would lead to changes in trade policy.

Given the centrality of trade stability in the objective statements of most international trade agreements, it is perhaps not surprising that this empirical question has been investigated previously (although the dearth of studies is perhaps surprising). Specifically, both [Rose, 2005] and [Mansfield and Reinhardt, 2008] run variants on what [Head and Mayer, 2014] defines as "naive gravity regressions": regressing several measures of trade volatility computed from annual bilateral trade flows on membership in an international trade agreement and a standard set of country-level control variables drawn from the gravity literature.[4] What is surprising, given the similarity of their approaches, is that their results differ drastically: [Rose, 2005] concludes that GATT/WTO membership has no effect on trade volatility while [Mansfield and Reinhardt, 2008] finds strong evidence that both RTA and GATT/WTO membership reduce trade volatility.

However, there have been many recent advances in the gravity regression literature, both

[3]Potential explanations for the trade collapse proposed in the literature are vertical production linkages [Levchenko et al., 2010], compositional effects [Engel and Wang, 2011], trade finance [Amiti and Weinstein, 2011], [Chor and Manova, 2012], and inventory adjustment [Alessandria et al., 2010].

[4][Rose, 2005] has over 175 countries from 1950–1999 and [Mansfield and Reinhardt, 2008] has 162 countries from 1951–2001. The reference to "naive" regressions is not meant to be disparaging as these two papers have combined over 500 citations including many in top economics journals. Rather, [Head and Mayer, 2014] uses the term to refer to the literature, prior to the appearance of papers such as [Anderson and Van Wincoop, 2003], which relied less on fixed effects to control for latent factors such as multilateral resistance.

theoretical and empirical, that have improved our understanding of the effects of trade agreements on trade flows (see surveys by [Head and Mayer, 2014] and [Yotov et al., 2016]). Our research question is clearly related to a long-standing empirical literature that has investigated the effect of trade agreement membership on the *volume* of international trade (e.g., see [Rose, 2004] and [Baier and Bergstrand, 2007]). Indeed, both [Cipollina and Salvatici, 2010] and [Head and Mayer, 2014] provide meta-analyses of this literature and conclude that RTAs have a large estimated effect on trade flows. The high variation in estimated effects across papers is also striking, with [Head and Mayer, 2014] noting that this variation is to a large extent driven by the equation specification. For instance, [Baier and Bergstrand, 2007] finds that the estimated effect of an RTA on trade almost doubles when country-pair fixed effects are included to control for latent factors that are potentially correlated with both trade flows and treaty participation. In this paper we revisit the question of how joint membership in an international trade agreement affects the volatility of trade flows between trading partners.

As a first step, we take a more structural approach to our estimating equation than [Rose, 2005] and [Mansfield and Reinhardt, 2008]. In so doing, we uncover a more ambiguous theoretical relationship between trade agreement membership and trade volatility than has been previously considered. Specifically, after removing own-country volatility (which we do through time-varying country fixed effects), we show that any remaining variation in bilateral trade volatility is due to variation in bilateral trade costs and the covariance in economic outcomes between the importing and exporting countries. The focus of the literature has been on how trade agreements can provide more certainty with respect to bilateral trade flows by reducing the volatility of bilateral trade barriers. However, trade agreements — especially explicitly regional trade agreements — can also influence bilateral trade volatility by affecting the covariance in economic outcomes between countries, and this has received less attention in the literature. Indeed, there is a small empirical literature suggesting that such regional trade agreements have increased business cycle co-movements between member countries (e.g., see [Bejan, 2011] and [De Pace, 2013]). If this is the case, then it is possible that even an agreement that successfully reduces the volatility of trade barriers between trading partners could still increase bilateral trade volatility.[5] Thus, the question of whether trade agreements actually reduce overall trade volatility becomes an empirical question (and, potentially, helps explain the ambiguous results from previous studies).

In this paper, we use a panel of industry-level bilateral trade data, covering nearly 200 countries and over 600 industries from 1964 to 2012, to estimate our preferred empirical specification. In contrast to previous studies, we employ time-varying country-industry fixed effects to control for country-industry volatility and run the specification at the industry level to control for industry heterogeneity (in section 4 we provide some evidence that measures of volatility averaged across industries are heavily influenced by the set of industries traded). Looking at the effect of trade agreement membership on various measures of bilateral export volatility reveals an interesting empirical regularity. While we find some evidence that WTO membership reduces trade volatility, we find more consistent evidence that membership in an RTA actually *increases* bilateral trade volatility. Indeed, the positive impact of RTA membership on trade volatility increases as the member countries become more integrated (i.e., progress from a free trade agreement, to a customs union, to a common market) and the agreement becomes deeper. This result is consistent with our theory, since a regional trade agreement is much more likely to impact bilateral comovements than a multilateral agreement. Of course, if this is the case, it suggests that the dual goals of regional trade agreements in both increasing integration and reducing trade volatility (at least as we have measured it) might be fundamentally incompatible.

In what follows, section 2 provides a structural approach to investigating the link between trade policy membership and bilateral trade volatility and section 3 introduces the data. We present the results in section 4 and we conclude in section 5.

[5]This also emphasizes the importance of distinguishing between policy certainty (as studied by [Handley, 2014] and [Limao and Maggi, 2015] and trade stability (as studied in this paper).

2 Motivation

Consider a standard sectoral structural gravity relationship between bilateral trade and its determinants, as derived by [Yotov et al., 2016] where i denotes the exporting country, j denotes the importing country, and k denotes the sector:[6]

$$X_{ijk} = \frac{Y_{ik} E_{jk}}{Y_k} \left(\frac{t_{ijk}}{\pi_{ik} P_{jk}} \right)^{1-\sigma_k} \tag{1}$$

Trade flows from exporter i to destination j in sector k, X_{ijk}, can be decomposed into three determinants: exporter size, Y_{ik}, importer size, E_{jk}, and a trade cost term, $\left(\frac{t_{ijk}}{\pi_{ik} P_{jk}} \right)^{1-\sigma_k}$. Y_{ik} is defined as the value of production or nominal income in country i and sector k and E_{jk} denotes expenditure in country j and sector k (the product of the two is normalized by aggregate world production $Y_k \equiv \sum_i Y_{ik}$). The trade cost term consists of three parts. First, the bilateral trade cost between countries i and j, t_{ijk}, which is sector-specific, captures both time-invariant aspects of the bilateral relationship (e.g., geographic or cultural distance) and time-varying aspects (e.g., tariffs or shipping costs). The other two terms, π_{ik} and P_{jk}, capture the standard multilateral resistance terms discussed in [Anderson and Van Wincoop, 2003].[7] They too are sector-specific and measure the ease of relative market access of the exporter i and importer j, respectively.

Assuming that the structural gravity equation (1) holds for every period t, it can be log-linearized to yield the familiar gravity equation:

$$\ln X_{ijkt} = \ln E_{jkt} + \ln Y_{ikt} - \ln Y_{kt} + (1-\sigma_k) \ln t_{ijkt} - (1-\sigma_k) \ln P_{jkt} - (1-\sigma_k) \ln \pi_{ikt} \tag{2}$$

Since we are interested in the volatility of trade flows, we compute the variance of these

[6] The derivation of this gravity equation follows [Larch and Wanner, 2017] and [Anderson and Yotov, 2016].

[7] Specifically, $\pi_{ik}^{1-\sigma_k} = \sum_j \left(\frac{t_{ijk}}{P_{jk}} \right)^{1-\sigma_k} \frac{E_{jk}}{Y_k}$ and $P_{jk}^{1-\sigma_k} = \sum_i \left(\frac{t_{ijk}}{\pi_{ik}} \right)^{1-\sigma_k} \frac{Y_{ik}}{Y_k}$. Finally, note that $\sigma_k > 1$ is the elasticity of substitution between product varieties in the underlying constant elasticity of substitution (CES) preferences.

logged trade flows, $Var(lnX_{ijkt})$, which can be expressed as the sum of variance and covariance terms:

$$Var(\ln X_{ijkt}) = V_{ikt} + V_{jkt} + (1-\sigma_k)^2 Var(\ln t_{ijkt}) + CV_{ijkt} \tag{3}$$

where V_{ikt} is a collection of variance and covariance terms specific to the exporting country and V_{jkt} is a collection of variance and covariance terms specific to the importing country. In our empirical specification, we absorb these variance terms into two time-varying country-industry fixed effects, α_{ikt} and α_{jkt}.

The focus of this paper is on the last two terms of this expression which capture the bilateral variation in trade volume volatility. First, $Var(\ln t_{ijkt})$ is the variance in bilateral trade costs across time. This encompasses both shipping costs (e.g., variance in fuel costs which could be a function of distance) and trade barriers (e.g., variance in tariffs). A key question is the extent to which a trade agreement between country i and j leads to more predictability in trade flows by reducing the year-to-year variability of these trade barriers. Thus, we model the variability of trade costs as given by:

$$(1-\sigma_k)^2 Var(\ln t_{ijkt}) = \gamma_{ijk} + \delta TA_{ijt} + \mu_{ijkt} \tag{4}$$

where γ_{ijk} represents an intrinsic component to this variability (e.g., distance or product characteristics), μ_{ijkt} is an additive error term, and $TA_{ijt} \in \{0,1\}$ is an indicator variable which takes the value of one if the two countries have a trade agreement in year t. International trade agreements are thought to reduce the variability of such trade barriers through several mechanisms. First, of course, they secure any market access commitments achieved through negotiations directly via restrictions on a country's trade policies (e.g., binding tariff ceilings and export subsidy restrictions). Second, they constrain the use of domestic policy (either intentional or unintentional) that might reduce market access below negotiated levels (see especially Article 3 of GATT).[8] Finally, they provide greater transparency and clarity

[8]For a discussion, see [Bagwell and Staiger, 2001].

about foreign trade barriers, thus imposing a cost to either introducing new trade barriers or "reinterpreting" old ones (as any changes would be subject to either retaliation or dispute settlement procedures). Therefore, the underlying assumption is that the existence of a trade agreement leads to greater certainty in trade barriers between the trading partners, and thus $\delta \leq 0$.

Second, CV_{ijkt} in equation (3) is a collection of cross-country covariance terms[9] (e.g., $Cov(\ln E_{jkt}, \ln Y_{ikt})$). Once again, these bilateral covariance terms could be a function of time-invariant factors that influence how similar the countries are in production structures or how closely their economies are intertwined. However, it is also reasonable to assume that these cross-country covariance terms may be a function of whether or not the countries have a trade agreement. Thus, we model the cross-country covariance between a trading pair as being given by:

$$CV_{ijkt} = \lambda_{ijk} + \rho TA_{ijt} + \nu_{ijkt} \tag{5}$$

where λ_{ijk} represents the intrinsic component to this variability and ν_{ijkt} is an additive error term. Note that, in this case, our prediction about the sign of ρ is somewhat ambiguous as we don't have an underlying model of how these countries are connected.[10] However, the conventional wisdom seems to be that international agreements tend, through increased connections and standardization of various policies, to lead to greater synchronizations of business cycles across member countries (see [Bejan, 2011] and [De Pace, 2013]). For example, production decisions in the exporting country might be more responsive to demand shocks in the importing country ($Cov(\ln Y_{ikt}, \ln E_{jkt}) > 0$) if the countries are members of a

[9]Specifically:

$$\begin{aligned}
CV_{ijkt} = {} & 2Cov(\ln E_{jkt}, \ln Y_{ikt}) + 2(1-\sigma_k)Cov(\ln E_{jkt}, \ln t_{ijkt}) - 2(1-\sigma_k)Cov(\ln E_{jkt}, \ln \pi_{ikt}) \\
& + 2(1-\sigma_k)Cov(\ln Y_{ikt}, \ln t_{ijkt}) - 2(1-\sigma_k)Cov(\ln Y_{ikt}, \ln P_{jkt}) - 2(1-\sigma_k)Cov(\ln Y_{kt}, \ln t_{ijkt}) \\
& - 2(1-\sigma_k)^2 Cov(\ln t_{ijkt}, \ln P_{jkt}) - 2(1-\sigma_k)^2 Cov(\ln t_{ijkt}, \ln \pi_{ikt}) + 2(1-\sigma_k)^2 Cov(\ln P_{jkt}, \ln \pi_{ikt})
\end{aligned}$$

[10]It should be acknowledged here that, in our modeling of the covariance, we are abstracting away from the underlying structure of our gravity equation which takes aggregate production and expenditure as exogenous, and thus the covariance of these terms is not modeled.

regional trade agreement that has facilitated trade connections. Thus, we expect that $\rho \geq 0$.

Combining the above, the resulting empirical gravity equation for the volatility of trade flows is given as the following:

$$Var(\ln X_{ijkt}) = \beta TA_{ijt} + \alpha_{ikt} + \alpha_{jkt} + \alpha_{ijk} + \epsilon_{ijkt} \tag{6}$$

Note, however, that the sign of β is ambiguous as it is a combination of the negative effect of trade agreements on the variability of trade costs ($\delta \leq 0$) and the possible positive effect of trade agreements on the cross-country covariance terms ($\rho \geq 0$). Thus, even if trade agreements are successful in creating more certainty and predictability about trade barriers and trade costs, this will not necessarily translate into reduced volatility of bilateral trade flows. The estimated impact of trade agreements on volatility is, therefore, an empirical question that we explore in the following sections.

3 Data

The trade data is from the UN Comtrade Database. Export values in current U.S. dollars for each exporter(reporter)-importer(partner)-industry at the SITC Rev. 1 four-digit level from 1962 to 2014 are used to compute the export earnings volatility measures (to be defined in the next section). One of the complications in investigating the link between trade agreements and trade volatility is that there are many ways of measuring volatility, and these measures are invariably ad hoc.[11] However, our structural framework in section 2 provides some guidance in how we measure volatility. Some measures are computed over rolling five-year periods while others use two periods, yet all focus on year-to-year volatility and have the following characteristics:

[11] There is an extensive literature that has investigated the determinants of export volatility. See [Massell, 1970], [MacBean and Nguyen, 1980], [Love, 1986], and [Han, 2021]. One of the constant sources of discussion in this literature is the proper measure of volatility as well as the need to test robustness of results to various measures.

First, to be consistent with our derived equation (6) we focus on measures of the volatility in log trade. As a result, our main volatility measures are based more on year-to-year (approximate) percentage changes in trade flows than on absolute changes in trade volume.[12]

Second, we calculate our volatility measures at a disaggregated four-digit SITC level (as opposed to aggregated country-level measures). This allows for a more accurate picture of bilateral volatility; to the extent that volatility varies across sectors (e.g., see [Han, 2021] for evidence that durable goods tend to have higher levels of trade volatility), more aggregate measures of bilateral trade volatility could be determined by the set of industries traded (which would be influenced by trade agreements as well). Indeed, in section 4 we show that standard measures of volatility are heavily influenced by such selection effects. In addition, this approach provides analysis at a level of aggregation that policymakers are more likely to care about, unlike the more disaggregated HS10 (product) level. The fact that the vast majority of trade barriers do not vary across firms, and that many firms produce multiple HS10-level products, leads to the formation of industry-level lobbying groups to influence governmental policy. Thus, many models of the political economy of trade protection model trade protection as emerging from a lobbying game between politically organized industries and governmental policy makers (e.g., [Grossman and Helpman, 1994]). While the exact level of aggregation is not always specified in theoretical models, the vast majority of empirical studies of the political economy of trade protection in the U.S. are at the three or four-digit SIC level (see [Gawande and Krishna, 2004]) which is similar to the four-digit SITC level that we adopt in this paper.

Third, our underlying structural model assumes positive trade flows and so our focus is on volatility in the *intensive* margin of trade. Thus, we only analyze existing, stable trade relationships between country pairs. Specifically, our dataset includes only observations with exports that exceed 500 USD in each of the surrounding five years.[13] This means that our

[12] In an online appendix available from the authors, we provide some robustness checks using alternative measures of volatility (including some based on non-logged trade flows) and find similar results.

[13] Prior to year 2000, the minimum trade value reported was 501 USD. However, any positive dollar value has been reported since 2000. For consistency, the sample is restricted to export values that exceed 500 USD.

Table 1: Regional Trade Agreement Ranking (RTA)

Type of Agreement	RTA Ranking	Description
No country	.	At least one of the two countries does not exist or have independence
No agreement	0	Do not have any economic integration agreement
Non-reciprocal PTA	1	Preferential terms given to developing countries
Preferential trade agreement (PTA)	2	Preferential terms given to members
Free trade agreement (FTA)	3	No (or substantially low) trade barriers to members
Customs union	4	Same as FTA but equal treatment of non-members
Common market	5	Same as customs union but free movement of labor and capital
Economic union	6	Same as common market but monetary and fiscal policy coordination

measures of volatility do not incorporate volatility associated with entry into new products or new markets (or exit from them). Our approach is supported by [Bernard et al., 2009], who finds that short-run (year-to-year) changes in aggregate U.S. exports are predominately accounted for by changes in the intensive margin (this is because recently added/dropped product-country trade flows are, on average, smaller than continuing product-country trade flows.)

The data on regional trade agreements (RTAs) is from the NSF-Kellogg Institute Economic Integration Agreements (EIA) database which records the level of economic integration of each country pair from 1950 to 2012. The RTA ranking variable is a multichotomous index defined for each country pair in a particular year which ranges from 0 to 6 with interpretations described in Table 1.

To measure the depth of a trade agreement, we use the World Bank Content of Deep Trade Agreements database ([Hofmann et al., 2017]). The database includes 52 provisions of trade agreements, ranging from tariffs on industrial goods and export taxes to human rights and cultural cooperation. As our measure of the depth of a trade agreement, *Deep*, we use the number of categories with at least one legally enforceable provision, scaled by the number possible (52) so that the variable ranges from zero in the case of no agreement to 0.73 in the case of the members of the European Union since 2004, with 38 categories of legally enforceable provisions. Finally, data on GATT/WTO membership is obtained from

The five-year requirement also assures that we do not have to deal with the complications of zero-trade flows in our volatility measures. Since the 500 USD figure is somewhat ad hoc, we also ran the specifications with a 5000 USD cut-off (resulting in the number of observations falling by around 15 percent). Results were consistent, although the WTO variable lost statistical significance.

[Tomz et al., 2007], and the GATT/WTO binary variable is equal to one if both exporter and importer are formal members or nonmember participants of the GATT or WTO and zero otherwise.

4 Empirics

To empirically examine the effects of trade agreements on export earnings volatility, we estimate equation (6). The presence of trade agreements is captured by the RTA ranking or depth measure and the GATT/WTO binary variable. A potential concern is that the decision to join a trade agreement is endogenous. Here, given our panel data approach, we follow the trade literature in the use of country-pair and time-varying country fixed effects to account for any latent factors that might determine both trade flows and agreement participation (see discussion in [Head and Mayer, 2014]). Thus, as in [Baier and Bergstrand, 2007], we employ country-pair fixed effects to account for any time-invariant bilateral determinants of agreement participation. Likewise, as in [Aichele and Felbermayr, 2015], we employ time-varying country fixed effects to control for any time-varying determinants of trade agreement membership.[14] In addition, our explanatory variables are lagged one period.

4.1 Measures of Volatility

The standard measures of volatility are similar to those used in [Rose, 2005] and [Mansfield and Reinhardt, 2008] as well as a related literature on the determinants of export volatility (e.g., see [Massell, 1964], [Wong, 1986], and [Han, 2021]). First, the squared log difference, which we denote $V1$ is the squared value of the change in log export values

[14] Other papers that employ fixed effects to control for endogenous agreement membership include [Regolo, 2013], [Baier et al., 2014], and [Soete and Van Hove, 2017].

for each exporter-importer-industry (ijk) between years *t-1* and t:[15]

$$V1_{ijkt} = \left(\ln X_{ijkt} - \ln X_{ijk(t-1)}\right)^2 \tag{7}$$

Larger values represent wider year-to-year fluctuations leading to greater export earnings volatility. The second and third measures capture the average deviation from a five-year moving average. $V2$ is the variance or average squared deviation from the five-year mean log export value for each exporter-importer-industry (ijk), computed over rolling five-year periods centered on the year of the observation:

$$V2_{ijkt} = \frac{1}{T}\sum_t (\ln X_{ijkt} - \overline{\ln X_{ijk}})^2 \tag{8}$$

where $\overline{\ln X_{ijk}} = \frac{1}{T}\sum_t \ln X_{ijkt}$. Finally, $V3$ is the coefficient of variation (the ratio of the standard deviation to the mean), also computed over rolling five-year periods centered on the observation year. It measures variability relative to the mean, making comparisons across different exporter-importer-industry (ijk) triplets possible, and is used to measure export instability in [Rose, 2005].[16]

$$V3_{ijkt} = \frac{\sqrt{V2}}{\overline{\ln X_{ijk}}} \times 100 = \frac{\sqrt{\frac{1}{T}\sum_t (\ln X_{ijkt} - \overline{\ln X_{ijk}})^2}}{\overline{\ln X_{ijk}}} \times 100 \tag{9}$$

A potential concern with the standard measures of volatility is that country pairs experience growth in trade, particularly after integrating into the world trading system, and this trade growth may be mistaken for an increase in volatility. To separate the long-run growth of exports over the period from short-run fluctuations around the growth path, the trend can be eliminated from the export series before constructing volatility measures as

[15] [Mansfield and Reinhardt, 2008] also uses the absolute log difference, which places less weight on larger fluctuations. As we show in the online appendix, coefficient estimates are similar if we use the absolute value measure.

[16] The coefficient of variation in [Rose, 2005] is computed for the log of real bilateral exports over non-overlapping 25-year intervals.

Table 2: Summary Statistics - Standard Measures of Volatility

	Mean	Median	Std Dev	Min	Max
$V1$	1.308	0.226	3.454	0	226.55
$V2$	0.710	0.308	1.114	0	54.179
$V3$	6.026	4.632	4.771	0	86.02
$V1^*$	1.292	0.219	3.424	0	227.73
$V2^*$	0.679	0.290	1.075	0	50.241
$V3^*$	82.98	91.42	34.71	0.032	196.83
Exporters			180		
Importers			194		
Industries (SITC Rev. 1 four-digit)			620		
Observations			23,050,547		

As described in the text, $V1$ is the squared difference in log exports, $V2$ is the five-year variance of log exports, and $V3$ is the five-year coefficient of variation. Asterisks indicate the respective detrended variables.

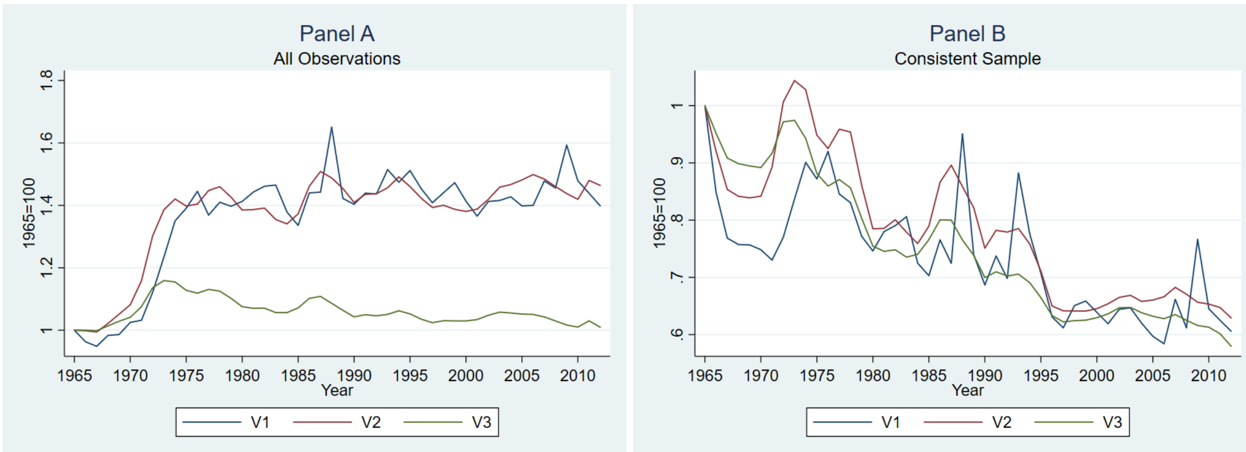
in [Massell, 1970], [Lawson, 1974], [Cariolle and Goujon, 2015], and [Han, 2021]. We use a linear trend to predict log export values of each exporter-importer-industry (ijk).[17]

The three detrended measures of volatility use these residuals, and are analogous to the three standard volatility measures. We use asterisks to denote the detrended measures. First, the squared difference in residual log exports ($V1^*$) is estimated by replacing the export values in equation (7) with the residuals. Second, the variance of residual log exports ($V2^*$) for each exporter-importer-industry (ijk) over overlapping five-year intervals is the average squared deviation of residual log exports from the five-year mean, centered on the year of the observation. [Massell, 1970] and [Lawson, 1974] use a similar measure as what they call the export instability index, which is defined as the standard deviation of the residuals from the trend.[18] Third, the coefficient of variation of the residuals ($V3^*$), also computed over the five years beginning two years before the observation, is analogous to equation (9) with residuals replacing export values. (In the case of $V3^*$, since residuals can be positive or negative, the standard deviation is divided by the average of the absolute value of the residuals.)

[17] This is equivalent to using an exponential trend to predict export values. The trend is estimated for each exporter-importer-industry.

[18] In [Massell, 1970], the instability index is calculated for each of 55 countries using data for the entire period 1950–66 and a cross-sectional analysis is conducted. Similarly, [Lawson, 1974] computes the weighted instability index for a set of countries over two time periods: 1950–59 and 1960–69.

Figure 1: Average Volatility Over Time



Notes: $V1$ is the squared difference in log exports, $V2$ is the five-year variance of log exports, and $V3$ is the five-year coefficient of variation. Panel A includes all observations in the analysis; Panel B restricts the sample to the 98,574 exporter-importer-industry observations included in all years of the 49-year panel.

Summary statistics for these six measures of volatility are provided in Table 2.[19] The average values for the original (not detrended) measures are plotted in Figure 1 (scaled so that 1965=100). In Panel A of Figure 1, volatility appears to increase substantially over time, including an especially rapid rise at the beginning of the sample period. However, this increase is primarily due to the addition of newer (and smaller) high-volatility trade relations, which raises average volatility considerably. In Panel B, we restrict the sample to ijk triplets with observations for all years in the sample (mostly long-standing trade relations between developed countries). In this case, volatility declines consistently and substantially over time for all three measures. This distinction is one of the reasons that we conduct our analysis at the disaggregated industry level.

4.1.1 Results

Tables 3 and 4 present the results of estimating equation (6) using our measures of volatility.[20] We include an indicator variable for membership in GATT/WTO, a broadly

[19] It is clear from Table 2 that there are some large outliers in volatility. Results were comparable when we repeated the estimation in Tables 3 and 4 excluding the highest one percent of each dependent variable.

[20] Given the potential for serial correlation, reported standard errors are clustered at the bilateral pair–industry level following [Aichele and Felbermayr, 2015]. We also experimented with multi-way clustering

multilateral agreement (current membership is 164 countries). We also account for regional trade agreements in two ways, given that such agreements vary widely in the scope of their integration. In Table 3, we use the RTA classifications defined in Table 1, and in Table 4 we use the variable *Deep* to measure the depth of the agreement. We also include the log of export value to control for scale issues, since each of the volatility measures is a percentage change (or an approximation of a percentage change).[21]

As can be seen in Table 3, as country pairs become more regionally integrated, the estimated coefficient becomes larger (i.e., export earnings volatility is increasing in regional integration). For example, in column 1, moving from no agreement to a Free Trade Area (FTA) would increase $V1$, the squared difference in log exports, by 0.122, which is about 54 percent of its median value. Going from no agreement to a more integrated agreement such as an economic union would increase $V1$ by 0.340, or 150 percent of the median value. In contrast, when both countries are members of GATT/WTO, $V1$ decreases by 0.024, which is an economically significant (albeit statistically insignificant) 11 percent of the median, holding other variables constant. In column 2, moving from no agreement to an FTA increases $V2$ by approximately 14 percent of the median, while moving from no agreement to an economic union increases $V2$ by more than twice as much, over 30 percent of the median. GATT/WTO membership reduces volatility by a statistically significant 0.027, almost nine percent of the median. This pattern is repeated consistently for the other measures of volatility.

at the exporter-importer-industry-year level as suggested by [Egger and Tarlea, 2015]. With multi-way clustering the RTA index remains positive and statistically significant in all specifications; however, the GATT/WTO variable is no longer statistically significant.

[21] Export value is negatively correlated with each of the volatility measures, with a correlation coefficient ranging from -0.16 to -0.28; large percentage changes are much less common with large trade flows. Our empirical strategy is to compare changes in the volatility of bilateral trade controlling for the size of the trade flow.

Table 3: Regional Trade Agreements and Volatility

	(1) $V1$	(2) $V2$	(3) $V3$	(4) $V1^*$	(5) $V2^*$	(6) $V3^*$
L.Non-reciprocal PTA	0.057***	0.017***	0.095***	0.052***	0.014***	0.811***
	(0.010)	(0.004)	(0.015)	(0.010)	(0.004)	(0.130)
L.Pref trade agreement	0.026***	0.021***	0.059***	0.021**	0.014***	-0.323***
	(0.008)	(0.003)	(0.013)	(0.008)	(0.003)	(0.109)
L.Free trade agreement	0.122***	0.044***	0.238***	0.103***	0.033***	1.447***
	(0.006)	(0.002)	(0.009)	(0.006)	(0.002)	(0.084)
L.Customs union	0.190***	0.031***	0.097***	0.147***	0.018***	0.860***
	(0.009)	(0.004)	(0.015)	(0.009)	(0.004)	(0.149)
L.Common market	0.262***	0.064***	0.392***	0.223***	0.052***	4.633***
	(0.010)	(0.004)	(0.016)	(0.010)	(0.004)	(0.144)
L.Economic union	0.340***	0.095***	0.592***	0.301***	0.082***	6.185***
	(0.012)	(0.005)	(0.020)	(0.012)	(0.005)	(0.186)
L.GATT/WTO	-0.024	-0.027***	-0.132***	-0.016	-0.007	-0.433*
	(0.021)	(0.008)	(0.030)	(0.021)	(0.008)	(0.233)
L.Log export value	-0.525***	-0.158***	-0.991***	-0.438***	-0.114***	-4.833***
	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)	(0.009)
Exporter-industry-year (α_{ikt})	Yes	Yes	Yes	Yes	Yes	Yes
Importer-industry-year (α_{jkt})	Yes	Yes	Yes	Yes	Yes	Yes
Exporter-importer-industry (α_{ijk})	Yes	Yes	Yes	Yes	Yes	Yes
Observations	23,286,643	23,286,643	23,286,643	23,286,643	23,286,643	23,286,641
Adjusted R^2	0.240	0.463	0.599	0.234	0.465	0.342

Notes: All regressions include exporter-industry-year (α_{ikt}), importer-industry-year (α_{jkt}), and exporter-importer-industry (α_{ijk}) fixed effects. Standard errors are clustered at the bilateral pair–industry level and reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
$V1$ is the squared difference in log exports, $V2$ is the five-year variance of log exports, and $V3$ is the five-year coefficient of variation. Asterisks indicate the respective detrended variables.

In Table 4, we replace the RTA classifications with a measure of the depth of the agreement. The variable *Deep* is positive and statistically significant in all regressions, indicating that as trade agreements become "deeper" by adding more areas of coverage, our measures of bilateral trade volatility increase. Magnitudes are comparable to Table 3: going from no agreement ($Deep = 0$) to an agreement equivalent to the depth of the European Union ($Deep = 0.73$) would increase $V1$ by over 100 percent of the median, and $V2$ by 13 percent of its median.

The consistent pattern that emerges from our analysis is that membership in a regional trade agreement increases the degree of trade volatility between regional trading partners, while membership in a multilateral agreement reduces trade volatility. Specifically, bilateral trade flows between GATT/WTO members exhibit about 5–10 percent less year-to-year trade volatility than other trade flows (relative to the median observation).[22] In contrast, bilateral trade flows between members of a regional trade agreement exhibit significantly *increased* year-to-year trade volatility, and this positive correlation is both statistically and economically significant across all of our measures of volatility. In addition, this effect increases with the depth of the agreement. Why do regional agreements appear to be correlated with increased trade volatility while multilateral agreements are correlated with decreased trade volatility? One possible answer can be found in our structural gravity approach: to the extent that regional trade agreements are more likely to increase the covariance of economic outcomes across member countries, they would also be less likely to contribute to decreased volatility in bilateral trade flows.

[22] Although it should be noted that this result is not statistically significant for all of our measures of trade volatility, it provides some evidence of the ability of multilateral institutions to fulfill their role of providing stability and certainty in trade relationships between member institutions.

Table 4: Deep Trade Agreements and Export Volatility

	(1)	(2)	(3)	(4)		
	$V1$	$V2$	$V3$	$V1^*$	$V2^*$	$V3^*$
L.Deep	0.323***	0.070***	0.388***	0.262***	0.045***	3.360***
	(0.013)	(0.005)	(0.022)	(0.013)	(0.005)	(0.218)
L.GATT/WTO	-0.007	-0.015	-0.084**	0.002	0.003	-0.422
	(0.024)	(0.009)	(0.034)	(0.024)	(0.009)	(0.279)
L.Log export value	-0.502***	-0.146***	-0.945***	-0.414***	-0.105***	-4.507***
	(0.002)	(0.000)	(0.001)	(0.002)	(0.000)	(0.010)
Exporter-industry-year (α_{ikt})	Yes	Yes	Yes	Yes	Yes	Yes
Importer-industry-year (α_{jkt})	Yes	Yes	Yes	Yes	Yes	Yes
Exporter-importer-industry (α_{ijk})	Yes	Yes	Yes	Yes	Yes	Yes
Observations	18,888,322	18,888,322	18,888,322	18,888,322	18,888,322	18,888,320
Adjusted R^2	0.244	0.478	0.610	0.238	0.479	0.346

Notes: All regressions include exporter-industry-year (α_{ikt}), importer-industry-year (α_{jkt}), and exporter-importer-industry (α_{ijk}) fixed effects. Standard errors are clustered at the bilateral pair–industry level and reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
$V1$ is the squared difference in log exports, $V2$ is the five-year variance of log exports, and $V3$ is the five-year coefficient of variation. Asterisks indicate the respective detrended variables.

5 Conclusion

The GATT/WTO system has made great strides in reducing trade barriers over the past 70 years. However, even as existing trade barriers fall to record low levels, regional trade agreements continue to proliferate. Partly this is due to the expansion of traditional trade agreements into other areas such as intellectual property rights, but it is also partly due to the fact that such agreements are viewed as important sources of stability for existing trade relationships. Indeed, a legal-economics framework has emerged (see [Bagwell and Staiger, 2001] and [Bagwell et al., 2002]) which views these institutions as not simply a forum for negotiations, but also a means to achieve secure market access to foreign markets. Thus, for example, Canada's objectives in the North American Free Trade Agreement (NAFTA) negotiations were not so much to reduce U.S. trade barriers (there was already an existing Canada-US free trade agreement), but rather to curtail the U.S.'s use of unilateral trade actions (see [Mansfield and Reinhardt, 2003]) and to clarify many of the prior trading rules that might be subject to reinterpretation by the U.S. (see [Abbott, 2000]). Likewise, [Jakubik and Piermartini, 2019] argues that one of the main benefits of WTO membership is that it constrains one's trading partners from instituting trade barriers in response to import shocks.

Consistent with this role for international agreements, we do find some evidence of increased trade stability among members of the GATT/WTO. However, we also find that regional trade agreements result in significant increases in bilateral trade volatility among member countries. This suggests that, at least among regional trade agreements, the joint goals of integration and reduced volatility may be at odds with one another, and that increased integration may come at a cost of heightened volatility. At the least it suggests that the increased policy certainty provided by some trade agreements (e.g., see [Handley, 2014] and [Limao and Maggi, 2015]) might not necessarily translate into reduced trade volatility.

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