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Three Essays on Export Earnings Volatility

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THREE ESSAYS ON EXPORT EARNINGS VOLATILITY

DISSERTATION

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Gatton College of Business and Economics at the University of Kentucky

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ABSTRACT OF DISSERTATION

THREE ESSAYS ON EXPORT EARNINGS VOLATILITY

My dissertation consists of three essays on export earnings volatility. In the first essay, I look at the determinants of export earnings volatility. The four main determinants suggested by the theoretical literature are export concentration, durability, vertical linkages, and financial vulnerability. A panel of bilateral trade data at the industry level, containing 178 exporting countries, 194 importing countries, and 590 SITC Rev. 1 four-digit industries from 1962 to 2011, is used and these aspects are incorporated to empirically examine their effects on export earnings volatility. The essay finds that diversifying exports across different industries and trade partners plays an important role in reducing aggregate export instability. Moreover, exports of durable goods and intermediate inputs exhibit higher volatility. Unlike its role in explaining the Great Trade Collapse, industry financial vulnerability does not affect the export earnings volatility of developed countries. However, trade credit reliance and asset tangibility matter in the export instability of developing countries which have weaker financial institutions and contractibility.

The second essay is joint work with Dr. Ederington and Dr. Minier. Given that a frequently stated objective of regional and multilateral trade agreements is to stabilize 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 that joining a multilateral trade agreement such as the GATT does make export earnings more stable. However, we find that signing a regional trade agreement actually raises instability in bilateral exports and that this rise in volatility increases as the trading partners become more integrated.

The third essay is an empirical study of the effects of export concentration on the Great Trade Collapse. First, it finds that country pairs whose exports are concentrated on a small number of products experienced greater reductions in bilateral exports. Second, it is the first to look at the relationship between trade flows and trade finance availability as a function of export concentration. Using bilateral trade data, the essay finds that the relationship between the fall in bilateral exports and the fall in the availability of trade finance, proxied by insured export credits, is more dramatic when exports are concentrated on few products. Similarly, using export data at the HS 2002 six-digit product level, the essay finds the relationship between the fall in product exports and financial vulnerability, specifically external finance dependence and asset tangibility, to be more intense when exports are concentrated on few trading partners. This result implies that exporter-importer (exporter-product) pairs whose exports are more diversified across different products (markets) may be less susceptible to financial shocks.

KEYWORDS: Export Earnings Volatility; Great Trade Collapse; Export Concentration; Trade Finance; Trade Agreements; Durable and Intermediate Goods

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THREE ESSAYS ON EXPORT EARNINGS VOLATILITY

By
Yoonseon Han

Director of Dissertation: Dr. Josh Ederington

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Date: July 29, 2021

To my husband, Seungki

“Praise be to the name of God forever and ever; wisdom and power are his.” (Daniel 2:20)

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Chapter 1 Introduction

Volatile export earnings raise uncertainty, which make it harder for firms to invest and enter a new foreign market. In addition, the 2008 global financial crisis was an unpleasant experience for many exporters who were forced to cut production and employment. For this reason, exporters' desire for stability is seen in several cases. For instance, the existence of export cartels and the exception on the General Agreement on Tariffs and Trade Article XX(h) regarding intergovernmental commodity agreements are partially justified by their motivation for stability. Moreover, with increased trade openness, countries have responded in several ways to insulate their economies from external shocks and instability, including joining international trade institutions such as the World Trade Organization (WTO) and regional trade agreements. (See section 2.1 of Chapter 2 for more details.) Given the discussion, trade volatility is something that people care about and the interest lies in finding potential ways to acheive greater stability of trade. My dissertation studies trade volatility, specifically export earnings volatility, and is composed of three essays.

The first essay (Chapter 2) studies the determinants of export earnings volatility. The four determinants that I examine empirically are export concentration, durability, vertical linkages, and financial vulnerability. I use a panel of bilateral trade data at the SITC Rev. 1 four-digit industry level, consisting of 178 exporting countries, 194 importing countries, and 590 industries for the period 1962–2011, and a fixed effects model to look at the effects of these four determinants on the two measures of export instability that I construct. In the aggregate level, I find that a country pair's export earnings become more unstable as they are concentrated on a small number of industries. Likewise, an exporter-industry pair's export revenues also become more volatile as they are concentrated on few destination markets. Export earnings of industries that produce durable goods and intermediate inputs are found to be more volatile. Financially vulnerable industries that have a high reliance on trade credit and low endowment of tangible assets are also found to have more volatile export earnings in developing countries with weaker financial institutions and contractibility. These industry results carry over into the disaggregated level. And surprisingly, export diversification reduces export instability even at the disaggregated level where individual risks are not diversified away, possibly suggesting the role of trade institutions and infrastructure.

In the second essay, which is coauthored with Dr. Ederington and Dr. Minier, we study the relationship between trade agreements and trade volatility. Increasing the stability and predictability of trade flows is an often-stated goal of both regional and multilateral trade agreements. We examine if this goal is indeed met. First, we use a structual gravity model to derive the equation for the variance of trade flows. We identify two potential channels through which trade agreements may influence bilateral trade volatility. One is a decrease in trade volatility by reducing the variance of bilateral trade costs such as tariffs and shipping costs. The other is a rise in trade volatility by increasing the covariance of economic outcomes between the exporting and importing countries due to increased connections and standardization of various policies. Then we use a panel of bilateral trade data at the SITC Rev. 1 four-digit industry level, covering 180 exporting countries, 194 importing countries, and 620 industries from 1964 to 2012, to empirically examine the effects of regional trade agreement and GATT/WTO membership on export earnings volatility, constructed in two different ways: standard and detrended measures. We find that becoming a member of the multilateral trading system (GATT/WTO) does reduce the volatility of bilateral trade flows. However, joining a regional trade agreement would in fact increase the instability of bilateral exports, which goes against its stated objective. Interestingly, the positive relationship between the rise in volatility and regional trade agreement membership is stronger as the economic integration grows deeper.

Finally, in the third essay, I focus on the trade collapse during the global financial crisis that outpaced the fall in production and empirically examine if countries with diversified exports experienced milder falls between 2008 and 2009. I use two datasets: bilateral (exporter-importer) and product-level (exporter-product) data where product is defined at the HS 2002 six-digit level and the bilateral trade data consist of 134 exporting countries and 191 importing countries. I find that country pairs whose bilateral exports were concentrated on a small number of products experienced a greater export fall during the global financial crisis. Moreover, I look at the relationship between trade and trade finance availability, measured by Berne Union members' extension of short term insured export credit, and find that the relationship becomes stronger as product concentration rises. Similarly, I find in the product-level data that the relationship between trade and financial vulnerability, measured by external finance dependence, access to trade credit, or asset tangibility using Compustat data, also grows as the market concentration index increases, with the exception of trade credit access. These results suggest that if trade is concentrated on few products or markets, the countries become more susceptible to trade finance shocks, and therefore, they are hit harder when there is a contraction in the availability of trade finance during financial shocks.

In what follows, Chapter 2 contains Essay 1, Chapter 3 contains Essay 2, and Chapter 4 contains Essay 3.

Chapter 2 Determinants of Export Earnings Volatility

2.1 Introduction

When the export revenues earned by exporting firms or countries experience unwanted, frequent, or unpredictable changes, there is greater uncertainty and higher volatility in export earnings. This in turn lowers the investment level of firms and deters them from entering a new foreign market Handley and Limão (2015), Crowley et al. (2018). In addition, adverse shocks to export earnings force firms to cut production and employment, which was the case during the global financial crisis (Schwartz, 2009). It is not surprising then to think that export instability is something that exporters want to avoid, and there are several examples where this seems to be true. First, export cartels affecting foreign markets are endorsed even though they would be illegal if put into effect domestically Martyniszyn (2012). Considering that one of the goals of cartels is to stabilize prices as stated in the OPEC's website OPEC (nd) or news article on Quebec Maple Syrup Producers, the OPEC of maple syrup (The Economist, 2015), the existence of export cartels is partially justified by their motivation for stability. Furthermore, General Agreement on Tariffs and Trade (GATT) Article XX(h) allows WTO members to deviate from the GATT disciplines and undertake measures with the aim of meeting obligations under any international commodity agreement whose objectives include stabilizing the prices of commodities GATT (1947). Second, as countries become more open to trade and exposed to external shocks, they respond by increasing savings through the precautionary saving motive Ghosh and Ostry (1994) or government spending to provide social insurance against external risk Rodrik (1998), or they choose to join international trade institutions such as the World Trade Organization (WTO) and preferential trade arrangements to insulate their economies from such instability Rose (2005), Mansfield and Reinhardt (2008), Ederington et al. (2021). Given this interest in shielding from volatility, it is important to be informed about the factors that influence export instability.

Literature suggests four determinants of export earnings volatility: export concentration or diversification (Coppock (1962), Massell (1964), MacBean (2011), Massell (1970), Love (1986), Romeu and da Costa Neto (2011), Han (2021b)), durability (Erceg et al. (2008), Engel and Wang (2011)), vertical linkages or trade in intermediate goods (Levchenko et al. (2010), Bems et al. (2011)), and reliance on trade finance (Amiti and Weinstein (2011), Chor and Manova (2012)). This paper is the first to conduct a large-scale panel investigation of these explanations using bilateral trade data at the industry level consisting of 178 exporting countries, 194 importing countries, and 590 SITC Rev. 1 four-digit industries from 1962 to 2011.[1]

The three main findings can be summarized as follows. First, aggregate export earnings of an exporter-importer become more stable as they are dispersed over different industries. Likewise, the more diversified the export revenues of an exporter-industry are across various partner countries, the less volatile they will be in the aggregate. Specifically, an increase in the Herfindahl-Hirschman *industry* concentration index (decrease in diversification) by one standard deviation would raise export instability by 4.5–6 percent of its median, and a rise in the Herfindahl-Hirschman *market* concentration index by one standard deviation leads to an increase in export earnings volatility by approximately 20–30 percent of its median.

Second, consistent with conventional wisdom, industries that produce durable goods and intermediate inputs are found to be more volatile relative to nondurable and non-intermediate goods industries at any level of aggregation. For instance, at the disaggregated level, durable goods sectors are approximately 6 percentage points more volatile, which is 12 percent of the median *Instability 1*. Similarly, at the disaggregated level, an increase in the indicator of downstream vertical linkages by one standard deviation leads to a rise in export instability by 3 percent of the median *Instability 1*. This is important because durable goods constitute a considerable share of international trade, particularly for developed countries. For example, half of U.S. exports in 2011 were in durable goods. It may also be of relevance to developing countries in the future as their incomes grow and their production expands to include more durable goods. Moreover, the increased interconnectedness of countries and industries due to global supply chains has raised concerns about vulnerability to external shocks, and the fact that cross-border vertical linkages contributes to trade volatility may be of great interest.

Third, although financially vulnerable industries have experienced greater trade reductions during the global financial crisis Chor and Manova (2012), their export earnings do not seem to be more volatile for developed countries. However, a sector's reliance on trade credit and endowment of tangible assets do have an influence on the export instability of developing countries. This is because trade credit and tangible assets matter more in developing countries which have less developed financial markets and weak financial contractibility. Since they have weaker financial institutions, they are more reliant on the

[1] A related paper on the sources of trade volatility is Bennett et al. (2016), which decomposes trade growth volatility into six components: a common (α_t), country-specific (α_{it}), partner (α_{jt}), sectoral (α_{kt}), resistance (α_{ijt}), and error term (ϵ_{ijkt}). Using bilateral trade flows for four broad sectors, the paper finds that the common factors play a dominant role in explaining the aggregate volatility of trade flows for the period 1990–2011.

trade credit from suppliers/buyers as a substitute for formal bank loans Fisman and Love (2003). Moreover, due to weak financial contractibility, a higher proportion of hard assets is required to secure external finance Braun (2005).

Most of the related literature falls into one of two categories. One focuses on the recent global recession and conducts an event study, coming up with various explanations for the Great Trade Collapse Levchenko et al. (2010), Chor and Manova (2012), Romeu and da Costa Neto (2011), Han (2021b). The Great Trade Collapse refers to the sudden, severe, and synchronized drop in world trade between the third quarter of 2008 and the second quarter of 2009 (Baldwin, 2009). World merchandise exports fell from 16,170 billion U.S. dollars in 2008 to 12,563 billion U.S. dollars in 2009 WTO (nd), a 22.3% drop compared to the 5.2% reduction in world GDP from 63,676 to 60,396 billion U.S. dollars during the same period World Bank (2021a). Many studies have strived to explain the larger fall in world trade relative to that in world production. Explanations include the plunge in demand for postponable durable goods which consist a large share of trade, global supply chains, and a decrease in trade finance. This paper is different in that each of these factors are examined to see if they also explain export earnings volatility in other periods and not just the global recession of 2008–2009.

The other is an older literature analyzing the effects of export concentration on export instability using cross sectional (Coppock (1962), Massell (1964), MacBean (2011), Massell (1970)) or time series (Love (1986)) data. Commodity concentration was viewed as a major factor contributing to the export earnings volatility of developing countries whose exports were predominantly focused on primary products. This was of interest to economists and policymakers as export instability was regarded to impede the economic growth of developing countries. However, the results of many empirical studies lacked evidence in support of a causal relationship between commodity concentration and export instability, partially due to data limitations. This paper addresses this constraint by using an extensive panel of bilateral trade data disaggregated at the four-digit SITC level. The use of such data also enables the inclusion of a set of fixed effects to deal with the endogeneity of export concentration. Fixed effects can absorb any unobserved country characteristics that are both correlated with export concentration and instability and bias the coefficient estimates.

The rest of the paper is organized as follows. Section 2.2 presents the determinants of export earnings volatility. Section 2.3 discusses the data along with stylized facts. The subsequent two sections present the empirical model as well as regression results: section 2.4 examines the effects on aggregate volatility, using either bilateral (exporter-importer-year) or industry-level (exporter-industry-year) trade data, and section 2.5 studies the effects on volatility using the most disaggregated bilateral trade data at the industry level (exporter-importer-industry-year). Finally, section 2.6 concludes.

2.2 Determinants of Export Earnings Volatility

The four main determinants of export earnings volatility suggested by the literature are durability, vertical linkages, financial vulnerability, and export concentration. The first three are motivated from Levchenko et al. (2010), which illustrates three potential explanations in the literature for the greater fall in trade relative to that in production during the global financial crisis: compositional effects, vertical linkages, and trade credit.[2] The last determinant, export concentration, comes from an older literature on export instability. This section presents each of the determinants of export earnings volatility in detail.

First, export revenues in industries producing durable goods may be more volatile than those in nondurable goods sectors because spending on durable goods (e.g., furniture, appliances, and automobiles) is more strongly affected by business cycles compared to that in nondurable goods (e.g., food and clothing) and services. For example, consumers will wait a little longer to replace their cars and computers during a recession, but they still have to continue purchasing groceries or spending on services such as utilities and health care. In fact, more than half of the fall in U.S. GDP during the Great Recession was a result of the drop in broadly defined durable spending[3] (Berger and Vavra, 2014). This translated into a disproportionately larger decline in trade relative to GDP given the importance of durables in trade. For instance, approximately three quarters of U.S. non-fuel trade flows consist of capital goods and consumer durables while under a fifth of U.S. production is in these investment goods[4] Erceg et al. (2008). Erceg et al. (2008) and Engel and Wang (2011) have proposed models incorporating this compositional difference trying to match the larger movements in trade seen in data. Since part of trade volatility stems from the volatile nature of expenditures on durable goods which make up a significant share of trade, durable goods sectors may demonstrate greater volatility in export earnings compared to nondurable goods sectors.

Second, vertical linkages or intermediate goods trade is commonly associated with the increase in exposure to external shocks, which could possibly lead to greater trade volatility. Particularly, much media attention has been paid to the role of vertical linkages

[2] Levchenko et al. (2010) finds evidence for the first two explanations using U.S. import and export data disaggregated at the six-digit NAICS level (about 450 sectors). The trade collapse was greater in sectors that experienced larger drops in domestic output (durable goods) and those used as intermediate inputs, but trade credit did not play a significant role.

[3] Purchases of consumer durables and residential investments

[4] Investment goods = capital goods (producer durables) + consumer durables

in the great trade collapse during the global recession of 2008–2009 Bems et al. (2009), Yi (2009). The underlying concern is that the supply chain of a good stretches across multiple countries, increasing interdependence of production processes and exposure to shocks that occur to supply chain participants; thus, facilitating the propagation of shocks. The ongoing COVID-19 pandemic demonstrates this well. Government containment policies aimed at slowing the spread of the disease have led to the reduction or suspension of production in manufacturing sectors around the world, making it harder or more costly to obtain intermediate inputs from one another (Baldwin and Freeman, 2020). For instance, due to China's supply side disruption, automobile manufacturers in South Korea were forced to halt production for a couple of days in February 2020 because they were not able to acquire the necessary parts (Shin, 2020). In this regard, vertical linkages are conventionally viewed as having led to the Great Trade Collapse. However, results of related empirical studies have been mixed. Levchenko et al. (2010) finds that sectors used as intermediate inputs experienced larger drops in trade during the global financial crisis. On the other hand, Bems et al. (2011) finds that intermediate goods contracted less than final goods during the same period. This paper attempts to uncover the relationship between vertical linkages and export instability and examine if the former contributes to the latter.

Third, export earnings in industries that are more reliant on trade finance[5] may be more volatile as their performance depends on the access to external finance. Similarly, Amiti and Weinstein (2011) finds that exporting firms are more susceptible to financial shocks than nonexporting firms due to their reliance on trade finance. Chor and Manova (2012) presents three reasons why credit availability matters more for exporting firms. First, they have to incur trade costs, including policy barriers and transportation costs, as well as additional upfront sunk and fixed costs such as learning about new foreign markets, complying with new regulations, customizing products, and establishing foreign distribution networks. Second, because international transactions take, on average, 30 to 90 days longer, there is a wider gap between the time exporters need to cover production costs and the time they receive payment for the delivery of goods, making them more dependent on working capital. Third, due to longer time lags and increased risk of non-payment, they need additional trade credit insurance. The need for outside capital may also differ across sectors. Industries that are financially vulnerable may be hit harder by financial shocks. Using the sector-level U.S. import and export data aggregated across

[5]Trade credit and trade finance are occasionally used interchangeably. In Amiti and Weinstein (2011), trade credit is the item that is recorded under accounts receivable of a firm's balance sheet when an order for a good or service is received but payment is expected in the future. The order may be placed by a foreign purchaser, but it could also be put in by a domestic buyer in which case it has nothing to do with international trade. Trade finance, on the other hand, refers to export working-capital loans and other means to finance international trade credits recorded on an exporting firm's balance sheet.

trading partners, Levchenko et al. (2010) finds no support that sectors using or offering trade credit more intensively experienced larger percentage reductions in trade between 2008 and 2009. However, using U.S. import data disaggregated not only by industry but also by partner country, Chor and Manova (2012) shows that countries with tighter credit conditions (higher interbank lending rates) exported relatively less to the U.S. in sectors that are financially vulnerable—sectors that are reliant on external finance, have restricted access to trade credit from suppliers or buyers, or have few physical assets that can serve as collateral when securing a loan. Along these lines, it may be that these finacially vulnerable industries also have more volatile export earnings in general.

Lastly, export concentration is included as a variable of interest to explain the instability of export earnings in numerous cross-country studies (Coppock (1962), Massell (1964), MacBean (2011), Massell (1970)) due to the conventional wisdom that the more spread out a country's export revenues are across dissimilar products influenced by different market forces, the less correlated they will be. In addition, a country whose export earnings are dispersed over a larger number of partners will depend less on the economic conditions of a single or few destination countries. However, contrary to the conventional view, there is lack of evidence in cross-sectional analyses associating the concentration of exports[6] with the indices of export instability. In fact, geographic concentration is even found to be negatively related to export instability. In contrast to these unexpected results, Love (1986) finds that there is widespread evidence of a statistically significant and positive relationship between commodity concentration and export instability at the level of the individual country using a time series approach.[7] In a more recent study by Romeu and da Costa Neto (2011), the effect of export diversification on trade during the global financial crisis is examined, using 14 Latin American countries' quarterly exports at the HS two-digit level to 16 destination countries whose trade comprises over 90 percent of world trade. The paper measures export concentration using the Herfindahl index by three different dimensions: HS two-digit industries, trading partners, and HS four-digit products within each two-digit sector. It finds that increasing export diversification by industry and product reduces the quarterly decline in exports, whereas the spread of export values across different trading partners does not have a significant effect. Following these papers, it seems reasonable to examine the effects of export concentration on export earnings volatility using a panel of bilateral industry-level trade data.

[6] The more concentrated exports are on few products or markets, the less diversified.

[7] 16 out of 24 countries are found to have a statistically significant and positive coefficient on commodity concentration.

2.3 Data

Annual export flows (*Trade volume*) from reporter i to partner j in current U.S. dollars both at the country and SITC Rev. 1 four-digit industry (k) level are from the UN Comtrade Database for the period 1962–2015. The *FTA* dummy variable is calculated using the NSF-Kellogg Institute Economic Integration Agreements (EIA) Database, and the year of GATT/WTO membership needed for the *GATT/WTO* dummy variable comes from Tomz et al. (2007).[8] (See Appendix A for how these dummy variables are defined.) As for the response variable and explanatory variables of interest, the data sources, measures, and stylized facts are provided in the following subsections.

The resulting dataset is an unbalanced panel that covers 178 exporting countries (reporters), 194 importing countries (partners), 590 SITC four-digit industries, and spans 50 years from 1962[9] to 2011 (export values of 1962–2015 are used to compute export earnings volatility measures of 1962–2011). The data is comprehensive containing countries with different levels of development, goods-producing industries ranging from primary commodities to manufactured goods, as well as a long period of time. This rich dataset permits the inclusion of various fixed effects to control for possible unobservables and treat omitted variable bias.

2.3.1 Export Earnings Volatility

Because there are numerous ways of constructing export instability indices, two measures are computed here as a robustness check using the export values from UN Comtrade: *Instability 1* and *2*. The correlation coefficient between the two is about 0.4, implying that they have a moderate positive linear relationship. Both are computed over rolling five-year periods, and thus the export instability indicators have a value in each year allowing for the study of year-to-year volatility. For example, *Instability 1* and *2* of year 2001 would use export values of the five-year period 2001–2005. The difference is that *Instability 1* captures short run fluctuations in export earnings around the five-year moving average, while *Instability 2* does so around the exponential trend.

[8] In addition to formal members, Tomz et al. (2007) classifies colonies, de facto members, and provisional members as having GATT membership since they shared the major rights and obligations of the agreement. When including these nonmember participants, Tomz et al. (2007) shows that GATT/WTO members have in fact experienced growth in trade unlike the little evidence found in Rose (2004), which only treats formal members introduced in the World Trade Organization website as having GATT/WTO membership.

[9] The observations of year 1962 are dropped in the regression analysis due to lagged explanatory variables (export concentration indices).

Instability 1 is a five-year moving coefficient of variation[10] computed as the following:

$$\frac{\sqrt{\frac{1}{T}\sum_t (y_t - \bar{y})^2}}{\bar{y}} \times 100,$$

where y_t is the observation of export earnings, $\bar{y}$ is the five-year mean export revenue, and $T = 5$. This is the average size of deviations of export earnings from the five-year moving average relative to the five-year mean.[11] For instance, *Instability 1* whose value is 40 means the standard deviation over the five-year period is 40 percent of the five-year mean.

Likewise, *Instability 2* is the average magnitude of deviations of export revenues from the exponential trend relative to the five-year average trend. The choice of exponential trend is based on the observation of export series of a typical exporter-importer (*ij*) and exporter-industry (*ik*) as shown in Figure 2.1. As might be suggested from the time plots, the exponential trend results in the highest goodness of fit when running fixed effects regressions on a deterministic trend (linear, quadratic, and exponential).[12] A couple of steps are taken to calculate *Instability 2*. First, the following is estimated by OLS for each $h \in \{ij, ik, ijk\}$:

$$Ln(y_{ht}) = \beta_0 + \beta_1 t + \epsilon_{ht},$$

[10] Massell (1964) and Wong (1986) use the trend-corrected coefficient of variation to compute the index of export instability, which takes the following form:

$$\frac{\sqrt{\frac{1}{T}\sum_t (y_t - \hat{y}_t)^2}}{\bar{y}},$$

where y_t is the observed export value, $\hat{y}_t$ is the fitted value after estimating a linear time trend, and $\bar{y}$ is the mean of the export values. This index shares similarities with both *Instability 1* and *2* used in this paper. The main difference is that the index is computed over the entire time period for each country to be used in a cross-sectional analysis while in this paper the measures are computed over rolling five-year periods, yielding a value for each year and allowing a panel analysis. Although *Instability 2* is also computed over five-year periods, the fitted export values are obtained after estimating the exponential trend just once.

[11] Similarly, MacBean (2011) uses an export instability index measured as the average percentage deviation of the export values from the five-year moving average centered on the middle year.

[12] This is also the deterministic trend adopted in Massell (1970) under the justification that countries plan using growth rates rather than absolute changes, making it relevant to look at deviations from an exponential growth path. The use of a deterministic trend as opposed to a stochastic one is based on the spectrum density of export series, which is often dominated by low-frequency variations Cariolle and Goujon (2015). As a robustness check, the trend values are obtained from a global mixed trend that includes a lagged dependent variable (stochastic component) as the following:

$$\textit{Ln(Export earnings}_{ht}) = \beta_0 + \beta_1 t + \beta_2 \textit{Export earnings}_{h,t-1} + \epsilon_{ht},$$

where $h \in \{ij, ik, ijk\}$ and $\epsilon_{ht} \sim N(0, \sigma^2)$. The resulting export earnings volatility measure is referred to as *Instability 3*. The correlation coefficients of *Instability 3* with the other two measures are 0.429 and 0.832, respectively. Regression results using *Instability 3* as an alternative measure of export instability are reported in Table A5 of Appendix B, and the main results are unchanged.

where y_{ht} is the observed export value, t is a linear trend, and ϵ_{ht} is a zero mean error term. The predicted log export value is $\widehat{ln(y)} = \hat{\beta}_0 + \hat{\beta}_1 t$, where the hat ($\hat{}$) indicates that the value is estimated. To obtain trend values of *y* rather than $ln(y)$ and to correct for systematically underestimating the expected value of *y*, an expression of the standard error of the estimate (*se*) is added; thus, $\hat{y} = e^{\widehat{ln(y)} + \frac{se^2}{2}} = e^{\hat{\beta}_0 + \hat{\beta}_1 t + \frac{se^2}{2}}$. Finally, the trend values ($\hat{y}$) are used to construct *Instability 2* as follows:

$$\frac{\sqrt{\frac{1}{T}\sum_t (y_t - \hat{y}_t)^2}}{\frac{1}{T}\sum_t \hat{y}_t} \times 100,$$

where the denominator is the average of trend values over the five-year period. As an example, *Instability 2* with a value of 60 implies that the average size of deviations of export earnings from the exponential trend is 60 percent of the five-year average trend.

The dataset is restricted to observations for which the export values exceed 500 U.S. dollars[13] in each of the 5 years over which *Instability 1* and *2* are computed. That is, only stable trade relationships between country pairs and established industries in terms of trade that last at least five years are analyzed. This intentional focus on volatility in the intensive margin of trade may bias the sample towards developed countries, but similar results are found when restricting the sample to non-high-income economies, with the exception of the effects of financial vulnerability on export instability (see sections 2.4.2.4 and 2.5.4). Besides, focusing on the intensive margin spares the trouble of dealing with the complications of zero-trade flows. Of course, studying volatility in the extensive margin of trade would also be important and interesting, but it is left for future research.

Figure 2.2 and 2.3 plots average values of *Instability 1* and *2* over 1962–2011 for the typical exporter-importer (*ij*) and exporter-industry (*ik*) respectively. Panel (a) includes all observations, whereas panel (b) is restricted to exporter-importer (exporter-industry) pairs that have observations throughout the whole sample period. There are a couple of things to note from these figures. To begin with, the average *Instability 2* is higher than the average *Instability 1*. This is because *Instability 2* detrends the export series once for each panel variable (exporter-importer, exporter-industry, or exporter-importer-industry) to compute the trend values, and with panel variables where no single exponential trend fits, the index tends to overstate the amount of short-run fluctuations.[14] Table 2.1 presents summary statistics for the export instability measures and confirms this fact—*Instability 2* has a higher mean and median. For instance, at the most disaggregated level (*ijkt*), the

[13]In the bilateral industry-level trade data, the minimum export value reported for an exporter-importer-industry prior to 2000 is 501 U.S. dollars. For consistency, this threshold value is applied to all years and also in the aggregate data.

[14]For this reason, MacBean (2011) prefers the five-year moving average to the widely used linear time trend.

mean *Instability 1* is 57 while the mean *Instability 2* is higher at 83. In other words, the average size of deviations from the five-year moving average is 57 percent of the five-year mean while the average magnitude of deviations from the exponential trend is 83 percent of the five-year average trend. In addition, *Instability 2* is approximately three to four times more volatile (the standard deviation is three to four times larger) than *Instability 1*. The instability measures also seem to be correlated with global business cycles, showing spikes in times of recessions, e.g., the 1970s energy crisis and the global financial crisis, which is another reason to include time fixed effects in estimation. Lastly, compared to the full sample in panel (a), the average export earnings volatility measures of the consistent sample appear to gradually decline, though *Instability 2* seems to pick up as it includes years affected by the recent global recession. This implies that trade volatility decreases over time for the most stable trade relationships and exporting industries that have survived over the entire period, but the addition of new markets and products keeps average export instability from falling in the full sample.[15]

Figure 2.4 compares the average values of export earnings volatility between different groups of countries by level of development: high-income (developed) vs non-high-income (developing) exporters.[16] The figure shows that on average, export revenues earned by developing countries are more volatile than those earned by their developed counterparts.[17]

2.3.2 Export Concentration

Two dimensions of export concentration are measured by the Herfindahl-Hirschman concentration index (HHI) using the export values obtained from UN Comtrade. One is an exporter-importer's spread of export values across industries ($HHI^{industry}$), and the other is an exporter-industry's spread of export values across trading partners (HHI^{market}). See Appendix A for more details.

Table 2.2 reports the summary statistics for explanatory variables. The mean values of $HHI^{industry}$ and HHI^{market} are 0.348 and 0.414, respectively, and the indices range from 0 (perfect diversification) to 1 (perfect concentration). For example, U.S.-Canada's $HHI^{industry}$ in 2011 was close to 0 at 0.014, suggesting the country pair's export values are diversified across industries. In fact, the number of U.S. industries that export to Canada

[15]The contrast between the full and consistent sample is more evident in Ederington et al. (2021).

[16]The division of countries (used interchangeably with economies) into income groups comes from the World Bank website: https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups

[17]In addition, exports flowing to non-high-income economies usually exhibit higher volatility compared to those flowing to high-income economies.

surged from 536 in 1988 to 588 in 1989, which is the year the U.S.-Canada Free Trade Agreement entered into force, and has stayed pretty much stable. Considering there are 625 potential SITC Rev.1 four-digit industries (590 in the sample), most of the industries in the U.S. export to Canada, which is why the export values are spread out across many industries contributing to the low $HHI^{industry}$. On the other hand, Malawi-Romania's $HHI^{industry}$ in 2011 was 1 because only one industry ("tobacco, unmanufactured and scrap") in Malawi exported to Romania. As a matter of fact, Malawian exports in 2011 to 10 partner countries, including Romania, were all from this one industry. Accordingly, Malawi's $HHI^{industry}$ with these 10 countries was 1. Similarly, the "passenger motor car (other than buses)" industry in the U.S. exported to 180 countries in 2011, resulting in a relatively low HHI^{market} of 0.108 for U.S.-"passenger motor cars (other than buses)". However, the "electric energy" industry of the U.S. has only exported to one trading partner, Canada, since 1990, and because the industry's exports have been concentrated on just one market, the HHI^{market} has also been 1 for U.S.-"electric energy".

2.3.3 Durability

The division of exports into categories of durable and nondurable goods comes from Engel and Wang (2011). Based on this classification, the *Durability* binary variable is created which assumes the value 1 if the sector produces durable goods and 0 otherwise. Among the 590 four-digit industries in the sample, 35.4 percent are durable goods sectors. See Appendix A for the list of these industries.

2.3.4 Vertical Linkages

Two measures of vertical linkages are constructed. One is the indicator of *Downstream vertical linkages* adopted from Levchenko et al. (2010) but using the Direct Requirements Table of 2007 prepared by the Bureau of Economic Analysis.[18] This indicator represents the intensity with which a commodity is used as an intermediate input by other industries, and lies between 0 and 100—the closer to 100, the higher the intensity.[19] The other is a binary variable given a value of 1 if the industry produces intermediate inputs; 0 otherwise. The UN Broad Economic Categories (BEC) are used to classify intermediate goods, and out of the 590 four-digit industries in the sample, 61.2 percent are intermediate goods

[18] The indicator of downstream vertical linkages in Levchenko et al. (2010) is based on the 2002 benchmark version of the detailed U.S. I-O matrix.

[19] The indicator used in Levchenko et al. (2010) ranges from 0 to 1. However, due to the extremely small values, I have rescaled the indicator to range from 0 to 100, e.g., the mean value of 0.00184 has been rescaled to 0.184. Even then, the values are quite small.

sectors. The correlation coefficient between the two measures is about 0.4.[20] See Appendix A for more details.

2.3.5 Financial Vulnerability

Following Chor and Manova (2012), three financial vulnerability measures are calculated using data items obtained from Compustat on all publicly-held firms in North America: *External finance dependence*, *Trade credit reliance*, and *Asset tangibility*.[21] Industries are considered financially vulnerable when they are highly dependent on external finance, highly reliant on trade credit, or have a low share of hard assets such as real estate, machinery, and plant, which can serve as collateral to obtain external finance and provide protection to the supplier of funds. The correlation coefficients between the three measures are reported in Table A1 of Appendix B. For the construction of these variables, see Appendix A.

2.4 Aggregate Volatility: Bilateral and Industry Level

Three levels of analysis are examined in this paper: bilateral trade (exporter-importer-year), industry-level trade (exporter-industry-year), and bilateral trade at the industry level (exporter-importer-industry-year). The first two corresponds to the aggregate level and the third to the disaggregated level. The reason for the three levels is because different economic agents may be interested in different levels of volatility. For instance, within the aggregate level, governments may care about the volatility of bilateral trade while producers may be more interested in trade volatility at the industry level. In addition, the effects on export instability may be different between the aggregate versus the disaggregated level. This section studies the effects of the determinants on export earnings volatility in the aggregate using either bilateral trade or industry-level trade data.

2.4.1 Bilateral Trade: Exporter-Importer-Year

The unit of observation in the bilateral trade data is an exporter-importer-year (*ijt*) triplet. Industry variation is not used here yet and will be introduced later when dealing with

[20] It is assumed that an industry's average usage as an intermediate input is determined technologically, and the indicator of downstream vertical linkages constructed using U.S. data is representative of that in other countries. This strong assumption is justified by the moderate and positive correlation coefficient between the indicator and the binary variable which is created using global categories of intermediate goods.

[21] In lieu of the flow measures used in Chor and Manova (2012), the corresponding stock measures of external finance dependence and trade credit reliance are used as in Fisman and Love (2003). This is because the stock measures are stabler over the sample period, justifying the use of time-invariant industry financial vulnerability variables.

industry-level data. The regression equation that is estimated is the following:

$$\begin{aligned}\textit{Export earnings volatility}_{ijt} = \beta_0 + \beta_1 HHI^{industry}_{ij(t-1)} + \beta_2 FTA_{ijt} + \beta_3 GATT/WTO_{ijt} \\ + \beta_4 \textit{Trade volume}_{ijt} + \alpha_{ij} + \alpha_{it} + \alpha_{jt} + \alpha_t + \epsilon_{ijt}, \qquad (1)\end{aligned}$$

where *i* is the exporter, *j* is the importer or destination market, and *t* is the year. *Export earnings volatility* refers to either *Instability 1* or *2*. The variable of interest is export concentration measured by the Herfindahl-Hirschman concentration index (HHI) whose value lies between 0 and 1. For each exporter-importer (*ij*), $HHI^{industry}_{ijt}$ represents the spread of export values in year *t* across different industries. The higher the concentration index, the less diversified the exports. Since there is no industry variation, this is the only determinant of export instability to be investigated here. Export concentration is lagged one year to reduce the contemporaneous correlation between the concentration index and the error term. For example, negative bilateral shocks (ϵ_{ijt}) may make bilateral trade flows more volatile and knock out trade in smaller industries, raising $HHI^{industry}$. Using past values for export concentration lessens its correlation with the negative bilateral shocks in the current year. The level of trade integration between the exporter and importer is controlled for using the *FTA* and *GATT/WTO* dummy variables. Each takes on the value 1 if the two countries are members of a free trade agreement or the GATT/WTO multilateral system, respectively. In addition, trade volume is included to control for infrastructure and institutions that facilitate trade such as ports, roads, telecommunications, customs, and regulations.[22] Finally, fixed effects are included to control for observed characteristics of countries (and country pairs) as well as address the issue of endogeneity of export concentration. For instance, developed countries tend to have a more diversified export basket and at the same time exhibit lower trade volatility for reasons unobserved to the researcher, and including time-varying country-year fixed effects addresses the problem of omitting these unobserved country characteristics. The country-pair effects (α_{ij}) capture the time-invariant bilateral distance between exporter *i* and importer *j* such as the geographic distance and whether they share a common language or border.[23] Exporter-year (α_{it}) and importer-year (α_{jt}) effects capture time-varying country charateristics such as country size, population, level of income, macro policies, and exchange rate volatility. Year (α_t) effects absorb global shocks common to all countries.

[22] Bougheas et al. (1999) finds that the stock of infrastructure lowers transport costs which in turn increases the volume of trade. Levchenko (2007) finds that the differences in the quality of institutions across countries and dependence on institutions across industries are an important determinant of trade flows.

[23] Directional country-pair fixed effects are used in the analysis. The main results are unchanged when using symmetric pair effects.

The expected sign on the $HHI^{industry}$ estimated coefficient is positive. If a country pair's exports are diversified (low HHI) across various industries, the variability of export earnings in one industry could be offset by that in another, contributing to lower instability of export earnings in the aggregate. On the other hand, the expected sign on the estimated coefficients of the trade agreement dummy variables is negative since signing a free trade agreement or trading within the WTO framework reduces uncertainty and promotes predictability in the trade environment, resulting in more stable export revenues.[24] Trade volume is expected to be negatively correlated with export instability since countries that trade a lot have better infrastructure or institutions for trade, providing enhanced predictability, consistency, and protection against volatility. In addition, exporting to countries that lack such infrastructure may be costly and exporters may choose to make fewer and larger shipments causing trade to be more lumpy and volatile.

The results are reported in Table 2.3. Standard errors are two-way clustered by exporter and importer to account for within-cluster error correlation.[25] Consistent with expectations, the estimated coefficient on $HHI^{industry}$ suggests that on average, an increase in the concentration index by 1 from a perfectly diversified export basket (0) to a perfectly concentrated one (1) results in a 5.675 percentage point increase in *Instability 1* and 11.441 percentage point increase in *Instability 2*, holding other variables constant. More realistically, a rise in the HHI by one standard deviation (0.302) leads to an increase in *Instability 1* by 1.714 percentage points (median *Instability 1* is 38.211%) and *Instability 2* by 3.455 percentage points (median *Instability 2* is 57.151%). Therefore, diversifying bilateral exports across different industries reduces trade volatility in the aggregate.

The *FTA* estimated coefficient is not statistically significant and the sign is positive. This is against expectation, but Ederington et al. (2021) identifies a channel through which trade agreements may result in increased volatility of bilateral exports: by raising the covariance in economic outcomes between trading partners. The *GATT/WTO* dummy variable is also insignificant and one of the two trade volume estimated coefficients is statistically significant and negative as expected.

2.4.2 Industry-Level Trade: Exporter-Industry-Year

In the industry-level trade data, each unit of observation is an exporter-industry-year (*ikt*) triplet. The regressors vary across industries allowing the use of industry variation. The

[24]In Ederington et al. (2021), we study the relationship between trade agreements and trade volatility in more detail.

[25]Clustering by country pair yields similar results. The only difference is that one of the FTA coefficients becomes statistically significant at the 5% significance level.

following is the regression equation that is estimated:

$$\begin{aligned} \textit{Export earnings volatility}_{ikt} = \beta_0 + \beta_1 HHI^{market}_{ik(t-1)} + \beta_2 Durability_k \\ + \beta_3 \textit{Vertical linkages}_k + \beta_4 \textit{Financial vulnerability}_k \\ + \beta_5 \textit{Trade volume}_{ikt} + \alpha_i + \alpha_{it} + \alpha_t + \epsilon_{ikt}, \end{aligned} \tag{2}$$

where *i* is the exporter, *k* is the industry, and *t* is the year. The variables of interest are export concentration of markets, durability, vertical linkages, and financial vulnerability, which are discussed in more detail in turn. As in the previous section, trade volume is controlled for to account for the presence of trade-facilitating infrastructure and institutions that provide better predictability and consistency. In addition, time-invariant exporter effects (α_i), time-varying exporter-year effects (α_{it}), and year effects (α_t) are included. In addition to the observed characteristics of the exporting country, the fixed effects capture all the unobservables that are correlated with export concentration and volatility. E.g., richer countries tend to have lower export concentration indices and more stable export earnings for unobserved reasons. The results are reported in Table 2.4, and standard errors are two-way clustered by exporter and industry to control for within-cluster correlation of the error.

2.4.2.1 Export concentration

A different dimension of export concentration/diversification is examined here: HHI^{market}_{ikt}, which measures the dispersion of export values of each exporter-industry (*ik*) across different partner countries or destination markets in year *t* and ranges between 0 (perfectly diversified) and 1 (perfectly concentrated). Export concentration is lagged one period to reduce the contemporaneous correlation with the error term. For instance, negative shocks in a country's industry (ϵ_{ikt}) may raise the volatility of its export revenues and force small partner countries to drop out of the trade relationship resulting in a higher HHI^{market}. The estimated coefficient on HHI^{market} is expected to be negative. A high concentration index implies that the export revenues are concentrated in few destination markets, exposing the exporter-industry (*ik*) to the ups and downs of a handful of markets. However, as the concentration index approaches 0 and exports are spread out among a larger number of markets, the fluctuations of individual markets are balanced out and export earnings in the aggregate become less volatile. Consistent with the expectation, the estimated coefficient of HHI^{market} implies that on average, a rise in the index by 1 (going from perfect diversification to perfect concentration) raises *Instability 1* by 40 percentage points, holding all else constant (refer to the first three columns of Table 2.4). Put differently, a standard deviation (0.284) increase in HHI raises *Instability 1* by approximately 11 percentage points (median *Instability 1* is 36.332%). The effect of HHI on *Instability 2* is similar.

2.4.2.2 Durability

The durability of an industry is represented by a binary variable which is equal to 1 if the sector is a durables sector and 0 otherwise. Since spending on durable goods is more volatile than expenditures on nondurables or services, the hypothesis is that the durable goods sectors demonstrate higher export instability compared to the nondurables sectors. Therefore, the expected sign on the estimated coefficient of the *Durable* dummy variable is positive. Consistent with the hypothesis, on average, exports in durables sectors are 3–4 percentage points more volatile relative to those in nondurables sectors, holding other variables constant (refer to Table 2.4). The size and significance of the coefficient is stable regardless of which measure of export earnings volatility, vertical linkages, and financial vulnerability is used.

2.4.2.3 Vertical linkages

Vertical linkages refer to either *Downstream vertical linkages* or the *Intermediate* goods sector dummy variable. The former is an indicator of the average usage of a commodity/industry as an intermediate input by other downstream industries and ranges between 0 and 100–the closer to 100, the higher the usage. The latter is a dummy variable given a value of 1 if the industry is an intermediate goods industry; 0 otherwise. Conventional wisdom says cross-border vertical linkages, or international trade in intermediate goods, have increased the interconnectedness of countries and industries and have exposed them to external shocks. This is viewed to have contributed to the larger decline in trade during the Great Recession of 2008–2009. However, results of empirical studies on the role of vertical linkages during the global recession have been mixed. This paper finds that on average, *Instability 1* increases by approximately 2 percentage points as the indicator of *Downstream vertical linkages* rises by one standard deviation (0.199), ceteris paribus (refer to the first three columns of Table 2.4). Similarly, on average, intermediate goods sectors exhibit 2–3 percentage points higher export instability compared to non-intermediate goods sectors, holding other variables constant (refer to Table A2 of Appendix B). Regardless of which vertical linkages measure is used, the estimated coefficient is positive and statistically significant. This result that global supply chains may contribute to trade volatility is in line with Bems et al. (2009), Yi (2009), and Levchenko et al. (2010).

2.4.2.4 Financial vulnerability

Financial vulnerability refers to one of the three measures: *External finance dependence*, *Trade credit reliance*, or *Asset tangibility*. (See Appendix A for definitions.) The three measures are assumed to vary across industries due to technological reasons, but the values of these sector characteristics are assumed to be relatively stable across countries. Since the U.S. has one of the most developed financial systems, an industry's technological demand for credit can be identified using U.S. data and is assumed to carry over to other countries Rajan and Zingales (1998), Fisman and Love (2003), Braun (2005), Chor and Manova (2012). Financially vulnerable industries are expected to have more volatile export earnings since their steady export performance depends on the stability of their access to finance. Therefore, the expected sign of the estimated coefficient of the first two measures is positive and that of the third is negative. That is, industries that are highly dependent on external finance or trade credit and those with a low share of tangible assets are expected to have more unstable export revenues.

Surprisingly, all three measures of financial vulnerability are statistically insignificant (refer to Table 2.4). When the sample is restricted to developing countries, however, for which financial constraints would play a more important role, *Trade credit reliance* and *Asset tangibility* become statistically significant. (See Table A3 of Appendix B.) As the industry's reliance on trade credit grows stronger by one standard deviation (0.022) for developing countries, export instability increases by 2–3 percent of its median. Likewise, as the industry's share of tangible assets increases in developing countries, their ability to pledge collateral when securing external finance is also enhanced, and as a result, export instability decreases by 3–5 percent of its median. Trade credit and tangible assets are particularly important for developing countries because they have weaker financial institutions and contractibility. For this reason, they are more reliant on an alternative source of funds in the form of trade credit from suppliers Fisman and Love (2003) and are required to have a higher proportion of hard assets to be able to secure external finance Braun (2005).

2.5 Bilateral Industry-Level Trade: Exporter-Importer-Industry-Year

The previous section looks at aggregate export earnings volatility of an exporter-importer (*ij*) aggregated across industries (section 2.4.1) or exporter-industry (*ik*) aggregated over partners (section 2.4.2). This section examines volatility at the disaggregated level. Each observation corresponds to an exporter-importer-industry-year (*ijkt*) and the following regression equation is estimated which includes all the variables that have been discussed so far and an additional concentration variable (to be explained in the following subsection):

$$\begin{aligned}\textit{Export earnings volatility}_{ijkt} = {} & \beta_0 + \beta_1 HHI^{industry}_{ij(t-1)} + \beta_2 HHI^{market}_{ik(t-1)} + \beta_3 HHI^{market}_{jk(t-1)} \\ & + \beta_4 Durability_k + \beta_5 \textit{Vertical linkages}_k + \beta_6 \textit{Financial vul.}_k \\ & + \beta_7 FTA_{ijt} + \beta_8 GATT/WTO_{ijt} + \beta_9 \textit{Trade volume}_{ijkt} \\ & + \alpha_{ij} + \alpha_{it} + \alpha_{jt} + \alpha_t + \epsilon_{ijkt}, \qquad (3)\end{aligned}$$

where *i* is the exporter, *j* is the importer, *k* is the industry, and *t* is the year. As before, the trade agreement dummy variables (*FTA*, *GATT/WTO*)[26] and trade volume are controlled for and country-pair (α_{ij}), country-year (α_{it}, α_{jt}), and year effects (α_t) are included. The regression results are found in Table 2.5, and standard errors are three-way clustered by exporter, importer, and industry.

2.5.1 Export and Import Concentration

At this level of data, both $HHI^{industry}_{ijt}$ and HHI^{market}_{ikt} are included, each evaluating a different dimension of export concentration/diversification: the former is across industries for each exporter-importer (*ij*) in a specific year and the latter is across partner countries for each exporter-industry (*ik*) in year *t*. In addition, a third measure of concentration is included: HHI^{market}_{jkt}, which represents import concentration of an importer-industry (*jk*) across source countries. As before, the concentration indices are lagged one period.

As shown in section 2.4, export diversification matters in the aggregate. This result was expected due to the following: when export values of an exporter-importer (exporter-industry) are spread out across different industries (markets), some of the industry (market) specific shocks will offset each other causing aggregate export revenues to be more stable. For instance, the results of section 2.4.1 and 2.4.2.1 suggest that Canada-U.S. exports overall become more stable if Canada exports an additional product to the U.S. Similarly, Canada-“maple syrup” exports become more stable overall when Canada’s maple syrup industry exports to an additional market. Following the same logic, U.S.-“maple syrup” imports are expected to become more stable when the U.S.’s maple syrup industry imports from an additional source country.

[26]The presence of a free trade agreement between a country pair reduces uncertainty in the trade environment and lowers *Instability 1* (not statistically significant for *Instability 2* though), but GATT/WTO membership and export instability have no statistical relationship (see Table 2.5). These results are not consistent with Ederington et al. (2021) pointing to the fact that the choice of export instability measures, using non-logged vs logged trade flows, and controlling for non-logged vs logged trade volume matters when examining the effects of trade agreements on trade volatility.

However, at the disaggregated level, the effects of diversification are presumed to go away. One would not expect the stability of Canada-U.S.-"maple syrup" exports to be affected by Canada exporting an additional product to the U.S. or Canada's maple syrup industry exporting to an additional market. Likewise, it seems unlikely that the stability of Canada-U.S.-"maple syrup" exports is influenced by U.S.'s maple syrup industry importing from an additional source country/exporter. This is indeed true for $HHI^{industry}$. Export diversification of an exporter-importer across industries reduces aggregate volatility as shown in Table 2.3, but it no longer affects export earnings volatility at the disaggregated level. Even if it does, the effect is not economically significant (change in *Instability 1* by less than one percent of its median). (See the first row of Table 2.5.)

Surprisingly, this does not seem to be the case for HHI^{market}_{ikt} and HHI^{market}_{jkt}. That is, diversification across destination markets (importers) or source countries (exporters) still matters at the disaggregated level. The estimated coefficients of the two concentration indices are positive and both statistically and economically significant in all columns of Table 2.5. On average, a rise in HHI^{market}_{ikt} by one standard deviation (0.284) raises *Instability 1* by approximately 7.5 percentage points, ceteris paribus, which is 15 percent of the median value of *Instability 1* (50.483) (Refer to the first three columns of Table 2.5.) In addition, *Instability 1* increases by approximately 9 percent of the median as HHI^{market}_{jkt} rises by one standard deviation (0.263), holding all else constant. Even though shocks in the destination markets or source countries are not offset at the disaggregated level, diversification across these countries still somehow reduces volatility. This is an unexpected result that requires further study, but it could be that diversified country-industry pairs (both exporter-industry and importer-industry) have more established institutions, infrastructure, and networks that facilitate trade since they have trade relationships with various partners. This perhaps leads to enhanced consistency and predictability in trade flows, and therefore, lower trade volatility.

2.5.2 Durability

Previously in section 2.4.2.2, export earnings of durable goods were shown to exhibit greater volatility than those of nondurable goods in the aggregate. This result also holds at the disaggregated level. On average, durable goods sectors are 6–7 percentage points more volatile than those of nondurable goods, holding other variables constant (refer to Table 2.5). This is because spending on durable goods is more sensitive to business cycles and more volatile. Moreover, since durable goods constitute a significant part of trade compared to GDP, studies have shown that the fall in trade was greater than the fall in production during the recent global recession Engel and Wang (2011), Levchenko et al.

(2010). The results in Table 2.5 are consistent with this view and further suggest that the role of durable goods is not confined to explaining the trade collapse of 2008–2009 but to the general volatility of trade. This may be of more interest to high-income economies who have a higher share of durable goods in trade.[27] It may also be something that developing countries should expect in the future as their incomes grow and production expands to include more durable goods.

2.5.3 Vertical Linkages

As discussed in section 2.4.2.3, vertical linkages lead to higher export earnings volatility in the aggregate. Export instability rose in response to an increase in the indicator of downstream vertical linkages (see Table 2.5), and intermediate goods sectors were found to be more volatile than their non-intermediate counterparts (see Table A2 of Appendix B). This result in the aggregate level persists at the disaggregated level—vertical linkages remain to be associated with higher trade volatility. On average, *Instability 1* grows by approximately 1.5 percentage points (3 percent of the median value of Instability 1) as the indicator of *Downstream vertical linkages* rises by one standard deviation (0.199), holding other variables constant (refer to column (2) of Table 2.5).[28] Despite the conventional wisdom on vertical linkages, empirical studies have given mixed results regarding their role in the Great Trade Collapse. This paper uncovers a clear positive relationship (both in the aggregate and at the disaggregated level) between international trade in intermediate inputs and export instability using an extensive global panel data.

2.5.4 Financial Vulnerability

As was the case in the aggregate level (2.4.2.4), industry financial vulnerability does not have a consistently significant impact on export earnings volatility at the disaggregated level in the pooled sample.[29] (See Table 2.5.) However, when restricting the sample to country pairs where at least one is a developing country, which experiences relatively greater financial constraints, *Trade credit reliance* and *Asset tangibility* become consistently significant: On average, a rise in trade credit reliance of a sector by one standard

[27]In 2011, the average share of durable goods in exports was 30 percent, and the share rises to 44 percent for developed countries. For instance, in 2011, half of U.S. exports and 80 percent of South Korea's exports were durable goods.

[28]The intermediate goods sector binary variable is no longer statistically significant, though. It could be that the intermediate goods sector binary variable does not fully capture vertical linkages. In fact, although vertical specialization has increased over time, the share of intermediate goods in trade based on the UN BEC classification has decreased from 1970 to 1992 Hummels et al. (2001).

[29]Only *Instability 2* is affected by *Trade credit reliance* and *Asset tangibility*, and not *Instability 1*.

deviation leads to an increase in export instability by approximately 2 percent of its median, while a higher share of a sector's tangible assets by one standard deviation decreases export instability by approximately 2–4 percent of its median, holding all else equal.[30] It is somewhat surprising that financial vulnerability does not matter in explaining the variation of export earnings volatility in the pooled sample given the role trade finance played in explaining the Great Trade Collapse Amiti and Weinstein (2011), Chor and Manova (2012). This suggests that an industry's financial needs may be more responsive to specifically financial shocks. Furthermore, the result that developing countries' export instability is affected by *Trade credit reliance* and *Asset tangibility* is consistent with Fisman and Love (2003) and Braun (2005): developing countries have weak financial intermediaries, and thus, they are more reliant on borrowing from suppliers/buyers in the form of trade credit as a substitute for institutional financing, and they also have weak financial contractibility requiring borrowers to have a higher share of tangible assets to be able to pledge collateral.

2.6 Conclusion

The determinants of export earnings volatility found in the literature are export concentration, durability, vertical linkages, and financial vulnerability. The effects of these variables on export instability have been examined both at the aggregate (exporter-importer & exporter-industry) and disaggregated level (exporter-importer-industry) using a panel approach. The findings are summarized as follows:

For exporter-importer pairs, diversifying their exports across various industries helps reduce the volatility of bilateral aggregate trade flows. Similarly, exporter-industry pairs also experience lower export instability in the aggregate when their exports are spread over different destination markets. This is because aggregate exports are less reliant on the ups and downs of an individual industry or market as the number of industries and markets increases, and the size of shocks is also mitigated as they offset each other. This may be of interest to both governments and producers who prefer more stable export revenues and the greater certainty and predictability that follows. For example, to achieve greater stability of trade through diversification, countries may sign trade agreements with new partners to create opportunities for exporting firms planning to do business in a new foreign market. Or countries may expand the coverage of goods and services receiving favorable treatment when signing a trade agreement to make exporting more accessible and less costly for producers looking to engage in trade.

[30] The table of results is not reported in this paper due to redundancy but readers may refer to Table A3 of Appendix B to get the point.

As expected, the effects of diversification by industry goes away at the disaggregated level. But unexpectedly, the effects of diversification by destination markets and source countries remain even at the disaggregated level. An exporter-industry (importer-industry)'s diversification of exports (imports) across many destination countries (source countries) reduces the volatility of an exporter-importer-industry's export earnings. Further study is required to understand this result, but it could be that diversified country-industry pairs have better access to institutions, infrastructure, and networks for trade which in turn increases consistency and predictability in the trade environment and result in lower trade volatility.

Export earnings of durable goods sectors are more volatile than those of nondurables sectors both at the aggregate and disaggregated level. This is related to the fact that durable goods have bigger shocks than nondurable goods because people adjust their spending more on durables. Since developed countries tend to have a higher share of durable goods in their exports, this finding may be of greater relevance to developed economies as well as developing countries in the future as their incomes rise and their export baskets include more durables. Possible policies may include the provision of additional insurance to firms exporting durable products to help them smooth their export revenues.

Vertical linkages, or trade in intermediate goods, have contributed to raising export earnings volatility. Conventional wisdom has it that global supply chains have increased the interconnectedness of countries and industries and the exposure to external shocks, which may have magnified the drop in trade during the global recession. Nevertheless, results of empirical studies have been mixed regarding the role of vertical linkages in the Great Trade Collapse. This paper, using an extensive panel of bilateral trade data at the industry level, uncovers a clear positive relationship between vertical linkages and export instability. It is also consistent with Levchenko et al. (2010) which finds that intermediate goods sectors experienced greater falls in trade during the Great Recession.

Lastly, Chor and Manova (2012) finds that financially constrained industries experienced a larger drop in exports during the global financial crisis. I do not find, however, that these industries have more volatile export earnings in general. This suggests that financial constraints may affect trade volatility only during financial shocks and not in general. In addition, trade credit reliance and asset tangibility become significant only after restricting the sample to developing countries. This is because for developing countries, trade credit is an alternative source of funds to the few formal lenders they have and tangible asset is a requirement in securing external finance when financial contractibility is poor.

2.7 Tables

Table 2.1: Summary Statistics - Response Variable (Export Earnings Volatility)

	Mean	Median	Std. Dev.	Min	Max
ijt (N=424,129)					
Instability 1	48.315	38.211	35.455	0.448	199.928
Instability 2	73.868	57.151	134.904	1.417	16,290.920
ikt (N=1,371,502)					
Instability 1	46.223	36.332	34.672	0.382	199.979
Instability 2	72.108	58.462	107.483	1.084	15,986.948
ijkt (N=24,279,398)					
Instability 1	57.199	50.483	34.507	0	199.999
Instability 2	82.573	66.208	113.666	$<$0.001	50,490.754

i: Exporter, *j*: importer, *k*: industry, *t*: year

Table 2.2: Summary Statistics - Explanatory Variables

	Mean	Median	Std. Dev.	Min	Max
ijt (N=424,129)					
HHI industry	0.348	0.246	0.302	0.006	1
FTA dummy	0.093	0	0.290	0	1
GATT/WTO dummy	0.714	1	0.452	0	1
Trade volume (bil U.S.$)	0.426	0.007	4.058	$<$0.001	351.108
ikt (N=1,371,502)					
HHI market$_{ikt}$	0.414	0.334	0.284	0.013	1
Trade volume (bil U.S.$)	0.122	0.002	1.105	$<$0.001	171.639
jkt (N=3,152,347)					
HHI market$_{jkt}$	0.466	0.399	0.263	0.038	1
ijkt (N=24,279,398)					
Trade volume (mil U.S.$)	6.726	0.170	112.393	0.001	69,065.914
k (N=590)					
Durable dummy	0.354	0	0.479	0	1
Downstream vertical linkages (N=587)	0.184	0.131	0.199	0.006	1.893
Intermediate dummy	0.612	1	0.488	0	1
External finance dependence	0.999	0.912	0.355	0.660	3.654
Trade credit reliance	0.089	0.091	0.022	0.037	0.175
Asset tangibility	0.337	0.338	0.115	0.104	0.741

i: Exporter, *j*: importer, *k*: industry, *t*: year

Table 2.3: Bilateral Trade (*ijt*)

	(1) Instability 1	(2) Instability 2
L.HHI industry	5.675***	11.441***
	(0.709)	(2.634)
FTA dummy	0.920	2.334
	(0.748)	(2.088)
GATT/WTO dummy	0.449	-5.862
	(1.363)	(4.986)
Trade volume (bil U.S.$)	-0.094***	0.031
	(0.035)	(0.054)
Exporter-Importer FE (α_{ij})	Yes	Yes
Exporter-Year FE (α_{it})	Yes	Yes
Importer-Year FE (α_{jt})	Yes	Yes
Year FE (α_t)	Yes	Yes
Observations	424,129	424,129
R^2	0.578	0.250

Standard errors are two-way clustered by exporter & importer and reported in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.4: Industry-Level Trade (*ikt*)

	(1)	(2)	(3)	(4)	(5)	(6)
	Instability 1			Instability 2		
L.HHI market	40.061***	40.087***	40.044***	43.786***	43.904***	44.171***
	(1.564)	(1.563)	(1.539)	(2.204)	(2.172)	(2.130)
Durable dummy	3.570***	3.531***	3.580***	3.178***	3.070***	2.599**
	(0.743)	(0.723)	(0.755)	(1.071)	(1.055)	(1.092)
Downstream vertical linkages	9.394***	9.401***	9.278***	10.270***	10.466***	12.528***
	(1.719)	(1.712)	(1.948)	(2.525)	(2.480)	(2.665)
External finance dependence	0.306			-0.087		
	(0.844)			(1.257)		
Trade credit reliance		4.062			15.358	
		(15.298)			(23.572)	
Asset tangibility			0.277			-8.405
			(3.351)			(5.559)
Trade volume (bil U.S.$)	-1.036***	-1.038***	-1.034***	-0.478**	-0.491***	-0.497***
	(0.255)	(0.256)	(0.255)	(0.187)	(0.187)	(0.188)
Exporter FE (α_i)	Yes	Yes	Yes	Yes	Yes	Yes
Exporter-Year FE (α_{it})	Yes	Yes	Yes	Yes	Yes	Yes
Year FE (α_t)	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,371,502	1,371,502	1,371,502	1,371,502	1,371,502	1,371,502
R^2	0.271	0.271	0.271	0.075	0.075	0.075

Standard errors are two-way clustered by exporter & industry and reported in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.5: Bilateral Trade at the Industry Level (*ijkt*)

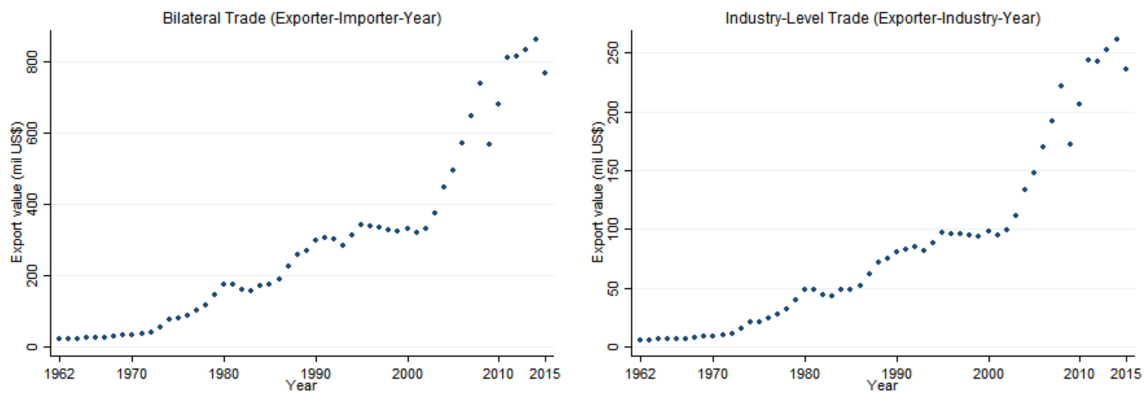
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Instability 1				Instability 2			
L.HHI industry	0.899**	0.912**	0.910**	2.638***	0.405	0.438	0.440	0.633
	(0.396)	(0.391)	(0.391)	(0.450)	(0.958)	(0.951)	(0.948)	(0.925)
L.HHI market_{ikt}	26.430***	26.512***	26.639***	10.420***	25.967***	26.161***	26.566***	7.677***
	(2.095)	(2.109)	(2.060)	(0.736)	(2.623)	(2.667)	(2.591)	(0.951)
L.HHI market_{jkt}	17.519***	17.690***	17.742***	4.291***	18.964***	19.377***	19.605***	2.970***
	(1.712)	(1.680)	(1.618)	(0.448)	(2.749)	(2.705)	(2.578)	(0.644)
Durable dummy	5.739***	5.660***	5.493***		6.519***	6.328***	5.808***	
	(0.780)	(0.772)	(0.760)		(1.006)	(0.995)	(1.000)	
Downstream vertical linkages	7.079***	7.369***	8.437***		4.903*	5.598**	8.816***	
	(1.807)	(1.786)	(1.955)		(2.556)	(2.527)	(2.666)	
External finance dependence	-0.024				-0.008			
	(0.987)				(1.338)			
Trade credit reliance		20.123				48.778**		
		(16.026)				(19.431)		
Asset tangibility			-4.503				-13.007**	
			(4.059)				(5.777)	
FTA dummy	-1.752***	-1.743***	-1.740***	-1.688***	-0.225	-0.204	-0.191	-0.083
	(0.439)	(0.438)	(0.437)	(0.517)	(0.564)	(0.563)	(0.563)	(0.506)
GATT/WTO dummy	1.463	1.443	1.438	0.474	3.018	2.968	2.946	1.957
	(0.968)	(0.962)	(0.963)	(1.034)	(1.944)	(1.936)	(1.941)	(2.127)
Trade volume (mil U.S.$)	-0.010***	-0.010***	-0.010***	-0.003***	-0.004***	-0.004***	-0.004***	0.009***
	(0.003)	(0.003)	(0.003)	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)
Exp-Imp FE (α_{ij})	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Exp-Imp-Ind FE (α_{ijk})	No	No	No	Yes	No	No	No	Yes
Exp-Year FE (α_{it})	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Imp-Year FE (α_{jt})	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ind-Year FE (α_{kt})	No	No	No	Yes	No	No	No	Yes
Year FE (α_t)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	24,279,398	24,279,398	24,279,398	24,631,295	24,279,398	24,279,398	24,279,398	24,631,295
R^2	0.128	0.128	0.128	0.457	0.031	0.031	0.031	0.240

Standard errors are three-way clustered by exporter, importer, & industry and reported in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

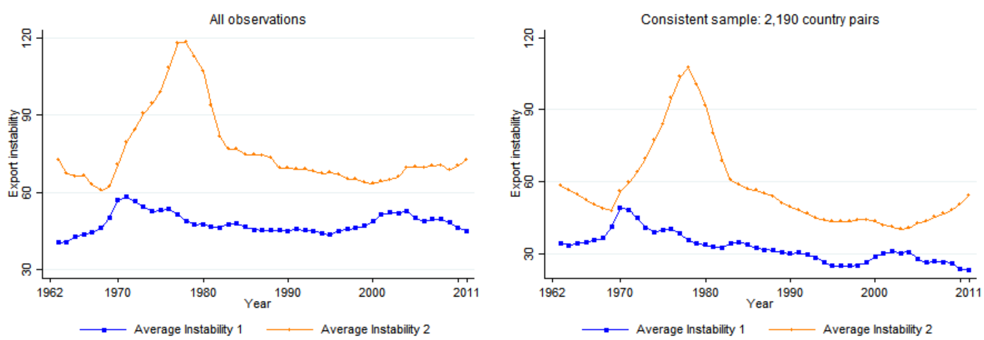
2.8 Figures

Figure 2.1: Average Export Earnings over Time



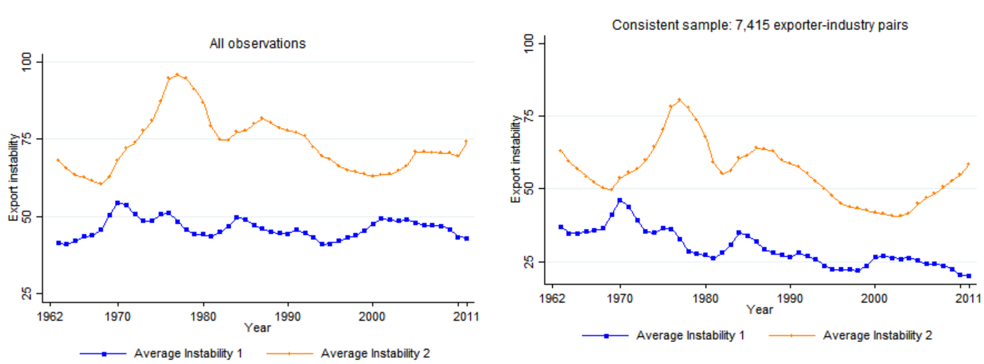
(a) Bilateral trade (exporter-importer-year) (b) Industry-level trade (exporter-industry-year)

Figure 2.2: Bilateral Trade - Average Export Earnings Volatility over Time



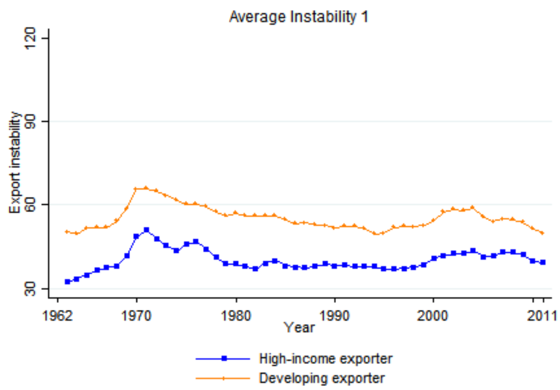
(a) Full sample (b) Consistent sample: 2,190 country pairs

Figure 2.3: Industry-Level Trade - Average Export Earnings Volatility over Time

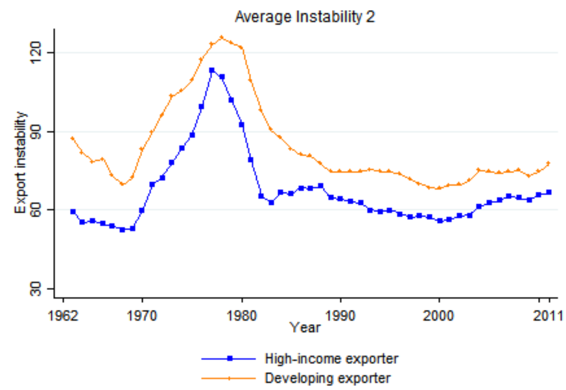


(a) Full sample (b) Consistent sample: 7,415 exporter-industry pairs

Figure 2.4: Bilateral Trade - Developed vs Developing Exporter



(a) Average Instability 1



(b) Average Instability 2

Chapter 3 Do Trade Agreements Actually Reduce Trade Volatility?

3.1 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 certainty in trade relationships. Indeed, Handley and Limão (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

[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.

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 Limão and Maggi (2015)), a recent study, Jakubik and Piermartini (2019), has 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 reduces trade volatility.

However, there have been many recent advances in the gravity regression literature, both 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 one included country-pair fixed effects to control for latent factors that might be

[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) and 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.

correlated with both trade flows and treaty participation. Thus, our intent in this paper is to, both theoretically and empirically, revisit the question of how joint membership in an international trade agreement might affect 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 might provide more certainty with respect to bilateral trade flows by reducing the volatility of bilateral trade barriers. However, what has received less attention is that trade agreements (especially explicitly regional trade agreements) can also influence bilateral trade volatility by affecting the covariance in economic outcomes between countries. 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, provides insight into 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 3.4 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 WTO membership consistently reduces trade volatility, 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

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

a free trade agreement, to a customs union, to a common market). 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 3.2 provides a structural approach to investigating the link between trade policy membership and bilateral trade volatility, section 3.3 introduces the data, sections 3.4 and 3.5 provide the results, and section 3.6 concludes.

3.2 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]

$$X_{ijk} = \frac{Y_{ik}E_{jk}}{Y_k}\left(\frac{t_{ijk}}{\pi_{ik}P_{jk}}\right)^{1-\sigma_k} \tag{3.1}$$

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:

$$lnX_{ijkt} = lnE_{jkt} + lnY_{ikt} - lnY_{kt} + (1-\sigma_k)lnt_{ijkt} - (1-\sigma_k)lnP_{jkt} - (1-\sigma_k)ln\pi_{ikt} \tag{3.2}$$

Since we are interested in the volatility of trade flows, we compute the variance of these logged trade flows, $Var(lnX_{ijkt})$, which can be expressed as the sum of variance

[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.

and covariance terms:

$$Var(lnX_{ijkt}) = V_{ikt} + V_{jkt} + (1 - \sigma_k)^2 Var(lnt_{ijkt}) + CV_{ijkt} \tag{3.3}$$

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.[8] 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, $Var(lnt_{ijkt})$ 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). The key question in the paper 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:

$$(1 - \sigma_k)^2 Var(lnt_{ijkt}) = \gamma_{ijk} + \delta TA_{ijt} + \mu_{ijkt} \tag{3.4}$$

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).[9] Finally, they provide greater transparency and clarity about foreign trade barriers, thus imposing a cost to either introducing new trade barriers or "reinterpreting" old ones (as any changes would be subject

[8] Specifically,

$$\begin{aligned} V_{ikt} = {} & Var(lnY_{ikt}) + (1 - \sigma_k)^2 Var(ln\pi_{ikt}) + .5Var(lnY_{kt}) - 2Cov(lnY_{ikt}, lnY_{kt}) \\ & - 2(1 - \sigma_k)Cov(lnY_{ikt}, ln\pi_{ikt}) + 2(1 - \sigma_k)Cov(lnY_{kt}, ln\pi_{ikt}). \end{aligned}$$

Similarly,

$$\begin{aligned} V_{jkt} = {} & Var(lnE_{jkt}) + (1 - \sigma_k)^2 Var(lnP_{jkt}) + .5Var(lnY_{kt}) - 2Cov(lnE_{jkt}, lnY_{kt}) \\ & - 2(1 - \sigma_k)Cov(lnE_{jkt}, lnP_{jkt}) + 2(1 - \sigma_k)Cov(lnY_{kt}, lnP_{jkt}). \end{aligned}$$

[9] For a discussion, see Bagwell and Staiger (2001).

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 3.3 is a collection of cross-country covariance terms[10] (e.g., $Cov(lnE_{jkt}, lnY_{ikt})$). 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:

$$CV_{ijkt} = \lambda_{ijk} + \rho TA_{ijt} + \nu_{ijkt} \tag{3.5}$$

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.[11] For example, if one assumes a classical model of trade, it is possible that the existence of a trade agreement could lead to greater specialization and thus a more dissimilar production structure that could even result in negative cross-country correlations. 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)). 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:

$$Var(lnX_{ijkt}) = \beta TA_{ijt} + \alpha_{ikt} + \alpha_{jkt} + \alpha_{ijk} + \epsilon_{ijkt} \tag{3.6}$$

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

[10] Specifically:

$$\begin{aligned} CV_{ijkt} = {} & 2Cov(lnE_{jkt}, lnY_{ikt}) + 2(1-\sigma_k)Cov(lnE_{jkt}, lnt_{ijkt}) - 2(1-\sigma_k)Cov(lnE_{jkt}, ln\pi_{ikt}) \\ & + 2(1-\sigma_k)Cov(lnY_{ikt}, lnt_{ijkt}) - 2(1-\sigma_k)Cov(lnY_{ikt}, lnP_{jkt}) - 2(1-\sigma_k)Cov(lnY_{kt}, lnt_{ijkt}) \\ & - 2(1-\sigma_k)^2Cov(lnt_{ijkt}, lnP_{jkt}) - 2(1-\sigma_k)^2Cov(lnt_{ijkt}, ln\pi_{ikt}) + 2(1-\sigma_k)^2Cov(lnP_{jkt}, ln\pi_{ikt}) \end{aligned}$$

[11] 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.

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.

3.3 Data

The trade data comes from the UN Comtrade Database. Data on export values in current U.S. dollars is collected for each exporter(reporter)-importer(partner)-industry at the SITC Rev. 1 four-digit level from 1962 to 2014 and 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.[12] However, our structural framework in section 3.2 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:

First, to be consistent with our derived equation, 3.6, 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. However, in Appendix C we provide some robustness checks using alternative measures of volatility based on non-logged trade flows and find similar results.

Second, we calculate our volatility measures at a disaggregated four-digit SITC level (as opposed to aggregated country-level measures). This is done for two reasons. First, to get a level of disaggregation that provides a more accurate picture of bilateral volatility. For example, to the extent that volatility varies across sectors (e.g., see Han (2021a) for evidence that durable goods tend to have higher levels of trade volatility), more aggregate measures of bilateral trade volatility could potentially be determined by the set of industries traded (which would be influenced by trade agreements as well). Indeed, in section 3.4 we show that standard measures of volatility are heavily influenced by such selection effects. Second, to get a level of aggregation that policy makers would care about. The fact that the vast majority of trade barriers do not vary across firms leads to the formation of industry-level lobbying groups to influence governmental policy. Thus, many models

[12]There is an extensive literature that has investigated the determinants of export volatility. See Massell (1970), MacBean and Nguyen (1980), Love (1986), and Han (2021a). 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.

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 perhaps not specified, 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 approximately the level of aggregation 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] Thus we are not analyzing the impact of trade agreements on volatility associated with the entry and exit of new products and new markets. Of course, the impact of trade agreements on fixed costs and, thus, potential volatility in the *extensive* margin of trade is also an area of interest and something we intend to analyze in a following paper. Although, it should be noted that Bernard et al. (2009) 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 due to the fact that 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 3.1.

Finally, data on the year of GATT or WTO membership is obtained from Tomz et al. (2007), which classifies formal members as well as nonmember participants such as colonies, de facto members, and provisional members as having GATT membership given that they also had rights and obligations under the agreement.[14] The GATT/WTO binary variable

[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. 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 in that the coefficient estimate on the RTA variable was positive and statistically significant for all volatility measures. However, the coefficient estimates for the WTO variable were no longer statistically significant.

[14]Rose (2004) obtains data on GATT/WTO membership from the World Trade Organization website and finds little evidence that formal members experienced growth in trade compared to the nonmembers. This result is reversed by Tomz et al. (2007) when it includes nonmember participants who shared the major duties and privileges of the agreement.

is created such that GATT/WTO = 1 if both exporter and importer are formal members or nonmember participants of the GATT or WTO and zero otherwise.

The final dataset includes 180 exporting countries, 194 importing countries, and 620 SITC Rev. 1 four-digit industries from 1964 to 2012.

3.4 Empirics

To empirically examine the effects of trade agreements on export earnings volatility, we estimate equation 3.6. The presence of trade agreements is captured by the RTA ranking and GATT/WTO binary variable. Another issue to take into account 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.[15]

As mentioned, several measures of export earnings volatility are introduced due to the ad hoc nature of measuring volatility. The standard and detrended measures are presented in the following subsections, respectively. Then in Appendix C we consider some other variants that have also been employed in the literature.

3.4.1 Standard Measures of Volatility

3.4.1.1 Definition

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 (2021a)). First, the squared log difference (*Sq log diff*)[16] is the squared value of the change in log export values for each exporter-

[15] 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).

[16] Mansfield and Reinhardt (2008) also uses the absolute log difference:

$$\textit{Abs log diff} = |lnX_{ijkt} - lnX_{ijk(t-1)}|$$

The difference between the squared log difference and the absolute log difference is that the former places higher weights on larger fluctuations. However, as we show in Appendix C, coefficient estimates are similar if we use the absolute value measure.

importer-industry (*ijk*) between years *t-1* and *t*:

$$\textit{Sq log diff} = \left(lnX_{ijkt} - lnX_{ijk(t-1)}\right)^2 \tag{3.7}$$

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. *Variance 1* 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:

$$\textit{Variance 1} = \frac{1}{T}\sum_t (lnX_{ijkt} - \overline{lnX_{ijk}})^2 \tag{3.8}$$

where $\overline{lnX_{ijk}} = \frac{1}{T}\sum_t lnX_{ijkt}$. Similarly, *CV 1* 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).[17] The measure is expressed as a percentage. For example, a CV of 25 means the standard deviation is 25 percent of the mean.

$$\textit{CV 1} = \frac{\sqrt{\textit{Variance 1}}}{\overline{lnX_{ijk}}} \times 100 = \frac{\sqrt{\frac{1}{T}\sum_t (lnX_{ijkt} - \overline{lnX_{ijk}})^2}}{\overline{lnX_{ijk}}} \times 100 \tag{3.9}$$

Summary statistics for these three standard measures are provided in Table 3.2 and average values are plotted over time in Figure 3.1 (scaled so that $1964 = 100$). What is perhaps surprising in Figure 3.1 is that volatility appears to be increasing 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 Figure 3.2, we restrict the sample to ijk triplets that have observations for all years in the sample (mostly long-standing trade relations between developed countries), and volatility declines consistently and substantially over time for all three measures. This distinction is important as it is exactly this bilateral variation over time that we are exploiting in our empirical specification to estimate the effect of trade agreements on volatility, and this is one of the main reasons we estimate our regressions at the disaggregated industry level.

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

3.4.1.2 Results

Table 3.3 presents the results of estimating equation 3.6 using our three standard measures of volatility.[18] Log export value is included in the first two columns since *Sq log diff* and *Variance 1* do not control for scale issues.[19] The first column of Table 3.3 presents results with the squared log difference in annual trade flows as the dependent variable. On average, when the RTA ranking increases by 1 category (e.g., from no trade agreement of any kind to a non-reciprocal preferential trade agreement or from a PTA to an FTA), *Sq log diff* rises by 0.048, which is 21.24% of the median (holding GATT/WTO membership and trade volume constant). On the other hand, when both exporting and importing countries are members of the GATT/WTO, *Sq log diff* decreases by 0.027, which is an economically significant (albeit statistically insignificant) 11.95% of the median, holding other variables constant.

The second column presents the results using our five-year measure of variance in export flows. As can be seen, a similar pattern emerges in which membership in a regional trade agreement increases export volatility in the bilateral pair, while membership in the multilateral GATT/WTO reduces trade volatility. However, the magnitude of the estimates are reduced (although, now, the coefficient estimate on GATT/WTO membership is statistically significant). Specifically, a one category increase in a regional trade agreement causes *Variance 1* to rise by 0.014, which is 4.55% of the median, while, when both exporting and importing countries are members of the GATT/WTO, *Variance 1* decreases by 0.028, which is 9.09% of the median.

The next two columns report results for the coefficient of variation (*CV 1*) in trade flows, where our measure of volatility is normalized by the volume of trade. Comparing column 3 (which does not include the log of trade as an additional control) with column 4 (which does) shows that the estimated impact of trade agreement membership on volatility is much more negative when trade volume is not included. This is due to the strong negative correlation between trade volume and trade volatility in all our measures, including the coefficient of variation (this can be confirmed with a simple scatter plot). Thus, in addition to the direct effects discussed in section 3.2, trade agreements can also indirectly reduce trade volatility simply by increasing the volume of trade.

[18] Reported standard errors are clustered by country-pair. We also experimented with muli-way clustering 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.

[19] Given our focus on log measures of volatility, it turns out that log export value and export earnings volatility are negatively correlated. This is because log difference measures are approximations of percentage changes and large percentage changes turn out to be much more likely at low export volume levels.

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. One explanation for this difference can be found in our structural framework of section 3.2. The negative coefficient on the GATT/WTO is potentially due to it achieving its stated goals of reducing the volatility of trade barriers and thus stabilizing trade flows. In addition, since it is a multilateral agreement that stresses non-discrimination across members, it would not be likely to drastically increase the covariance between any two bilateral trading partners. In contrast, a regional trade agreement, which is inherently discriminatory, is more likely to tie the trading partners more tightly together, increasing the covariance of economic outcomes and thus the volatility of bilateral trade flows.

3.4.2 Detrended Measures of Volatility

3.4.2.1 Definition

One problem 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 in Massell (1970), Lawson (1974), Cariolle and Goujon (2015), and Han (2021a).

Figure 3.3 plots the average log export values against time. A linear trend is used to fit these log export values[20] of each exporter-importer-industry (*ijk*) by estimating the following by OLS:

$$\ln X_{ijkt} = \beta_0 + \beta_1 t + \epsilon_{ijkt} \tag{3.10}$$

where $\ln X_{ijkt}$ represents the logged value of exports from country *i* to partner *j* in industry *k* and year *t*. Then the residuals are obtained as the following:

$$e_{ijkt} = \ln X_{ijkt} - \widehat{\ln X_{ijkt}} = \ln X_{ijkt} - (\hat{\beta}_0 + \hat{\beta}_1 t) \tag{3.11}$$

where $\hat{\beta}_0$ and $\hat{\beta}_1$ are OLS coefficient estimates.

The three detrended measures of volatility use these residuals. First, the squared difference in residuals (*Sq diff in resid*)[21] is the squared value of the difference in residuals

[20] This is equivalent to using an exponential trend to fit the export values.

[21] A similar measure is the absolute difference in residuals (*Abs diff in resid*), which is the absolute value of the change in residuals for each exporter-importer-industry (*ijk*) between years *t-1* and *t*:

$$\textit{Abs diff in resid} = |(e_{ijkt} - e_{ijk(t-1)})|$$

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

$$\textit{Sq diff in resid} = \left(e_{ijkt} - e_{ijk(t-1)}\right)^2 \tag{3.12}$$

Second, the variance of residuals (*Variance 2*) for each exporter-importer-industry (*ijk*) over overlapping five-year intervals is the average squared deviation of residuals 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:[22]

$$\textit{Variance 2} = \frac{1}{T}\sum_t (e_{ijkt} - \overline{e_{ijk}})^2 \tag{3.13}$$

where $\overline{e_{ijk}} = \frac{1}{T}\sum_t e_{ijkt}$. Third, the coefficient of variation of residuals (*CV 2*), also computed over the five years beginning two years before the observation, adjusts for the difference in the means and makes comparisons possible among different exporter-importer-industry (*ijk*) triplets:[23]

$$\textit{CV 2} = \frac{\sqrt{\textit{Variance 2}}}{\overline{|e_{ijk}|}} \times 100 = \frac{\sqrt{\frac{1}{T}\sum_t (e_{ijkt} - \overline{e_{ijk}})^2}}{\overline{|e_{ijk}|}} \times 100 \tag{3.14}$$

Summary statistics for these three detrended measures are provided in Table 3.4 and average values are plotted over time in Figure 3.4 (once again scaled so that $1964 = 100$). To avoid issues generated by the changes in the set of ijk triplets over time, Figure 3.4 is drawn using a consistent set of ijk trade relationships that are in our sample for the entire time period.

3.4.2.2 Results

Table 3.5 reports estimation results for equation 3.6 using the detrended measures of volatility. As before, *Sq diff in resid* and *Variance 2* are not normalized by size and require the inclusion of trade volume. On the other hand, since *CV 2* is standardized, one specification includes trade volume and the other does not. The results in all four columns show that greater regional integration is correlated with increases in trade volatility while

[22] 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.

[23] Given that the residuals can be either positive or negative, the standard deviation is divided by the average of the absolute value of the residuals.

multilateral integration is not (although the estimated coefficients for GATT/WTO membership remain negative they are no longer statistically significant).[24]

In addition, the magnitudes of the estimates are quite consistent with those of the standard measures of volatility. For example, consider column 1 which provides estimates for the squared difference in residuals. Increasing the RTA ranking by 1 category raises *Sq diff in resid* by 0.041, which is 18.72% of the median, holding other variables constant (quite similar to the increase in volatility of 21.24% of the median estimated in section 3.4.1.2 for the squared log difference). Also consistent with the results of section 3.4.1.2, moving to the 5-year measures reduces the magnitude of the estimated impact of RTAs but maintains the negative correlation between RTA membership and trade stability. For example, see column 2 where an increase in the RTA ranking by 1 category raises *Variance 2* by 0.011, which is 3.79% of the median (comparable to an increase in *Variance 1* of 4.55% of the median in section 3.4.1.2).

3.5 RTA Heterogeneity

One of the more surprising results of the previous section is that trade volatility actually rises between country pairs that enter into a regional trade agreement (RTA). One potential explanation for this fact is that regional agreements are leading to increased bilateral integration which could cause greater covariance between the trading partners (thus increasing bilateral trade volatility). If so, then it seems possible that the more integrated the countries get, the greater the increase in trade volatility. In the previous sections, we estimated equation 3.6 with one multichotomous RTA ranking variable. In this section, six separate RTA dummy variables are included to examine the heterogeneous effects of the types of regional trade agreements (see Table 3.1 for definitions). For example, the FTA binary variable has the value of 1 if the country pair is part of a free trade area. The reference category is no trade agreement. Results are reported in Table 3.6.

As can be seen, as country pairs become more regionally integrated, the estimated coefficient becomes larger (i.e., export earnings volatility is increasing in regional integration). For example, consider column 1 which provides coefficient estimates for the squared log difference defined in section 3.4.1.1. Recall that we previously estimated that a one category increase in the RTA index causes *Sq log diff* to rise by 21.24% of the median (see section 3.4.1.2). Similarly, the first column of Table 3.6 suggests that moving from no agreement to a Free Trade Area (FTA) would increase *Sq log diff* by 0.122 which is about 53.98% of its median value. However, going from no agreement all the way to an economic

[24] As before, we also used the absolute value of the difference in residuals as another measure of volatility and obtained similar results.

union (equivalent to a 6 category increase in the RTA index) would increase *Sq log diff* by 0.340 which is around 150% of the median value.

Coefficient estimates for our five-year measures are reduced but remain economically significant. From section 3.4.1.2, we previously estimated that a one category increase in a regional trade agreement causes *Variance 1* to rise by 4.55% of the median. The results of column 2 of Table 3.6 suggest that moving from no agreement to an FTA would increase *Variance 1* by around 14.20% of the median. However, moving from no agreement to a full economic union would cause *Variance 1* to increase by over twice as much (i.e., around 30.84% of its median value).

Thus, increased integration between bilateral trading partners appears to be coming at the expense of increased year-to-year trade volatility. As mentioned, one possible explanation is that increased integration is also leading to greater comovements in economic outcomes across trading partners. Regardless, this correlation between the degree of integration and volatility in trade flows suggests that the joint goals of many regional trade agreements to both integrate the economies of member countries and induce greater stability in trade relations may be in conflict.

3.6 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, 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. 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). Although it should be noted that this result is not statistically significant for all 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.

However, a robust and somewhat surprising result of our analysis is that bilateral trade flows between members of a regional trade agreement exhibit *increased* year-to-year trade volatility, and this positive correlation is both statistically and economically significant across all our measures of volatility. 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 may also contribute to increased volatility in trade relations. This suggests that regional trade agreements' 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 Limão and Maggi (2015)) might not translate into reduced trade volatility.

3.7 Tables

Table 3.1: Regional Trade Agreement (RTA) Ranking

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

Table 3.2: Summary Statistics - Standard Measures of Volatility

	Mean	Median	Std Dev	Min	Max
Sq log diff	1.308	0.226	3.454	0	226.551
Variance 1	0.710	0.308	1.114	0	54.179
CV 1	6.026	4.632	4.771	0	86.020
Observations	23,050,547	23,050,547	23,050,547	23,050,547	23,050,547

Table 3.3: Effects of Trade Agreements on Export Earnings Volatility - Standard Measures

	(1) Sq log diff	(2) Variance 1	(3) CV 1	(4) CV 1
L.RTA ranking	0.048^{***}	0.014^{***}	-0.006	0.076^{***}
	(0.003)	(0.001)	(0.009)	(0.007)
L.GATT/WTO dummy	-0.027	-0.028^{*}	-0.204^{**}	-0.142^{**}
	(0.035)	(0.015)	(0.088)	(0.071)
L.Log export value	-0.526^{***}	-0.158^{***}		-0.989^{***}
	(0.003)	(0.001)		(0.003)
Exporter-industry-year (α_{ikt})	Yes	Yes	Yes	Yes
Importer-industry-year (α_{jkt})	Yes	Yes	Yes	Yes
Exporter-importer-industry (α_{ijk})	Yes	Yes	Yes	Yes
Observations	23,050,547	23,050,547	23,050,547	23,050,547
Adjusted R^2	0.241	0.464	0.549	0.600

Standard errors are clustered by country pair and reported in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3.4: Summary Statistics - Detrended Measures of Volatility

	Mean	Median	Std Dev	Min	Max
Sq diff in resid	1.292	0.219	3.424	0	227.730
Variance 2	0.679	0.290	1.075	0	50.241
CV 2	82.984	91.416	34.705	0.032	196.826
Observations	23,050,547	23,050,547	23,050,547	23,050,547	23,050,547

Table 3.5: Effects of Trade Agreements on Export Earnings Volatility - Detrended Measures

	(1) Sq diff in resid	(2) Variance 2	(3) CV 2	(4) CV 2
L.RTA ranking	0.041***	0.011***	0.262***	0.664***
	(0.003)	(0.001)	(0.076)	(0.068)
L.GATT/WTO dummy	-0.019	-0.008	-0.812	-0.509
	(0.035)	(0.014)	(0.685)	(0.653)
L.Log export value	-0.439***	-0.114***		-4.870***
	(0.003)	(0.001)		(0.020)
Exporter-industry-year (α_{ikt})	Yes	Yes	Yes	Yes
Importer-industry-year (α_{jkt})	Yes	Yes	Yes	Yes
Exporter-importer-industry (α_{ijk})	Yes	Yes	Yes	Yes
Observations	23,050,547	23,050,547	23,050,545	23,050,545
Adjusted R^2	0.235	0.466	0.318	0.342

Standard errors are clustered by country pair and reported in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3.6: RTA Heterogeneity

	(1) Sq log diff	(2) Variance 1	(3) CV 1	(4) Sq diff in resid	(5) Variance 2	(6) CV 2
L.Non reciprocal PTA	0.057^{***}	0.017^{***}	0.095^{***}	0.052^{***}	0.014^{**}	0.811^{***}
	(0.014)	(0.006)	(0.028)	(0.014)	(0.006)	(0.310)
L.Preferential trade arrangement	0.026^{*}	0.021^{***}	0.059^{**}	0.021	0.014^{**}	-0.323
	(0.014)	(0.006)	(0.028)	(0.013)	(0.006)	(0.268)
L.Free trade areas	0.122^{***}	0.044^{***}	0.238^{***}	0.103^{***}	0.033^{***}	1.447^{***}
	(0.010)	(0.005)	(0.024)	(0.010)	(0.004)	(0.253)
L.Customs union	0.190^{***}	0.031^{***}	0.097^{**}	0.147^{***}	0.018^{*}	0.860^{*}
	(0.023)	(0.010)	(0.044)	(0.023)	(0.010)	(0.470)
L.Common market	0.262^{***}	0.064^{***}	0.392^{***}	0.223^{***}	0.052^{***}	4.633^{***}
	(0.018)	(0.007)	(0.038)	(0.017)	(0.007)	(0.419)
L.Economic union	0.340^{***}	0.095^{***}	0.592^{***}	0.301^{***}	0.082^{***}	6.185^{***}
	(0.027)	(0.011)	(0.054)	(0.026)	(0.011)	(0.507)
L.GATT/WTO dummy	-0.024	-0.027^{*}	-0.132^{*}	-0.016	-0.007	-0.433
	(0.034)	(0.015)	(0.071)	(0.034)	(0.014)	(0.651)
L.Log export value	-0.525^{***}	-0.158^{***}	-0.991^{***}	-0.438^{***}	-0.114^{***}	-4.833^{***}
	(0.003)	(0.001)	(0.003)	(0.003)	(0.001)	(0.019)
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
R^2	0.397	0.574	0.682	0.392	0.575	0.478

Standard errors are clustered by country pair and reported in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

3.8 Figures

Figure 3.1: Average Volatility Over Time - Full Sample

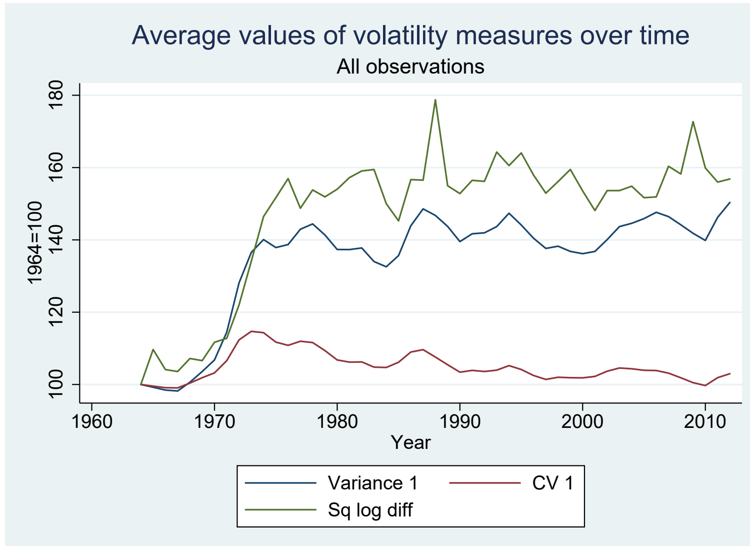


Figure 3.2: Average Volatility Over Time - Restricted Sample

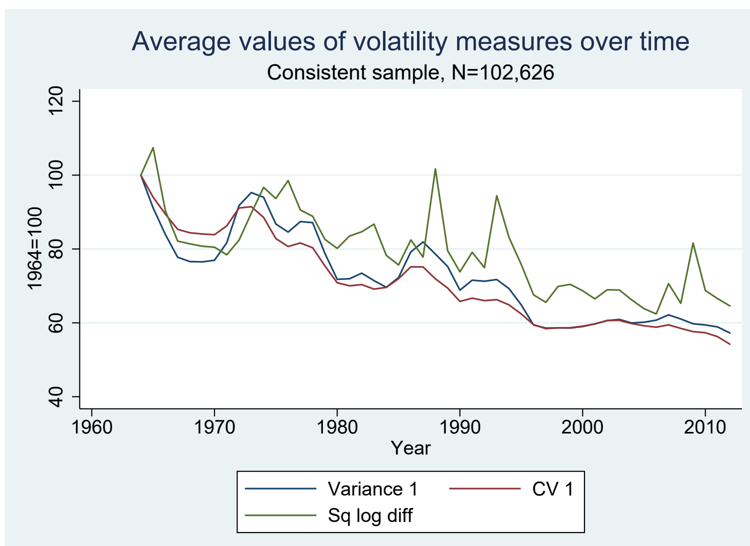


Figure 3.3: Average Log Export Earnings over Time

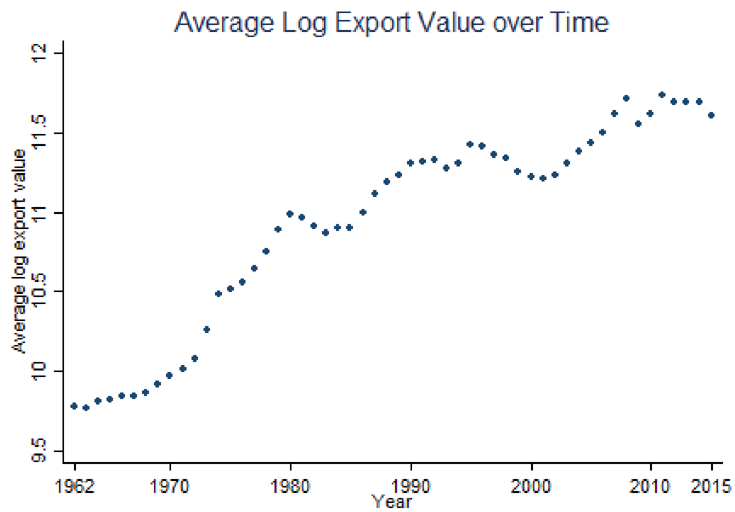
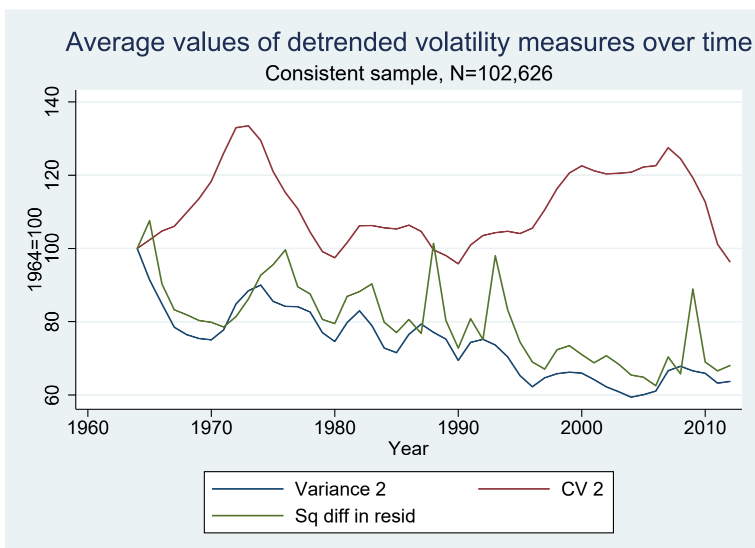


Figure 3.4: Average (Detrended) Volatility Over Time - Consistent Sample



Chapter 4 Did Countries with Diversified Exports Fare Better in the 2008 Global Financial Crisis?

4.1 Introduction

The 2008 global financial crisis was marked by a drop in output and proportionately larger fall in trade. GDP in current U.S. dollars was 63.69 trillion in 2008 which dropped to 60.41 trillion in the following year World Bank (2021a), a 5.15 percent decrease, while merchandise exports in current U.S. dollars were 16.275 trillion in 2008 which fell to 12.644 trillion in 2009 World Bank (2021b), a 22.31 percent decrease. This sudden, severe, and synchronized plunge in world trade between the third quarter of 2008 and the second quarter of 2009, which outpaced the reduction in GDP, is referred to as the Great Trade Collapse (Baldwin, 2009).

A range of potential explanations for the Great Trade Collapse has been proposed in the literature. One is the plunge in demand for postponable durable goods which consist a large share of international trade Levchenko et al. (2010), Engel and Wang (2011). Because durable goods consumption is more volatile than GDP and international trade is concentrated in these durable goods, the fall in trade was larger than that of GDP during the global financial crisis. Another is the contraction of trade finance availability Amiti and Weinstein (2011), Auboin and Engemann (2014), Chor and Manova (2012), Korinek et al. (2010). Exporters are more reliant on trade finance because international transactions take longer to process than domestic sales, increasing the needs for working capital loans and insurance. For this reason, the tigher credit conditions and lack of trade finance during the global financial crisis had a bigger effect on trade than production. Finally, the prevalence of vertical production linkages has made the transmission of shocks easier, and Levchenko et al. (2010) finds that sectors that are intensively used as intermediate inputs experienced greater reductions in trade during the Great Trade Collapse.

This paper examines the role of export concentration in the Great Trade Collapse using both bilateral and product-level trade data. The paper finds that on average, a rise in the product concentration index of 2007 by one standard deviation (0.307) results in a decrease in bilateral exports between 2008 and 2009 by 15.956 million U.S. dollars[1], holding all else constant. Exporter-importer pairs whose exports were concentrated on a small number of products experienced a greater trade collapse. In addition, the decline in bilateral exports

[1]The median is a fall in bilateral exports by 0.570 million U.S. dollars; the mean is a decrease by 193.861 million U.S. dollars. See Table 4.2.

due to the fall in trade finance activity was more severe for country pairs whose exports were concentrated on few products. On the other hand, market concentration does not have a consistently significant effect on the trade collapse of exporter-product pairs, but the paper finds that the financial vulnerability of a product, specifically external finance dependence and asset tangibility, plays a larger role in the fall in exports as the market concentration index increases.

There have been numerous studies looking at the relationship between export concentration and export instability Coppock (1962), Massell (1964), MacBean (2011), Massell (1970), Love (1986), Han (2021a)[2]. The underlying idea is that a country's exports fluctuate with the ups and downs in the exports of a handful of products or markets when they are concentrated, but the risks are diversified away when exports are dispersed over a large number of products or markets. However, this paper and Romeu and da Costa Neto (2011) are the only papers to the best of my knowledge that study the effects of export concentration on trade focusing on the global financial crisis. Using quarterly exports at the HS two-digit level of 14 Latin American countries to 16 destination markets whose trade comprises over 90 percent of world trade, Romeu and da Costa Neto (2011) finds that increasing export diversification by industry and product reduces the quarterly decline in exports, but geographic diversfication does not have a significant impact. This paper is different in that it expands the scope of analysis to 134 exporting countries, 191 importing countries, and 5,003 products defined at the HS 2002 six-digit level. Moreover, it is the first to look at the relationship between trade flows and trade finance availability as a function of export concentration.

The rest of the paper is organized as follows. Section 4.2 starts with a cross-country exercise. Section 4.3 discusses the data. Section 4.4 presents the empirical model as well as regression results. Finally, section 4.5 concludes.

4.2 A Cross-Country Analysis

4.2.1 Variables and Data Sources

To motivate the study of the effects of export concentration on the Great Trade Collapse, a cross-country excercise is performed using annual export values of 2008–2009 in current U.S. dollars for 124 exporting countries obtained from UN Comtrade. The trade collapse

[2] Han (2021a) empirically examines the effects of export concentration, durability, vertical linkages, and financial vulnerability on export earnings volatility using a panel of bilateral trade data at the SITC Rev. 1 four-digit industry level.

between 2008 and 2009 is measured by the change in exports as follows:

$$\Delta Exports_i = Exports_{i2009} - Exports_{i2008},$$

where *i* refers to the exporting country. Two dimensions of export concentration are measured using the Herfindahl-Hirschman concentration index. First, product concentration is measured as the following:

$$HHI_i^{product} = \frac{\sum_k (\frac{x_{ik}}{X_i})^2 - \frac{1}{5{,}223}}{1 - \frac{1}{5{,}223}},$$

where *k* refers to products, x_{ik} is country *i*'s value of exports of product *k*, and X_i is country *i*'s total value of exports. 5,223 is the total number of HS 2002 six-digit products. This index measures how concentrated a country's exports are on a small number of products. Second, market concentration is measured as the following:

$$HHI_i^{market} = \frac{\sum_j (\frac{x_{ij}}{X_i})^2 - \frac{1}{193}}{1 - \frac{1}{193}},$$

where *j* refers to partner countries or destination markets and x_{ij} is the value of exports from exporter *i* to importer *j*. 193 is the total number of partners. This index measures the spread of a country's exports across different destination markets. The two indices are computed for the year 2007 and also averaged over 2005–2007 (3 years) and 2003–2007 (5 years) as a robustness check. Their values lie between 0 (perfect diversification) and 1 (perfect concentration)—the closer to 1, the lower the degree of export diversification.

Along with export concentration, the change in demand is controlled for with the change in real GDP between 2008 and 2009 ($\Delta GDP_i = GDP_{i2009} - GDP_{i2008}$) and the income level of a country is controlled for using the real GDP per capita of 2007. Furthermore, a proxy for the financial health of a country is included to control for the change in the availability of trade finance necessary for international transactions, which is partially captured by the change in domestic credit provided to the private sector by banks between 2008 and 2009 as follows:

$$\Delta \textit{Domestic credit}_i = \textit{Domestic credit}_{i2009} - \textit{Domestic credit}_{i2008}.$$

The data on these three control variables are taken from the World Bank's World Development Indicators. GDP and per capita GDP are in constant 2017 international dollars.[3] Domestic private credit is in current U.S. dollars.[4]

[3] An international dollar can buy the same amount of goods and services as the U.S. dollar can in the United States.

[4] The data on domestic credit provided to the private sector by banks are recorded as a percentage of GDP. To

4.2.2 Summary Statistics

Summary statistics for the 124 countries included in the sample are reported in the top section of Table 4.2 and Table 4.3. The average value of the product concentration index ($HHI_i^{product}$) in 2007 is 0.125, and the mean value of the market concentration index (HHI_i^{market}) in 2007 is 0.145. The degree of export concentration varies greatly across the sample countries. For example, in 2007, Aruba had the most concentrated export basket in terms of products ($HHI_i^{product}$ = 1), while Italy had the most diversified export basket in terms of products ($HHI_i^{product}$ = 0.003). Likewise, Mexico had the highest value of the market concentration index at 0.679, while Turkey had the lowest value of the market concentration index at 0.038.

The average trade collapse is a decrease in exports by 25.658 billion U.S. dollars. Among the 124 countries in the sample, only 12 countries experienced a positive growth in exports; the rest saw a decline in their exports. The average change in real GDP and domestic private credit is a decrease by 5.164 and 11.228 billion U.S. dollars, respectively. However, 61 countries experienced a rise in GDP between 2008 and 2009, and domestic credit to the private sector by banks increased in 49 countries during the same period. Figure 4.1 shows the dip in average exports and domestic credit between 2008 and 2009.

4.2.3 OLS Results

The following model is estimated by OLS:

$$\begin{aligned}\Delta Exports_i = {} & \beta_0 + \beta_1 HHI_i^{product} + \beta_2 HHI_i^{market} + \beta_3 \Delta \textit{Domestic credit}_i \\ & + \beta_4 \Delta \textit{Domestic credit}_i \times HHI_i^{product} + \beta_5 \Delta \textit{Domestic credit}_i \times HHI_i^{market} \\ & + \beta_6 \Delta \textit{Real GDP}_i + \beta_7 \textit{Real GDP per capita}_i + \beta_8 Exports_i + \alpha_{region} + \epsilon\end{aligned}$$

Both the product and market concentration indices are included. The sample correlation coefficient between the two is about 0.40 and the variance inflation factor is 1.19. The financial health of a country may be correlated with both the concentration indices and the change in exports. For instance, countries that have healthier financial institutions will be more capable of extending trade finance to exporting firms, encouraging the production and trade in a wider variety of goods to a larger number of markets. Financially healthier countries may also experience a milder fall in trade finance activity during the global financial crisis and consequently a smaller drop in their trade flows. Therefore, the change

extract the dollar value, I multiply by GDP in current U.S. dollars (also from World Bank) and divide by 100. Alternatively, I obtain data from the Other Depository Corporations Survey (line 22D) of the International Monetary Fund's International Financial Statistics on claims on the private sector in domestic currency. Then I use the end of period exchange rates to convert the values to current U.S. dollars. The resulting two variables have a sample correlation coefficient that is nearly 1.

in domestic credit provided to the private sector by banks is included to control for the financial health of a country. In addition, I control for the change in demand/production, the level of income of a country, and trade volume in 2007. Lastly, region dummy variables[5] are included to absorb region specific shocks to exports. The results are reported in Table 4.1.

The first three columns are estimated without interaction terms. The coefficient on product concentration index is negative and statistically significant in all six columns. For example, column (1) says that on average, an increase in the product concentration index by one standard deviation (0.189) decreases exports by 3.487 billion U.S. dollars, holding other variables constant. In other words, the trade collapse is more severe for countries with exports concentrated on a small number of products. Surprisingly, the coefficient on market concentration index is positive and statistically significant, but the significance goes away with the inclusion of the interaction terms.

The next three columns include interaction terms between the change in domestic credit and each export concentration index. To begin with, the effect of product concentration on the fall in exports depends on the change in domestic credit. For example, for a country that experienced the median change in domestic credit (-0.140 billion USD), a one standard deviation increase in product concentration leads to a 2.116 billion U.S. dollars[6] fall in exports on average, holding all else constant (see column (4) of Table 4.1). Moreover, the interaction terms serve to examine if the effect of the fall in domestic credit on the fall in exports is milder for countries that are more diversified and have lower concentration indices. The coefficient on the interaction term between the change in domestic credit and *product* concentration index is positive and statistically significant. This finding suggests that the more concentrated the exports are on few products, the stronger the relationship between domestic credit availability and export flows. That is, countries whose exports are more diversified across different products may be less susceptible to financial shocks. However, the coefficient on the interaction term between the change in domestic credit and *market* concentration is negative and statistically significant. The magnitude of the coefficient is smaller, though. Thus, overall, the effects of domestic credit on the trade collapse seem to intensify as exports become more concentrated provided that the values of the two concentration indices are similar. The relationship between trade and trade finance as a function of export concentration is examined more carefully in the subsequent

[5] The countries are categorized into seven groups: East Asia & Pacific, Europe & Central Asia, Latin America & Caribbean, Middle East & North Africa, North America, South Asia, and Sub-Saharan Africa. Seven dummy variables are created accordingly, of which six are added in the regression equation with North America as the base category.

[6] $[b_1 + b_4 * (\text{Median } \Delta \textit{Domestic credit})] * (\text{Std. dev. of } HHI^{product}) = [-10.875 + 2.292 * (-0.140)] * 0.189 = -2.116$

sections.

There are two takeaways from the cross-country exercise. First, the trade collapse between 2008 and 2009 was milder for countries whose exports were diversified across different products. Second, the effect of the change in domestic credit on the trade collapse was possibly stronger at higher levels of product concentration. In other words, for countries that have a concentrated export basket in terms of products, the fall in domestic credit due to the global financial crisis may have meant that they had to reduce their exports by a larger amount than the countries that are more diversified across export goods. The cross-country analysis also comes with caveats. The sample size of 124 is small and there could be omitted variables correlated with both the dependent and independent variables making the estimated coefficients biased. Moreover, the use of domestic credit to the private sector by banks as a proxy for financial health, specifically trade finance availability, may be problematic since it includes loans, purchases of nonequity securities, and trade credits by all deposit money banks excluding the central bank to finance not only international but also domestic activities in the private sector. In section 4.3 and section 4.4, these limitations are complemented using disaggregated data (bilateral trade and product-level data) and a fixed effects model to control for all unobservables. In addition, insured export credits are used to proxy for short term trade finance availability, which is the best proxy available Auboin and Engemann (2014), Korinek et al. (2010).

4.3 Data

Building on the cross-country exercise of section 4.2, the current and following sections use disaggregated data to study the effects of export concentration on the Great Trade Collapse and the relationship of trade and trade finance as a function of export concentration. Two types of data are used. One is bilateral trade data where the unit of observation is an exporter-importer, and the other is product-level data where the unit of observation is an exporter-product.

Annual export values in current U.S. dollars are downloaded from the UN Comtrade Database for each exporter-importer and exporter-product pair, respectively, for the period of 2008–2009. Product is defined at the HS 2002 six-digit level and 5,003 products are included in the sample. In addition, the bilateral trade data contains 134 exporting countries and 191 importing countries.

4.3.1 Bilateral Exports

The dependent variable is the change in exports between 2008 and 2009 computed as the following:

$$\Delta Exports_{ij} = Exports_{ij2009} - Exports_{ij2008},$$

where *ij* refers to the exporter-importer pair. The average change in bilateral exports during this period is a fall by 193.861 million U.S. dollars (see Table 4.2). The drop in average bilateral exports between 2008 and 2009 is also confirmed in Figure 4.2 panel (a).

The two main independent variables are export concentration and the change in the availability of trade finance. First, the product concentration index is computed for each country pair as follows:

$$HHI_{ij}^{product} = \frac{\sum_k (\frac{x_{ijk}}{X_{ij}})^2 - \frac{1}{5{,}223}}{1 - \frac{1}{5{,}223}},$$

where X_{ij} is the total value of exports from exporter *i* to importer *j*, and x_{ijk} is the value of exports of product *k* from exporter *i* to importer *j*. 5,223 is the total number of HS 2002 six-digit products. This index measures how concentrated a country pair's trade flows are on a small number of products. The closer to 1, the more concentrated on few products; the closer to 0, the more diversified across numerous products. The concentration index is computed for the year 2007, which precedes the Great Trade Collapse and also averaged over 2005–2007 and 2003–2007, respectively.

Second, trade finance availability (*Trade finance*$_j$) is measured by short term[7] insured export credit provided by Berne Union members around the world for exports to country *j*. Berne Union, also known as the International Union of Credit and Investment Insurers, is an international not-for-profit trade association, whose members consist of government-backed export credit agencies, private insurers of credit and political risk, and multilateral institutions. These members provide insurance products to exporters and protect them against losses derived from credit and political risks of importers (Berne Union (2021)). The data on short term insured export credit reported by Berne Union come from the Joint External Debt Hub in current U.S. dollars. This is the most extensive and consistent data series currently available for trade finance[8] Auboin and Engemann (2014), Korinek

[7]Short term refers to credit insurance for trade goods and services, as opposed to capital equipment transactions and infrastructure projects, with credit terms up to and including twelve months.

[8]Trade finance can be either funded or unfunded. Unfunded trade finance products are focused on mitigating the payment risk from the importer (buyer) and the supply/performance risk of the exporter (seller). These products transfer the trade risks to the financial sector and guarantee that the exporter will ship the goods and the importer will pay for the goods. Examples include credit insurance and letters of credit. On the other hand, funded trade finance products focus on the provision of funding and liquidity such as

et al. (2010). Because the stock values are reported quarterly, the annual change in the availability of trade finance between 2008 and 2009 is computed as the following:

$$\Delta \textit{Trade finance}_j = \textit{Trade finance}_{j2009Q2} - \textit{Trade finance}_{j2008Q2},$$

where *j* refers to the importing country and Q2 refers to the second quarter. The second quarter is used because insured export credit peaks in the second quarter and falls thereafter as can be seen in Figure 4.3. Note that the variable varies across importing countries.

4.3.2 Product-Level Exports

The dependent variable, the change in product exports between 2008 and 2009 is defined as the following:

$$\Delta Exports_{ik} = Exports_{ik2009} - Exports_{ik2008},$$

where *k* refers to the product. The average change in product exports is a decline by 10.588 million U.S. dollars (see Table 4.2) and the drop during this period is shown in Figure 4.2 panel (b).

The two main independent variables are export concentration and financial vulnerability. First, the market concentration index is computed for each exporter-product pair as the following:

$$HHI_{ik}^{market} = \frac{\sum_j (\frac{x_{ijk}}{X_{ik}})^2 - \frac{1}{193}}{1 - \frac{1}{193}},$$

where X_{ik} is the total value of exports of product *k* from exporter *i* and 193 is the total number of destination markets. The value of the concentration index falls between 0 (perfect diversification) and 1 (perfect concentration) and is computed for the year 2007, averaged over 3 years (2005–2007), and averaged over 5 years (2003–2007) to check for robustness.

Second, the financial vulnerability of a product is measured in three ways following Chor and Manova (2012) but using the stock measures[9] presented in Fisman and Love (2003). The three measures are $\textit{External finance dependence}_k$, $\textit{Trade credit access}_k$, and $\textit{Asset tangibility}_k$ constructed as follows:

$$\textit{External finance dependence}_k = \frac{\textit{Total assets - Retained earnings}}{\textit{Total assets}}$$

accelerated receivables to the exporter and extended credit to the importer Trade Finance Global (2020). The trade finance variable in this paper refers to unfunded trade finance, specifically export credit insurance.

[9]Stock measures are used in lieu of flow measures because they are more stable over time. Since the financial vulnerability measures presented here are time invariant, the stability of the measures over time matters.

$$\textit{Trade credit access}_k = \frac{\textit{Accounts payable}}{\textit{Total assets}}$$

$$\textit{Asset tangibility}_k = \frac{\textit{Net property, plant and equipment}}{\textit{Total assets}}$$

A product is considered financially vulnerable when it is highly dependent on external finance, has limited access to trade credit, and has a low endowment of tangible assets such as real estate, machinery, and plant, which can serve as collateral when securing external finance. Data on each of the items are from Compustat North America, a database containing information on U.S. and Canadian publicly-held companies. After restricting to firms that report consolidated financial statements, the three financial vulnerability measures are computed for each firm and year. Then the firm average is computed over the period 1998–2007. Finally, for each SIC industry, the median value across all the firms within the industry is chosen as the industry/product financial vulnerability measure. Because the reported SIC codes differ in the number of digits, the measure computed for each four-digit industry is used when available and replaced with the three-digit or two-digit industry measure when not available. To merge with the trade data, the SIC codes are matched to the HS 2002 codes using the concordance in WITS. Note that the financial vulnerability variables vary across industries due to technological reasons and not across countries. The assumption is that the U.S. has one of the most developed financial systems, and the technological demand for credit identified using U.S. data is carried over to other countries Rajan and Zingales (1998), Fisman and Love (2003), Braun (2005), Chor and Manova (2012).

4.4 Fixed Effects Results

This section introduces the model to be estimated and the regression results using bilateral trade data in section 4.4.1 and product-level exports data in section 4.4.2.

4.4.1 Bilateral Exports

The following fixed effects model is estimated:

$$\begin{aligned}\Delta Exports_{ij} = \beta_0 + \beta_1 HHI_{ij}^{product} + \beta_2 \Delta \textit{Trade finance}_j \times HHI_{ij}^{product} \\ + \beta_3 Exports_{ij} + \alpha_i + \alpha_j + \epsilon_{ij},\end{aligned}$$

where *i* is the exporter and *j* is the importer. Trade volume of 2007 is controlled for to account for scale effects, and exporter (α_i) and importer (α_j) effects are included. The country effects capture both observed and unobserved country characteristics such as the size, wealth, and financial health of a country. The change in the availability of trade finance between 2008 and 2009 is also absorbed in the importer effects, which is why it only appears in the interaction term with product concentration.

The regression results are reported in Table 4.4. The first three columns do not contain the interaction term. The estimated coefficient on product concentration is negative and statistically significant. On average, a rise in the 2007 product concentration index by one standard deviation (0.307) results in a decrease in exports by 15.956 million U.S. dollars, holding all else constant (see column (1) of Table 4.4). This result implies that country pairs whose trade is more diversified across a large number of products fared better in the global financial crisis.

In the next three columns, the interaction term between the change in trade finance availability and the product concentration index is included to examine if the effect of trade finance on trade changes by the degree of product concentration. With the interaction term, the effect of product concentration on the fall in bilateral exports depends on the value of the change in trade finance. For example, on average, for a country pair where the importer experienced the median change in trade finance availability (-72 million USD), raising the product concentration index by one standard deviation decreases bilateral exports by 1.29 million U.S. dollars[10], holding all else constant (see column (4) of Table 4.4). Furthermore, the estimated coefficient on the interaction term is positive and statistically significant, implying that the susceptibility to trade finance shocks grows with the degree of product concentration. In other words, the effects of trade finance on trade are mitigated when a country pair's trade is diversified across a large number of products. To give an example, given a one standard deviation (2,874.455 million USD) decrease in trade finance availability, the country pair whose product concentration is at the 75th percentile (more concentrated) experiences a further drop in exports by 57.489 million U.S. dollars compared to the country pair whose product concentration is at the 25th percentile (more diversified) (refer to column (4) of Table 4.4).[11]

[10] $[b_1 + b_2 * (\text{Median } \Delta \textit{Trade finance})] * (\text{Std. dev. of } HHI^{product}) = [-1.035 + 0.044 * (-72)] * 0.307 = -1.29$

[11] Let the estimated coefficient on Δ*Trade finance* be b_4, which is assumed to be positive and cannot be estimated because trade finance is absorbed in the importer effects. Then the marginal effect of the change in trade finance on the export fall is $b_2 * HHI^{product} + b_4 = 0.044 * HHI^{product} + b_4$.
Marginal effect when $HHI^{product}$ is in the 25th percentile (0.089): 0.044 * 0.089 + b_4 = 0.004 + b_4
Marginal effect when $HHI^{product}$ is in the 75th percentile (0.538): 0.044 * 0.538 + b_4 = 0.024 + b_4

4.4.2 Product-Level Exports

The following fixed effects model is estimated:

$$\Delta Exports_{ik} = \beta_0 + \beta_1 HHI_{ik}^{market} + \beta_2 \textit{Financial vulnerability}_k \times HHI_{ik}^{market} \\ + \beta_3 Exports_{ik} + \alpha_i + \alpha_k + \epsilon_{ik},$$

where *i* is the exporter and *k* is the importer. Trade volume of 2007 is included to control for scale effects, and exporter (α_i) and product (α_k) effects are added. Product effects capture any inherent characteristics of products such as financial vulnerability, factor intensity, and supply/demand shocks. In addition, an interaction term between each measure of financial vulnerability and the market concentration index is included. Since financial vulnerability is absorbed in the product effects, it only appears in the interaction term.

The results are reported in Table 4.5. External finance dependence is interacted with the market concentration indices in the first three columns. The next three columns report the estimates for the interaction terms between access to trade credit and the market concentration indices. In the last three columns, asset tangibility is interacted with the concentration indices. Chor and Manova (2012) finds that exports of financially vulnerable industries were more sensitive to the cost of external capital and experienced a greater trade collapse when credit conditions tightened during the global financial crisis. The interaction terms are included to examine if these industries experienced larger falls when product exports are concentrated on a small number of destination markets.

The sign on the market concentration index coefficients is not consistent and changes with the measure of financial vulnerability chosen. However, the coefficient on the interaction terms between external finance dependence and market concentration is negative and statistically significant. Since products highly reliant on external finance experienced a larger decline in trade (negative coefficient on external finance dependence), the relationship between external finance dependence and the trade collapse becomes more dramatic (more negative) with the increase in the market concentration index. For instance, when a product's dependence on external finance grows by one standard deviation (0.388), the exporter-product pair whose market concentration is at the 75th percentile (more concentrated) sees its exports go down by 4.337 million U.S. dollars[12] more than the exporter-product pair whose market concentration is at the 25th percentile (more diversified). See column (1) of Table 4.5.

[12] Let the estimated coefficient on *External finance dependence* be $b_5 < 0$, which cannot be estimated because financial vulnerability is absorbed in the product effects. Then the marginal effect of the dependence on external finance on the fall in exports is $b_2 * HHI^{market} + b_5 = (-21.170) * HHI^{market} + b_5$.
Marginal effect when HHI^{market} is in the 25th percentile (0.223): (-21.170) * 0.223 + b_5 = -4.721 + b_5
Marginal effect when HHI^{market} is in the 75th percentile (0.751): (-21.170) * 0.751 + b_5 = -15.899 + b_5

Likewise, the coefficient on the interaction term between asset tangibility and market concentration is positive and statistically significant. Since products with a high share of hard assets experienced a smaller reduction in trade (positive coefficient on asset tangibility), this implies that the effect of asset tangibility on exports is stronger (more positive) with a higher value of market concentration index. As an illustration, when a product's endowment of hard assets decreases by one standard deviation (0.132), the exporter-product pair whose market concentration is at the 75th percentile (more concentrated) experiences a greater trade collapse by 7.667 million U.S. dollars[13] relative to the exporter-product pair whose market concentration is at the 25th percentile (more diversified). See column (7) of Table 4.5. The interaction term between access to trade credit and the concentration index is not statistically significant. This is consistent with Levchenko et al. (2010) which finds no evidence that industries with higher trade credit intensity expere-rienced higher percentage reductions in trade.

4.5 Conclusion

The Great Trade Collapse was synchronized in that nearly all countries and product categories experienced a decline in trade (Baldwin, 2009). The paper finds that the trade collapse was greater for exporter-importer pairs whose exports were more concentrated on a small number of products. In addition, numerous studies have found that trade flows are reliant on trade finance because exporting firms need working capital loans while waiting to get paid and insurance to hedge the inherent risks associated with trade Amiti and Weinstein (2011), Auboin and Engemann (2014), Chor and Manova (2012), Korinek et al. (2010). This paper finds that the relationship between trade and trade finance depends on the level of export concentration.

In the bilateral trade data, the product concentration index is computed for each exporter-importer pair and trade finance availability is captured by short term insured trade credits granted by Berne Union members. The product concentration index is significant both independently and through the interaction term with the change in trade finance availability. For country pairs whose bilateral trade was more concentrated on few products, exports decreased further. In addition, the effects of the change in trade finance availability on the change in exports were stronger when the product concentration index was higher. In other words, the fall in trade resulting from the fall in trade finance was milder

[13]Let the estimated coefficient on *Asset tangibility* be b_6, assumed to be positive. Then the marginal effect of the share of tangible assets on the export fall is $b_2 * HHI^{market} + b_5 = (110.012) * HHI^{market} + b_5$.
Marginal effect when HHI^{market} is in the 25th percentile (0.223): (110.012) * 0.223 + b_5 = 24.533 + b_5
Marginal effect when HHI^{market} is in the 75th percentile (0.751): (110.012) * 0.751 + b_5 = 82.619 + b_5

for country pairs with lower product concentration indices (more diversified).

In the product-level trade data, the market concentration index is computed for each exporter-product pair and the financial vulnerability of a product is measured by either external finance dependence, access to trade credit, or asset tangibility. Unlike the product concentration index, market concentration is not consistently significant on its own. However, it is significant when interacted with external finance dependence and asset tangibility. Financially vulnerable industries were more sensitive to the cost of capital, resulting in greater reductions in trade during the global financial crisis Chor and Manova (2012). This paper finds that the exports of financially vulnerable products, which have a high dependence on external finance and low share of hard assets, experienced bigger drops in trade as exports were more concentrated on a small number of trade partners.

In both datasets, trade diversification serves as a substitute for trade finance. If trade is concentrated on few products or markets, the susceptibility to trade finance shocks grows, and therefore, the contraction in the availability of trade finance during the global financial crisis is a bigger hit. In this regard, countries whose exports were diversified across different products and markets did indeed fare better during the Great Trade Collapse of 2008–2009. This is yet another reason for countries to diversify their exports—not only to reduce export instability as in Han (2021a) but also to reduce the susceptibility to trade finance shocks.

4.6 Tables

See next couple of pages.

Table 4.1: $\Delta Exports_i$, 2008-2009: OLS Results (Country-Level Trade)

	(1)	(2)	(3)	(4)	(5)	(6)
HHI product 07	-18.447***			-10.875**		
	(6.883)			(5.177)		
Average HHI product 05-07		-20.566***			-12.198**	
		(7.083)			(5.482)	
Average HHI product 03-07			-18.913**			-10.448*
			(7.468)			(5.966)
HHI market 07	17.675**			8.022		
	(7.650)			(6.688)		
Average HHI market 05-07		18.805**			9.424	
		(7.428)			(5.709)	
Average HHI market 03-07			18.021**			8.420
			(7.080)			(5.232)
ΔDomestic Private Credit 08-09	-0.018	-0.018*	-0.018	0.024	0.010	0.012
	(0.011)	(0.011)	(0.011)	(0.024)	(0.019)	(0.019)
ΔDomestic Private Credit 08-09 × HHI product 07				2.292***		
				(0.155)		
ΔDomestic Private Credit 08-09 × Average HHI product 05-07					2.133***	
					(0.140)	
ΔDomestic Private Credit 08-09 × Average HHI product 03-07						2.249***
						(0.163)
ΔDomestic Private Credit 08-09 × HHI market 07				-0.937**		
				(0.368)		
ΔDomestic Private Credit 08-09 × Average HHI market 05-07					-0.686**	
					(0.279)	
ΔDomestic Private Credit 08-09 × Average HHI market 03-07						-0.683**
						(0.273)
ΔReal GDP 08-09	0.108***	0.108***	0.108***	0.106***	0.110***	0.111***
	(0.023)	(0.023)	(0.023)	(0.007)	(0.008)	(0.009)
Real GDP per capita 07	35.437	38.685	38.651	14.981	17.954	18.074
	(52.423)	(53.684)	(54.579)	(41.399)	(42.211)	(42.577)
Country Exports 07	-0.243***	-0.243***	-0.243***	-0.233***	-0.233***	-0.232***
	(0.006)	(0.006)	(0.006)	(0.005)	(0.005)	(0.006)
Region dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	124	124	124	124	124	124
Adjusted R^2	0.962	0.962	0.961	0.972	0.972	0.972

Robust standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4.2: Summary Statistics - Dependent Variable (Change in Exports 2008-09)

	Mean	Median	Std. Dev.	Min	Max
Exporter *i* (N=124)					
ΔExports 08-09 (bil USD)	-25.658	-4.624	53.095	-338.297	1.261
Exporter-importer *ij* (N=15,869)					
ΔExports 08-09 (mil USD)	-193.861	-0.570	1,649.261	-117,301.758	6,319.444
Exporter-product *ik* (N=278,597)					
ΔExports 08-09 (mil USD)	-10.588	-0.034	249.587	-58,088.375	17,188.068

i: Exporter, *j*: importer, *k*: product

Table 4.3: Summary Statistics - Independent Variables

	Mean	Median	Std. Dev.	Min	Max
Exporter *i* (N=124)					
HHI product 07	0.125	0.048	0.189	0.003	1.000
Average HHI product 05-07	0.129	0.049	0.184	0.003	0.866
Average HHI product 03-07	0.131	0.053	0.186	0.003	0.876
HHI market 07	0.145	0.101	0.122	0.038	0.679
Average HHI market 05-07	0.153	0.108	0.130	0.041	0.713
Average HHI market 03-07	0.158	0.114	0.133	0.042	0.740
ΔDomestic Private Credit 08-09 (bil USD)	-11.228	-0.140	202.711	-991.313	1,660.555
ΔReal GDP 08-09 (bil USD)	-5.164	-0.067	107.680	-426.700	922.900
Real GDP per capita 07 (mil USD)	0.024	0.015	0.023	0.001	0.115
Country Exports 07 (bil USD)	101.686	13.531	221.784	0.016	1,328.841
Exporter-importer *ij* (N=15,869)					
HHI product 07	0.347	0.245	0.307	0.003	1.000
Average HHI product 05-07	0.354	0.280	0.288	0.003	1.000
Average HHI product 03-07	0.359	0.292	0.284	0.003	1.000
Bilateral exports 07 (mil USD)	773.888	8.532	6,402.416	0.000	331,601.969
Exporter-product *ik* (N=278,597)					
HHI market 07	0.490	0.424	0.308	0.019	1.000
Average HHI market 05-07	0.498	0.463	0.285	0.022	1.000
Average HHI market 03-07	0.505	0.480	0.278	0.023	1.000
Product exports 07 (mil USD)	41.756	0.541	547.330	0.000	113,822.109
Importer *j* (N=191)					
ΔTrade finance 08-09 (mil USD)	-1,151.251	-72.000	2,874.455	-20,731.000	428.000
Product *k* (N=5,003)					
External finance dependence	1.059	1.000	0.388	0.455	5.957
Trade credit reliance	0.086	0.085	0.025	0.019	0.213
Asset tangibility	0.299	0.311	0.132	0.054	0.790

i: Exporter, *j*: importer, *k*: product

Table 4.4: $\Delta Exports_{ij}$, 2008-2009: Fixed Effects Results (Bilateral Trade)

	(1)	(2)	(3)	(4)	(5)	(6)
HHI product 07	-51.974*			-1.035		
	(27.497)			(41.983)		
Average HHI product 05-07		-76.417**			-11.309	
		(34.544)			(52.107)	
Average HHI product 03-07			-77.558**			-9.733
			(32.045)			(53.360)
ΔTrade finance 08-09 $\times$ HHI product 07				0.044*		
				(0.025)		
ΔTrade finance 08-09 $\times$ Average HHI product 05-07					0.052*	
					(0.029)	
ΔTrade finance 08-09 $\times$ Average HHI product 03-07						0.053*
						(0.030)
Bilateral exports 07	-0.232***	-0.232***	-0.232***	-0.233***	-0.233***	-0.233***
	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)
Exporter FE (α_i)	Yes	Yes	Yes	Yes	Yes	Yes
Importer FE (α_j)	Yes	Yes	Yes	Yes	Yes	Yes
Observations	15,990	15,990	15,990	15,869	15,869	15,869
Adjusted R^2	0.818	0.819	0.819	0.819	0.819	0.819

Robust standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4.5: $\Delta Exports_{ik}$, 2008-2009: Fixed Effects Results (Product-Level Trade)

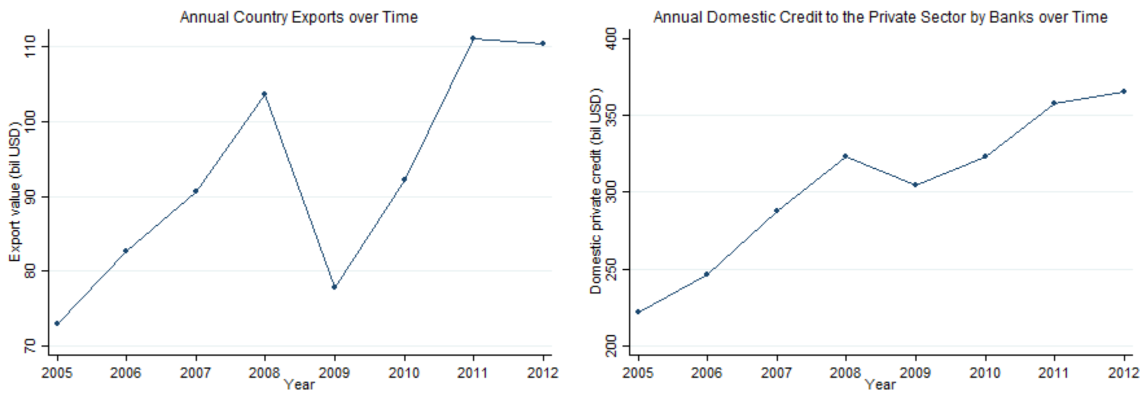
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
HHI market 07	27.573***			1.484			-26.335***		
	(4.688)			(3.442)			(5.441)		
Average HHI market 05-07		34.028***			1.358			-31.382***	
		(5.750)			(4.144)			(5.944)	
Average HHI market 03-07			36.335***			0.806			-32.698***
			(6.099)			(4.421)			(6.244)
Ext fin dep × HHI market 07	-21.170***								
	(4.253)								
Ext fin dep × Avg HHI market 05-07		-26.622***							
		(5.241)							
Ext fin dep × Avg HHI market 03-07			-28.636***						
			(5.550)						
Trade cred rel × HHI market 07				42.779					
				(33.349)					
Trade cred rel × Avg HHI market 05-07					52.998				
					(40.691)				
Trade cred rel × Avg HHI market 03-07						61.365			
						(43.391)			
Asset tang × HHI market 07							110.012***		
							(22.523)		
Asset tang × Avg HHI market 05-07								129.538***	
								(24.022)	
Asset tang × Avg HHI market 03-07									134.641***
									(24.958)
Product exports 07	-0.336***	-0.336***	-0.336***	-0.336***	-0.336***	-0.336***	-0.336***	-0.336***	-0.336***
	(0.037)	(0.037)	(0.037)	(0.037)	(0.037)	(0.037)	(0.037)	(0.037)	(0.037)
Exporter FE (α_i)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE (α_k)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	278,597	278,597	278,597	278,597	278,597	278,597	278,597	278,597	278,597
R^2	0.606	0.606	0.606	0.606	0.606	0.606	0.607	0.607	0.607

Robust standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

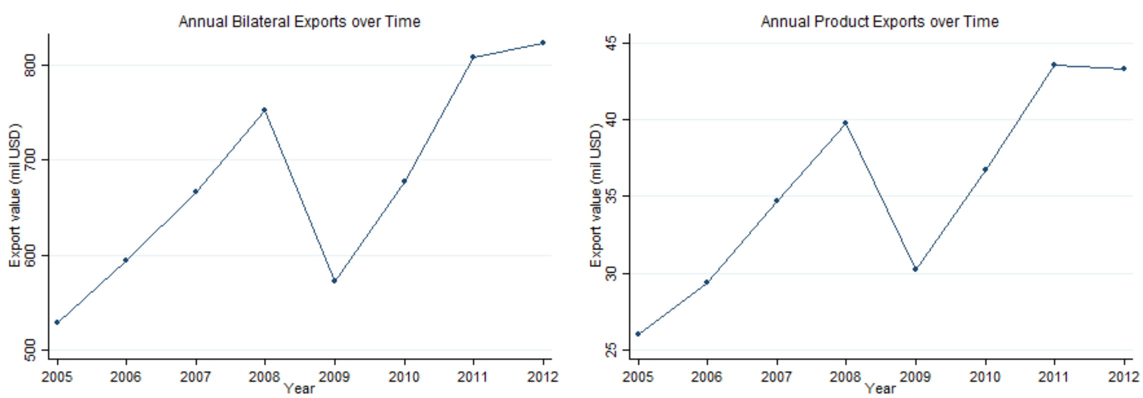
4.7 Figures

Figure 4.1: Trade and Domestic Private Credit over Time



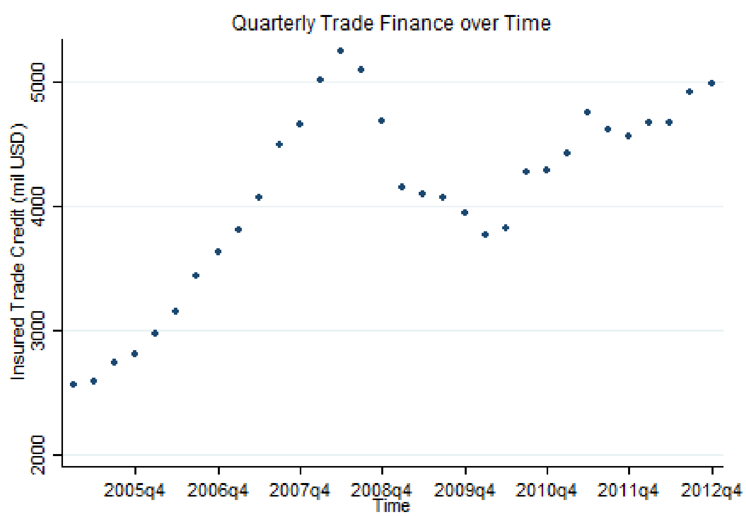
(a) Country exports (b) Domestic credit to the private sector by banks

Figure 4.2: Trade over Time



(a) Bilateral trade (exporter-importer) (b) Product-level trade (exporter-product)

Figure 4.3: Trade Finance over Time



Appendices

Appendix A: Variable Construction for Chapter 2

Export Concentration

Two measures of export concentration are computed using the Herfindahl-Hirschman concentration index: one across industries and the other across partners.[14] First, for each country pair, $HH_{ijt}^{industry}$ is computed as the following across industries defined at the SITC Rev. 1 four-digit level:

$$HH_{ijt}^{industry} = \frac{\sum_{k=1}^{n_k} (\frac{x_{ijkt}}{X_{ijt}})^2 - \frac{1}{n_k}}{1 - \frac{1}{n_k}}$$

X_{ijt} is the total value of exports from exporter *i* to importer *j* in year *t*, while x_{ijkt} is the value of exports of industry *k* from reporter *i* to partner *j* in year *t*. n_k is the number of potential SITC four-digit industries which is 625. This index measures the dispersion of export value across the 625 industries and ranges from 0 (perfect diversification) to 1 (perfect concentration). For instance, a country pair whose export value is concentrated on a few sectors will have an index value close to 1 and be more vulnerable to trade shocks. Second, for each exporter-industry pair, HH_{ikt}^{market} is computed as the following across destination markets defined as partner countries:

$$HH_{ikt}^{market} = \frac{\sum_{j=1}^{n_j} (\frac{x_{ijkt}}{X_{ikt}})^2 - \frac{1}{n_j}}{1 - \frac{1}{n_j}}$$

X_{ikt} is the total value of exports of industry *k* from exporter *i* in year *t* and n_j is the number of potential partners which is 194. This index measures the spread of export value across the 194 destination countries. As before, the index lies between 0 and 1, and a lower index indicates a broader partner base and lower dependency on certain trading partners.

Like export concentration, import concentration is also computed using the Herfindahl-Hirschman concentration index. HH_{jkt}^{market} is computed for each importer-industry pair across source countries (exporters) as follows:

$$HH_{jkt}^{market} = \frac{\sum_{i=1}^{n_i} (\frac{x_{ijkt}}{X_{jkt}})^2 - \frac{1}{n_i}}{1 - \frac{1}{n_i}}$$

[14]These measures are similar to those in Section 2 (Export Diversification) of the User's Manual for the Online Trade Outcomes Indicators. The difference is that the product and market diversification indicators in the manual are computed for each exporting country (as opposed to country pair or exporter-industry pair) across products and partners, respectively.

X_{jkt} is the total value of imports of industry k and importer j in year t, x_{ijkt} is the value of imports of industry k and importer j from exporter i in year t, and n_i is the number of potential source countries which is 189. The index measures the dispersion of an importer-industry pair's import value across the 189 exporters and takes the value between 0 and 1. A lower index represents greater import diversification across various source countries.

Durability

The division of SITC industries into durable and nondurable goods sectors comes from Engel and Wang (2011). Matching the code description to that in the SITC Rev. 1 data, the following categories are classified as durable goods: 61 Leather, leather manufactures, n.e.s., and dressed furskins; 62 Rubber manufactures, n.e.s.; 66 Non-metallic mineral manufactures, n.e.s.; 67 Iron and steel; 68 Non-ferrous metals; 69 Manufactures of metal, n.e.s.; 7 Machinery and transport equipment; 81 Sanitary, plumbing, heating and lighting fixtures; 82 Furniture; 86 Scientific and controlling instruments, photographic goods, clocks; 96 Coin, other than gold coin, not legal tender. The durable goods indicator variable is created such that it is given a value of 1 if the SITC industry is a durable goods sector and 0 otherwise.

Vertical Linkages

Two measures of vertical linkages are constructed at the industry level. First, an indicator of downstream vertical linkages based on the U.S. Input-Output tables as in Levchenko et al. (2010). Second, a dummy variable that takes on the value 1 if the industry is an intermediate goods industry defined by the Broad Economic Categories (BEC).

i. Indicator of downstream vertical linkages

The commodity by industry direct requirements data from the U.S. Input-Output (I-O) benchmark accounts for the year 2007 are downloaded from the Bureau of Economic Analysis (BEA). Each cell, (*i*, *j*), of the Direct Requirements Table records how much of commodity *i* (in row *i*) is directly required as an input to produce a dollar's worth of industry output *j* (in column *j*). For each commodity (row), the average value of the elements across all industries (columns) is computed to create an indicator of downstream vertical linkages. This measure represents the average use of a commodity as an intermediate input by other downstream industries and is computed for the year 2007.

In the same data file downloaded from the BEA, the associated 2012 NAICS codes are presented for each I-O code for which the indicator of downstream vertical linkages is computed. The 2012 NAICS codes are then matched to 2007 NAICS codes, which are again matched to 2002 NAICS codes, which are finally matched to 1987 SIC codes using the concordances in Census. When an I-O industry matches to two or more 2012 NAICS industries, the latter industries share the same value of the downstream vertical linkages indicator. When multiple I-O industries are matched to one 2012 NAICS industry, the mean value of the measure is assigned. The same steps are taken when matching codes from 2012 NAICS to 2007 NAICS to 2002 NAICS to 1987 SIC. In addition, the related 2012 NAICS codes presented for each I-O code differ in the number of digits ranging from two to six digits. For this reason, the concordances are created for each digit, merged separately, and then appended.

Finally, using the concordances in WITS from HS 1988/1992 to 1987 SIC and HS 1988/1992 to SITC Rev. 1, the 1987 SIC codes are matched to the SITC Rev. 1 codes.

ii. Intermediate goods sector binary variable

According to UN Trade Statistics, the following eight BEC categories constitute intermediate goods: 111 Food and beverages, primary, mainly for industry; 121 Food and beverages, processed, mainly for industry; 21 Industrial supplies not elsewhere specified, primary; 22 Industrial supplies not elsewhere specified, processed; 31 Fuels and lubricants, primary; 322 Fuels and lubricants, processed (other than motor spirit); 42 Parts and accessories of capital goods (except transport equipment); 53 Parts and accessories of transport equipment. Therefore, the intermediate goods dummy variable takes the value 1 if the BEC code corresponds to one of the above; 0 otherwise. World Integrated Trade Solution (WITS) provides mapping between SITC Rev. 1 and BEC codes. A couple of SITC codes are matched to multiple BEC codes, and thus, multiple values of the intermediate goods indicator variable. The mode value of the intermediate goods dummy variable is assigned when there is one. When equally split between 0 and 1, the SITC industry is treated as a non-intermediate goods industry (i.e., assign the value 0 to the intermediate goods dummy variable).

Industry Financial Vulnerability

Following Chor and Manova (2012) but using the stock measures presented in Fisman and Love (2003), three variables of industry financial vulnerability are constructed as follows:

$$\textit{External finance dependence}_{stock} = \frac{\textit{Total assets - Retained earnings}}{\textit{Total assets}}$$

$$\textit{Trade credit reliance}_{stock} = \frac{\textit{Accounts payable}}{\textit{Total assets}}$$

$$\textit{Asset tangibility} = \frac{\textit{Net property, plant and equipment}}{\textit{Total assets}}$$

Data on each of the items are from Compustat North America, a database containing information on U.S. and Canadian publicly-held companies. After restricting to firms that report consolidated financial statements, the three financial vulnerability measures are computed for each firm and year. Then the firm average is computed over the period 1962-2011. Finally, for each SIC industry, the median value across all the firms within the industry is chosen as the industry financial vulnerability measure. To check robustness, I exclude industries for which there are fewer than five companies to compute the industry financial vulnerability measures. In addition, as an alternative, I use flow measures of *External finance dependence*[15] and *Trade credit reliance*[16] in lieu of stock measures in the estimation. In both cases, the two measures are either statistically (*External finance dependence*) or economically insignificant (*Trade credit reliance*), which is consistent with the main results. Because the reported SIC codes differ in the number of digits, the measure computed for each four-digit industry is used when available and replaced with the three-digit or two-digit industry measure when not available. To merge with the trade data, the SIC codes are matched to the SITC Rev. 1 codes using the concordances in WITS.

Trade Integration

The presence of trade agreements between country pairs is controlled for using two variables: FTA and GATT/WTO dummy variables. The NSF-Kellogg Institute Economic Integration Agreements (EIA) database records the level of economic integration of each country pair from 1950 to 2012. The FTA dummy variable takes on the value 1 if the exporting and importing countries are members of a free trade area or a deeper form of economic integration such as a customs union, common market, and economic union in a particular year as recorded in the EIA database.[17] The GATT/WTO dummy variable assumes the value 1 if both countries are members of the General Agreement on Tariffs and

[15]

$$\textit{External finance dependence}_{flow} = \frac{\textit{Capital expenditures - Total funds from operations}}{\textit{Capital expenditures}}$$

[16]

$$\textit{Trade credit reliance}_{flow} = \frac{\Delta \textit{ Accounts payable}}{\Delta \textit{ Total assets}}$$

[17]In Ederington et al. (2021), we use a multichotomous index (as in the EIA database) that is given an integer value between 0 (no agreement) and 6 (economic union) and increases with the level of economic integration, in lieu of the FTA dummy variable used here. We also include six separate dummy variables pertaining to each category to examine the heterogeneous effects of the types of regional trade agreements on trade volatility.

Trade or World Trade Organization in a specific year, including nonmember participants such as colonies, de facto members, and provisional members as GATT/WTO members Tomz et al. (2007).

Appendix B: Additional Tables for Chapter 2

Table A1: Correlation between Financial Vulnerability Measures

	Ext finance dep	Trade credit rel	Asset Tangibility
Ext finance dep	1		
Trade credit rel	-0.1525***	1	
Asset tangibility	-0.0198	-0.4803***	1

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A2: Industry-Level Trade with Intermediate Dummy (*ikt*)

	(1)	(2)	(3)	(4)	(5)	(6)
		Instability 1			Instability 2	
L.HHI market	40.104***	40.170***	40.013***	43.884***	44.018***	44.103***
	(1.571)	(1.571)	(1.542)	(2.195)	(2.175)	(2.131)
Durable dummy	3.909***	3.824***	4.028***	3.561***	3.408***	3.222***
	(0.743)	(0.728)	(0.759)	(1.058)	(1.049)	(1.090)
Intermediate dummy	2.390***	2.505***	2.137***	2.322**	2.560**	2.918**
	(0.655)	(0.665)	(0.764)	(1.015)	(1.048)	(1.193)
External finance dependence	0.392			0.333		
	(0.805)			(1.261)		
Trade credit reliance		11.492			22.685	
		(15.610)			(24.518)	
Asset tangibility			2.303			-5.735
			(3.448)			(6.112)
Trade volume (bil U.S.$)	-1.018***	-1.025***	-1.014***	-0.463**	-0.478**	-0.467**
	(0.250)	(0.251)	(0.250)	(0.186)	(0.187)	(0.187)
Exporter FE (α_i)	Yes	Yes	Yes	Yes	Yes	Yes
Exporter-Year FE (α_{it})	Yes	Yes	Yes	Yes	Yes	Yes
Year FE (α_t)	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,376,508	1,376,508	1,376,508	1,376,508	1,376,508	1,376,508
R^2	0.269	0.269	0.269	0.074	0.074	0.074

Standard errors are two-way clustered by exporter & industry and reported in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A3: Industry-Level Trade Restricted to Developing Countries (*ikt*)

	(1)	(2)	(3)	(4)	(5)	(6)
	Instability 1			Instability 2		
L.HHI market	37.940***	38.175***	38.191***	39.486***	39.790***	40.198***
	(1.535)	(1.534)	(1.533)	(1.994)	(1.979)	(1.991)
Durable dummy	5.850***	5.535***	5.333***	5.525***	5.130***	4.006***
	(0.834)	(0.809)	(0.838)	(1.087)	(1.115)	(1.204)
Downstream vertical linkages	8.520***	9.248***	10.851***	6.269**	7.243**	12.818***
	(2.141)	(2.177)	(2.463)	(3.140)	(3.142)	(3.494)
External finance dependence	-0.853			-1.391		
	(0.872)			(1.188)		
Trade credit reliance		44.016***			56.630**	
		(15.885)			(26.111)	
Asset tangibility			-7.958**			-22.827***
			(3.630)			(6.223)
Trade volume (bil U.S.$)	-1.259**	-1.284**	-1.259**	-0.351**	-0.385**	-0.349*
	(0.506)	(0.511)	(0.505)	(0.165)	(0.159)	(0.183)
Exporter FE (α_i)	Yes	Yes	Yes	Yes	Yes	Yes
Exporter-Year FE (α_{it})	Yes	Yes	Yes	Yes	Yes	Yes
Year FE (α_t)	Yes	Yes	Yes	Yes	Yes	Yes
Observations	732,666	732,666	732,666	732,666	732,666	732,666
R^2	0.197	0.197	0.197	0.047	0.047	0.048

Standard errors are two-way clustered by exporter & industry and reported in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A4: Bilateral Trade at the Industry Level Where At Least One Country Is Developing (*ijkt*)

	(1)	(2)	(3)	(4)	(5)	(6)
		Instability 1			Instability 2	
HHI industry	0.481	0.501	0.494	0.350	0.399	0.392
	(0.415)	(0.406)	(0.406)	(0.942)	(0.934)	(0.931)
HHI market$_{ikt}$	21.225***	21.351***	21.626***	18.991***	19.182***	19.782***
	(1.558)	(1.583)	(1.550)	(1.576)	(1.612)	(1.563)
HHI market$_{jkt}$	14.793***	15.130***	15.271***	15.981***	16.579***	16.958***
	(1.579)	(1.553)	(1.494)	(2.557)	(2.518)	(2.402)
Durable dummy	6.900***	6.772***	6.370***	8.043***	7.794***	6.913***
	(0.765)	(0.754)	(0.752)	(1.039)	(1.028)	(1.051)
Downstream vertical linkages	5.240***	5.915***	8.480***	2.486	3.622	9.155***
	(1.802)	(1.788)	(2.077)	(2.623)	(2.587)	(2.854)
External finance dependence	-0.648			-0.603		
	(1.062)			(1.495)		
Trade credit reliance		37.769**			69.269***	
		(16.322)			(20.271)	
Asset tangibility			-10.276**			-21.568***
			(4.148)			(5.964)
FTA dummy	-1.649***	-1.637***	-1.629***	-0.460	-0.433	-0.414
	(0.474)	(0.472)	(0.470)	(0.699)	(0.697)	(0.697)
GATT/WTO dummy	0.757	0.737	0.724	2.188	2.148	2.114
	(0.801)	(0.795)	(0.795)	(1.718)	(1.711)	(1.717)
Trade volume (mil U.S.$)	-0.011***	-0.011***	-0.011***	-0.002**	-0.003**	-0.003**
	(0.003)	(0.003)	(0.003)	(0.001)	(0.001)	(0.001)
Exporter-Importer FE (α_{ij})	Yes	Yes	Yes	Yes	Yes	Yes
Exporter-Year FE (α_{it})	Yes	Yes	Yes	Yes	Yes	Yes
Importer-Year FE (α_{jt})	Yes	Yes	Yes	Yes	Yes	Yes
Year FE (α_t)	Yes	Yes	Yes	Yes	Yes	Yes
Observations	16,339,624	16,339,624	16,339,624	16,339,624	16,339,624	16,339,624
R^2	0.102	0.102	0.103	0.031	0.031	0.031

Standard errors are three-way clustered by exporter, importer, & industry and reported in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A5: Alternative Export Instability Measure - Instability 3 (*ijkt*)

	Instability 3		
	(1)	(2)	(3)
HHI industry	1.024	1.062	1.060
	(0.764)	(0.756)	(0.754)
HHI market$_{ikt}$	22.690***	22.871***	23.207***
	(2.521)	(2.562)	(2.476)
HHI market$_{jkt}$	16.399***	16.823***	16.968***
	(2.405)	(2.359)	(2.242)
Durable dummy	6.499***	6.295***	5.856***
	(0.916)	(0.901)	(0.898)
Downstream vertical linkages	6.066***	6.740***	9.530***
	(2.230)	(2.215)	(2.534)
External finance dependence	0.281		
	(1.197)		
Trade credit reliance		50.878***	
		(17.965)	
Asset tangibility			-11.682**
			(5.330)
FTA dummy	-0.432	-0.410	-0.401
	(0.474)	(0.472)	(0.471)
GATT/WTO dummy	1.953	1.900	1.887
	(1.572)	(1.562)	(1.568)
Trade volume (mil U.S.$)	-0.004***	-0.005***	-0.005***
	(0.002)	(0.002)	(0.002)
Exporter-Importer FE (α_{ij})	Yes	Yes	Yes
Exporter-Year FE (α_{it})	Yes	Yes	Yes
Importer-Year FE (α_{jt})	Yes	Yes	Yes
Year FE (α_t)	Yes	Yes	Yes
Observations	24,279,398	24,279,398	24,279,398
R^2	0.029	0.029	0.029

Standard errors are three-way clustered by exporter, importer, & industry and reported in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Appendix C: Alternative Volatility Measures for Chapter 3

As previously noted, the choice of volatility measure is necessarily ad-hoc. Thus, in this section, we consider some alternate measures of trade volatility that have been used previously in the literature.

First, while Rose (2005) uses the coefficient of variation of log trade flows, similar to our measure in section 3.4, Mansfield and Reinhardt (2008) uses the absolute value of the difference in year-to-year log trade flows. Indeed, Mansfield and Reinhardt (2008) argues that any discrepancy in results between the two papers is likely due to the different measures of volatility. Thus, in column 1 of Table A6 we rerun the regression using the absolute value of the difference in log trade flows:

$$\textit{Ab log diff} = \left| lnX_{ijkt} - lnX_{ijk(t-1)} \right| \tag{4.1}$$

as the dependent variable. As can be seen, the results are qualitatively similar.

Second, an implication of analyzing the volatility of log trade flows is that it compresses the data and thus reduces the weights on large changes in (absolute) trade flows. Thus, as an additional robustness check we consider two alternative measures. In column 2 of Table A6 we use a year-to-year version of the coefficient of variation calculated on unlogged trade flows:

$$\textit{Ab CV} = \frac{\sqrt{(X_{ijkt} - X_{ijk(t-1)})^2}}{\frac{1}{2}\left(X_{ijk(t-1)} + X_{ijkt}\right)} \tag{4.2}$$

This measure is similar to those used in Han (2021a), Massell (1964), and Wong (1986). In column 3 of Table A6 we use a year-to-year version of the widely used Coppock (1977) measure of export instability (e.g., see Rangarajan and Sundararajan (1976)):

$$\textit{Antilog} = e^{\sqrt{(lnX_{ijkt} - lnX_{ijk(t-1)})^2}} \tag{4.3}$$

As can be seen, both measures give results qualitatively similar to those reported in section 3.4.

Table A6: Different Measures in the Literature

	(1) Ab log diff	(2) Ab CV	(3) Antilog
L.RTA ranking	0.009***	0.003***	0.273**
	(0.001)	(0.000)	(0.125)
L.GATT/WTO dummy	-0.005	-0.002	-3.031*
	(0.009)	(0.006)	(1.800)
L.Log export value	-0.155***	-0.090***	-3.373***
	(0.001)	(0.000)	(1.139)
Exporter-industry-year (α_{ikt})	Yes	Yes	Yes
Importer-industry-year (α_{jkt})	Yes	Yes	Yes
Exporter-importer-industry (α_{ijk})	Yes	Yes	Yes
Observations	23,050,547	23,050,547	23,050,547
R^2	0.445	0.449	0.514

Standard errors are clustered by country pair and reported in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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Professional Experience

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Awards

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Graduate Student Award, Southern Economic Association	2019
Luckett Fellowship, University of Kentucky	2018–2019
Gatton College's Award for Teaching Excellence by a Graduate Student	2018
Gatton Fellowship, University of Kentucky	2016–2018
Gatton College's Award for Excellence in First Year Ph.D. Coursework	2016
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Publications

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