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Abstract

We use panel data consisting of 96 countries and covering the period 1960–2000 to investigate the effects of free trade agreements (FTAs) and hub-and-spoke systems of FTAs on exports. Our empirical results imply an annual growth rate of 5.57% in exports, leading to a doubling of exports after 12.4 years, between FTA partners. Non-overlapping FTAs account for 4.12%, while hub-and-spoke FTAs account for 1.45% of the estimated export growth rate. This indicates that in addition to the direct trade liberalizing effect of FTAs, the hub-and-spoke nature of FTAs has an additional positive effect on trade.

Keywords: free trade agreement, hub and spoke, world bilateral trade data, panel data analysis, fixed effect, average treatment effect

JEL Classification: F15

1. Introduction

An interesting stylized fact of global trade is the proliferation of regional trade agreements (RTAs), including overlapping free trade agreements (FTAs). As of 31 December 2008, the General Agreement on Tariffs and Trade (GATT)/World Trade Organization (WTO) has been notified of 243 RTAs, of which about 60% were FTAs.[1] If the 65 service agreements and 27 partial agreements are excluded, the proportion of FTAs rises to 91%.[2] Many of the FTAs are overlapping and allow some countries to become a hub in the production networks of FTAs. On the one hand, relative to non-hub countries, an FTA-hub country gains preferential access to more markets and thus enjoys improved export competitiveness. To the extent that such an advantage translates into more exports, the hub-and-spoke feature of overlapping FTAs can have a positive effect on trade.[3] On the other hand, as Lloyd and MacLaren (2004) point out, in an FTA-hub country exporters and importers face multiple sets of rules of origin (ROOs) that can lead to costs related to the verification of such rules. These additional costs can, in turn, restrain trade creation. Therefore, being an FTA hub within the network of FTAs does not necessarily have a positive effect on exports.

The hub-and-spoke nature of FTAs has been analyzed at length in the trade literature. Early country-specific studies on hub-and-spoke systems include analysis of Canadian FTA policy by Wonnacott (1975, 1982). In addition, Kowalczyk and Wonnacott (1992) investigated hub-and-spoke systems within the context of the North American Free Trade Agreement (NAFTA). More recent studies include, among others, Benedictis et al. (2005) on the European Union (EU)-15 and Central and Eastern Europe; Deltas et al. (2006) on Israel; and Chong and Hur (2008) on Singapore, Japan, and the United States (US). For our purposes, the most relevant study is Lee et al. (2008), which empirically examined the trade effects of what they refer to as “overlapping RTAs” using the dataset from Rose (2004). They built a panel dataset comprising 175 countries from 1948 to 1999 and used an augmented gravity model with dummies representing several features of overlapping RTAs. They estimated the trade diversion and creation effects of overlapping RTAs and showed that overlapping RTAs are ultimately undesirable for global trade due to the dominance of the trade diversion effect. Our results and approaches are different from Lee et al. (2008) in a number of ways, as explained below.

Our estimation results show that an FTA has a positive effect on the FTA-hub country’s exports. More precisely, we found that under a hub-and-spoke FTA the exports of an

1 See www.wto.org for more details about RTAs.

2 According to the accounting method of the WTO, sometimes a new RTA is double-counted under GATT Article XXIV, the Enabling Clause; or GATS (General Agreement on Trade in Serves) Article V. For example, the FTA between Japan and Singapore reported on 14 November 2002 is listed as a new RTA under GATS Article V as well. Another example is the FTA between India and Sri Lanka notified to WTO on 17 June 2002 (date of entry into force: 15 December 2001), which is categorized as a new RTA under the Enabling Clause.

3 A hub of overlapping FTAs is also attractive to foreign investors, who gain preferential access to multiple FTAs. While FTAs may thus promote FDI inflows, we do not examine those effects in this paper. Our paper looks at the trade effects of FTAs rather than the FDI effects of FTAs. Being an FTA hub also entails some costs. For example, a hub has to manage multiple sets of trade regulations such as those pertaining to rules of origin.

FTA-hub country grow by 5.57% per year and double after 12.4 years. The intuition behind the result can be explained through a simple framework as follows. Consider a three-country trade model where countries A, B, and C trade with one another for all products. Suppose that A and B form an FTA. This will increase trade between A and B, owing to the preferential tariff treatments. Now, suppose that A forms another FTA with C and thus becomes an FTA hub. How does A's new hub status affect its exports to B and C? First, A's exports to C would increase due to the removal of tariffs between A and C. Second, there would be two simultaneous opposing effects on A's export to B. On the one hand, A's exports to B may decline because more of A's exports would be diverted to C as a result of the new FTA between A and C. On the other hand, A's exports to B may increase because the same FTA would divert C's exports from B to A. This is because C has an FTA with A but not with B. Thus, A would gain a higher export market share in B.

Our empirical results show that on average A's exports to B and C rise when A becomes an FTA hub by forming FTAs with both B and C. What we estimate in our regression is not a trade diversion effect or trade creation effect that A may experience in its trade with B. Instead, what we estimate is the average effect of A's FTA-hub position on its exports to both spoke countries, B and C. Therefore, even if there is a big enough trade diversion effect that A's net exports to B decline, A's average exports to both spoke countries can be still higher if the increase in its exports to C is larger than the reduction in its exports to B.[4]

In contrast to Lee et al. (2008), our econometric approach accounts for multilateral resistance in a gravity model with the country-and-time fixed effect. The importance and implications of multilateral resistance in a gravity model have been investigated by Anderson and van Wincoop (2003), and Baier and Bergstrand (2007, 2009). Anderson and van Wincoop (2003) show that trade depends not only on bilateral trade barriers between the two countries involved, but also on multilateral resistance from other trade partners in the rest of the world. They argue that a theoretically consistent gravity model should consider multilateral resistance terms such as exporter and importer price indices, which are the functions of bilateral resistance or trade barriers.[5] Otherwise, the estimators will suffer from omitted variable bias. To account for multilateral resistance, they use a customized nonlinear least square procedure to obtain unbiased estimators. Baier and Bergstrand (2007) extend the model of Anderson and van Wincoop (2003) to a panel setting and propose a country-and-time, fixed-effect model to consider unobservable time-varying multilateral resistance terms. The proposed method is useful because it is computationally less burdensome and avoids measurement errors due to the omission of multilateral resistance terms. Baier and Bergstrand (2009) suggest a third method to estimate multilateral resistance, a method that could generate theoretically motivated general equilibrium comparative statics. They use a simple

[4] In Appendix A, we consider a three-country trading structure in which no trade diversion occurs when some countries form FTAs. We consider this case in order to highlight the possibility that the FTA-hub position can bring about a positive export effect.

[5] Magee (2003) takes a different approach to address the endogeneity of FTAs. He uses two-stage least squares to estimate the effect of endogenous FTAs on trade, but is unable to find any reliable evidence as the estimated effect ranges from large and negative to large and positive.

ordinary least squares (OLS) regression of a first-order, log-linear Taylor series expansion of the multilateral resistance terms in the Anderson and van Wincoop (2003) system of equations, and show that their estimators are virtually identical to those of Anderson and van Wincoop (2003).

In our paper, we follow the framework of Baier and Bergstrand (2007), which uses panel data methods with country-and-time dummy variables to account for multilateral resistance. We incorporate the FTA-hub variable into Baier and Bergstrand's model. We run pooled OLS regression and test for serial correlation and violations of strict exogeneity assumption. We show that the error terms of pooled OLS regression are serially correlated and the assumption of strict exogeneity is violated. This could be evidence of endogeneity between FTA and time-invariant variables in the pooled OLS regression. Since the endogeneity problem could be handled by using panel data methods, we estimate the model using fixed-effect (FE) and first-differenced (FD) regressions as outlined in Baier and Bergstrand (2007). We also test for serial correlation and strict exogeneity in both FE and FD regressions. We show that neither the FE nor FD regressions suffer from serially correlated error terms and violations of the strict exogeneity assumption. This confirms Baier's and Bergstrand's contention that panel data methods solve the endogeneity problem in pooled OLS regressions.

The rest of this paper is organized as follows. Section 2 defines and discusses the hub-and-spoke features of overlapping FTAs, and provides evidence about FTA hubs and spokes in the real world. Section 3 discusses the data and methodology we use for our empirical analysis. The section also explores the FE and FD models. Section 4 examines the main results that emerge from our empirical analysis. We compare the results from the pooled OLS regressions, FE regressions, and FD regressions. Section 5 concludes with some final observations.

2. Features and Examples of FTA Hubs and Spokes

In this section, we define hub country and spoke country in a world of overlapping FTAs, discuss the potential effects of hub-and-spoke FTAs on trade among FTA member countries, and examine the extent to which hub-and-spoke FTAs are a feature of real world trade.

2.1 Features of Hub and Spoke FTAs

Our definition of hub and spoke is given below. It is theoretically possible for two countries to be each other's hub and spoke at the same time if both countries belong to more than two FTAs.

Definition of Hub and Spoke of FTAs: Suppose that country i has bilateral FTAs with m countries (m is strictly greater than one) and country j is one of the m countries. Country j is defined as a spoke country if it has bilateral FTAs with m-2 or less countries among the m countries that have bilateral FTAs with country i. Country i is defined as a hub country if it has at least two spokes.

We provide a simple trade structure in Appendix A in which there are three symmetric countries trading with each other under three different FTA structures—no FTA, one FTA, and two FTAs—and compare the different FTA structures in terms of their impact on welfare and exports of each country. Note that, in the model, we assume no trade diversion effect of FTAs in order to focus upon our primary issue of interest, i.e., whether being an FTA hub rather than an FTA spoke can be beneficial in terms of welfare levels and export performance. If so, a country would have the incentive to sign multiple FTAs and become the hub of an FTA network.

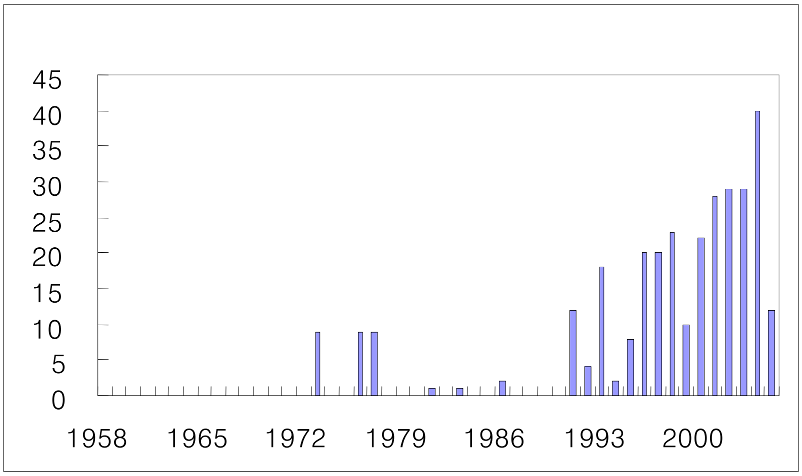
The following simple real world example of an FTA network, which is based on a more general setting than the one in Appendix A, is useful for giving the reader a more intuitive understanding of the hub-and-spoke concept. The US entered into NAFTA with Mexico on 1 January 1994 and into a bilateral FTA with Australia on 1 January 2005. Since Mexico and Australia do not have an FTA with each other, the US is clearly the hub country, while Mexico and Australia are the spoke countries. Let us consider the exports of the hub country to the spoke countries. First, regarding the exports of the US toward its new FTA partner, Australia, the US would enjoy a price advantage in its exports to Australia vis-à-vis Mexico because its exports receive preferential treatment in Australian markets whereas Mexican exports do not. The preferential treatment takes the form of lower tariffs and non-tariff barriers, which reduce the prices of US exports relative to those of Mexican exports. Second, there are two opposing effects with respect to the exports of the US toward its old FTA partner, Mexico. On the one hand, the US might increase its exports to Mexico because Australian exports are diverted toward US markets from Mexican markets and thus raise the US market share in Mexico. On the other hand, the US might experience a decrease in its exports to Mexico because the new FTA diverts US exports from Mexican markets to Australian markets, thereby reducing the US market share in Mexico.

In the above example, the US increases its exports to Australia, but it may or may not increase its exports to Mexico. Therefore, whether the average exports of the FTA hub—the US in our example—rise or fall is ultimately an empirical question that must be resolved through empirical analysis. We estimate the export effect of FTA-hub status in sections 3 and 4. More specifically, we estimate the effect of the formation of an FTA on members' exports due to the removal of trade barriers and the additional effect of FTA-hub status on the hub country's average exports.

2.2 Examples of FTA Hubs and Spokes

Given our discussions of FTA hubs and spokes in the preceding sub-sections, the next logical issue to examine is the prevalence of hubs and spokes in real world trade. Our primary data source for identifying FTAs and FTA hubs, as defined above, for the period 1958–2005 is the Regional Trade Agreements Notified to the GATT/WTO and in Force by Date of Entry into Force, which is available at the WTO website. The table provides detailed information on 186 RTAs during 1958–2005. We excluded agreements for trade in services since our analysis is more relevant for trade in goods, for which the advantages of FTAs for exporters are more concrete. We also excluded preferential agreements, which are not completely in the form of free trade areas or customs unions as specified by GATT Article XXIV. Those exclusions reduce our sample size to 132 agreements, which are listed in Appendix B.[6] Figure 1 below shows the number of new FTA hubs that have emerged each year during 1958–2005.

Figure 1: Number of New FTA Hubs, 1958–2005



FTA = free trade agreement.

Source: Authors' estimates.

Table 1 below ranks 211 countries in terms of the frequency of becoming a new FTA hub (denoted by H^i_t for country i and time t) during 1958–2005. Countries with the highest frequency of being FTA hubs (13 times) are the nine oldest members of the EU. Six countries that joined the EU at later dates and four European Free Trade Area (EFTA) countries have the second to the fourth highest frequency of becoming FTA hubs. Eastern European countries such as Romania, Turkey, and Bulgaria have also recently joined a number of FTAs and become FTA hubs. Mexico (5 times) and the US (4 times) have become FTA hubs in the Americas, while Australia (3 times), Singapore (3 times), New Zealand (2 times), the People's Republic of China (PRC) (1 time), and Japan (1 time) are FTA hubs in the Asia–Pacific region. The overall evidence suggests that FTA hub countries are likely to be members of RTAs. In particular, EU members seem to be prominent FTA hubs.

6 34 agreements for trade in services and 18 preferential agreements were removed from the list. In addition, we excluded the Commonwealth of Independent States (CIS) since many of its members have subsequently entered into bilateral agreements with each other despite the CIS. We do, however, include those bilateral agreements. We also exclude Romania's accession to the Central European Free Trade Agreement (CEFTA) in 1997 because it was the only member at that time.

Table 1: The Frequency of Becoming a New FTA Hub, 1958–2005

Ranking	Countries	
1	Belgium, Denmark, France, Germany, Ireland, Italy, Luxemburg, Netherlands, United Kingdom	13
2	Greece, Portugal, Spain	11
3	Austria, Finland, Sweden, Switzerland	9
4	Iceland, Liechtenstein, Norway	8
5	Romania, Turkey	6
6	Bulgaria, Israel, Mexico	5
7	Armenia, Croatia, Georgia, Kyrgyz Republic, Macedonia, United States	4
8	Australia, Chile, Moldova, Russian Federation, Singapore	3
9	Albania, Bosnia and Herzegovina, Canada, El Salvador, Kazakhstan, New Zealand, Ukraine,	2
10	People's Republic of China, Costa Rica, Cyprus, Czech Republic, Estonia, Hungary, Japan, Jordan, Latvia, Lithuania, Malta, Nicaragua, Palestine Authority, Poland, Slovak Republic, Slovenia, South Africa, Tunisia	1
11	Rest of the world (151)	0

Source: Authors' estimates.

Since we have 211 countries over 48 years, our total number of observations is 10,128. Table 2 below shows that the unconditional probability of a randomly chosen country i being an FTA hub at randomly chosen time t is 3.04%. A country's conditional probability of being an FTA hub if it has never been an FTA hub before is only 0.63%. On the other hand, a country's conditional probability of being an FTA hub if it has been an FTA hub at least once before is much higher at 38.93%. This implies that countries that have been FTA hubs in the past are much more likely to become FTA hubs in the future.

Table 2: Conditional Probability of Being a New Hub

	H^i_t=0	H^i_t=1	Total
$_{j=1}{}^{t-1958}\ H^i_{t-j}=0$	99.73% (9,431)	0.63% (60)	100% (9,491)
$_{j=1}{}^{t-1958}\ H^i_{t-j}\geq 1$	61.07% (389)	38.93% (248)	100% (637)
Total	96.96% (9,820)	3.04% (308)	100% (10,128)

Note: $_{j=1}{}^{t-1958}\ H^i_{t-j}=0$ means that a country has never been an FTA hub before. In this case, the probability of being an FTA hub is 0.63%. $_{j=1}{}^{t-1958}\ H^i_{t-j}\geq 1$ means that a country has been an FTA hub at least once before. In this case, the probability of being an FTA hub is 38.93%. The unconditionally probability of being an FTA hub is 3.04%.

Source: Authors' estimates.

The purpose of section 2(b) is to provide a global picture of the prevalence of FTA hubs and spokes in the real world. In fact, in the empirical analysis in section 4, we will restrict our attention to the years 1960–2000. This is because including the post-2000 FTAs, which are likely to be less than fully effective due to the gradual nature of FTA-based trade liberalization, will impart an upward bias on the estimated effect of FTA on trade, especially in light of the rapid growth of FTAs in the post-2000 period. Another benefit of using this time period is that it allows us to compare our results with earlier empirical literature of FTA effects, in particular Baier and Bergstrand (2007). In fact, we use the Baier and Bergstrand (2007) data set for our empirical analysis. In the next two sections we describe the data set and our empirical methodology and results.

3. Data and Empirical Framework

Our primary data set is from Baier and Bergstrand (2007). The data set includes nominal bilateral trade flows of 96 potential trading partners, scaled by the exporting country's gross domestic product (GDP) deflator to compute the real trade flows that we use in our panel data analysis. Baier and Bergstrand use the standard gravity model of trade to examine the impact of FTAs on international trade. The gravity model, a widely used workhorse of empirical analysis in international trade, explains the natural logarithm of bilateral trade with the logs of the distance between the two countries and their income. Most applications of the gravity model include a number of explanatory variables in addition to distance and income. Since our data are from Baier and Bergstrand, we use their basic empirical framework in the sense that we use the same explanatory variables such as adjacency, language, and FTA dummy variables. Baier and Bergstrand's data set has 48,235 observations of 96 trading partners over 5-year intervals beginning in 1960 and ending in 2000.

We supplement Baier and Bergstrand's data set with our data for our key variable, i.e., FTA hubs. As noted earlier, our primary source of data for the variable is the Regional Trade Agreements Notified to the GATT/WTO and in Force by Date of Entry into Force, which is available at the WTO website and reproduced in Appendix B. We construct FTA and FTA hub variables for all RTAs notified to the WTO between 1960 and 2000. More specifically, ${FTA^{ij}}_t$ is a binary (dummy) variable, 1 if country i has an FTA with country j at time t and 0 otherwise; and ${FTAHUB^{ij}}_t$ is a binary (dummy) variable, 1 if country j is a spoke country with respect to country i at time t and 0 otherwise. Merging Baier and Bergstrand's data set with our data set for FTA hubs leaves us with a balanced panel data set comprising 96 countries, which are listed in Appendix C. As Baier and Bergstrand (2007) point out, FTAs are typically phased in over 5 to 10 years and thus will not become fully effective before this time period. Therefore, following Baier and Bergstrand, we exclude from our sample the post-2000 period, which saw a surge of new FTAs.

The specification of the gravity model we estimate is:

$$\ln T_t^{ij} = \alpha_0 + \beta X_t^{ij} + \mu_0 FTA_t^{ij} + \mu_1 FTAHUB_t^{ij} + Dum_t^i + Dum_t^j + \varepsilon_t^{ij} \qquad (1)$$

T^{ij}_t is the non-zero exports of country i to country j at time t scaled by the exporting country's GDP deflator. The vector X^{ij}_t includes the log of real GDP of the exporting country, log real GDP of the importing country, log of distance between country i and j, and dummy variables for adjacency and common language. We follow Baier and Bergstrand (2007) in including up to three lags of FTA^{ij}_t in the estimation of equation (1). The lags capture an institutional feature of FTAs, which are typically phased in over a period of 5–10 year, as well as the lagged nature of FTAs' economic effects on trade volumes. Since FTAs have lagged effects, it is plausible that *FTAHUBs* would also have lagged effects on trade. Hence, we include lag effects on the *FTAHUB* variable.[7] In addition, we include the country-and-time dummy variables (Dum^i_t, Dum^j_t) to account for the multilateral price terms.

We initially estimate equation (1) by OLS after adjusting for serial correlation. As we show below, even with the adjustment for serial correlation, the OLS regression violates the strict exogeneity assumption, creating a bias in the OLS estimates. This could be due to FTAs being correlated to time-invariant variables such as log of distance and the dummies for adjacency and common language. Baier and Bergstrand propose estimating equation (1) using bilateral fixed effects to account for variations in the time-invariant variables and variations in the dummies for the country-and-time effects and the log of real GDPs. This gives an unbiased estimate of μ_1.[8]

While the estimate of μ_1 may be unbiased with FE estimation, Wooldridge (2002) notes that the FE estimation could be less efficient than FD estimation when the error terms are serial correlated. Hence, we estimate the FD form of equation (1) with country-by-time dummies as follows:

$$\begin{aligned} d\ln T^{ij}_{t-(t-1)} = \beta dX^{ij}_{t-(t-1)} + \mu_0 dFTA^{ij}_{t-(t-1)} + \mu_1 dFTAHUB^{ij}_{t-(t-1)} + \\ dDum^i_{t-(t-1)} + dDum^j_{t-(t-1)} + d\varepsilon^{ij}_{t-(t-1)} \end{aligned} \tag{2}$$

We estimate equation (2) following Baier and Bergstrand's (2007) procedure. We first difference the log of real trade ($d\ln T^{ij}_{t-(t-1)}$), log of real GDP for exporter i and importer j ($d\ln(RGDP^i_{t-(t-1)})$ and $d\ln(RGDP^j_{t-(t-1)})$), the FTA dummy variables ($dFTA^{ij}_{t-(t-1)}$, $dFTA^{ij}_{(t-1)-(t-2)}$ and $dFTA^{ij}_{(t-2)-(t-3)}$), and the FTA hub dummy variables ($dFTAHUB^{ij}_{t-(t-1)}$ and $dFTAHUB^{ij}_{(t-1)-(t-2)}$). Similarly, we first difference the country-and-time dummy variables

7 We also obtained the regression results, which include up to four lags of *FTA* and *FTAHUB*. However, the lags are not significant after three lags of *FTA* and two lags of *FTAHUB*.

8 We cannot perform the Baum, Schaffer, and Stillman (2003) test for exogeneity (or endogeneity) on FTA and FTA hubs because we have a large number of regressors when we include the country-and-time dummy variables. As noted above, the country-and-time dummies are created for 96 potential trading partners (96 exporters matched with 96 importers) and nine periods (5-year intervals from 1960 to 2000). The exogeneity test requires that the number of instruments should be at least as many as the number of regressors for the test to be unbiased.

($dDum^i_{t-(t-1)}$ and $dDum^j_{t-(t-1)}$). Second, we regress each of FD variables on the country-and-time dummies and retain the residuals. There are eight retained residuals from eight regressions of each of the left-hand side variables, $d\ln T^{ij}_{t-(t-1)}$, $d\ln(RGDP^i_{t-(t-1)})$, $d\ln(RGDP^j_{t-(t-1)})$, $dFTA^{ij}_{t-(t-1)}$, $dFTA^{ij}_{(t-1)-(t-2)}$, $dFTA^{ij}_{(t-2)-(t-3)}$ $dFTAHUB^{ij}_{t-(t-1)}$ and $dFTAHUB^{ij}_{(t-1)-(t-2)}$, regressed on country-and-time dummy variables, $dDum^i_{t-(t-1)}$ and $dDum^j_{t-(t-1)}$. Third, we regress the residuals on the $d\ln T^{ij}_{t-(t-1)}$ regression on the residuals of the regressions on $d\ln(RGDP^i_{t-(t-1)})$, $d\ln(RGDP^j_{t-(t-1)})$, $dFTA^{ij}_{t-(t-1)}$, $dFTA^{ij}_{(t-1)-(t-2)}$, $dFTA^{ij}_{(t-2)-(t-3)}$, $dFTAHUB^{ij}_{t-(t-1)}$ and $dFTAHUB^{ij}_{(t-1)-(t-2)}$. Baier and Bergstrand note that their procedure estimates equation (2).

Both FE and FD regressions assume that the errors in the regressions are serially uncorrelated. If the errors are serially correlated, the FE and FD estimators may be inefficient. There may be serial correlation since bilateral trade levels in earlier years may affect current bilateral trade levels. We use the test for first-order autoregressive AR(1) serial correlation outlined by Wooldridge (2002). The results of the serial correlation tests are reported in Table 3 for pooled OLS and FE regressions and Table 4 for the FD regressions. The coefficients of serial correlation for pooled OLS, FE, and FD regressions are 0.615, –0.108, and –0.299, respectively. All the coefficients are significant at the 1% level. We find evidence of serial correlation in pooled OLS regressions. In our estimate of the pooled OLS regression in Table 3, we correct for serial correlation in pooled OLS by using the Prais–Winsten (1954) transformation. However, the coefficient estimates for the coefficient of serial correlation of the FE and FD regressions are close to their true values of –0.125 and –0.50 respectively. Hence, we find no evidence of serial correlation on both the FE and FD regressions.[9]

We also test for strict exogeneity since its violation may also result in biased FE and FD estimators. For this purpose, we use a test put forth by Wooldridge (2002). The results are shown in Table 3 for pooled OLS and FE regressions, and Table 4 for FD regression. We reject the null of strict exogeneity for the pooled OLS regression, but we cannot reject the null of strict exogeneity of the FE and FD models.

[9] Wooldridge (2002) notes that the true value of the coefficient of correlation for the FE regression (ρ) is –(1/T-1), which in our case is –0.125. ρ is the coefficient derived from regressing the retained residuals of the FE regression on the lagged values of the retained residuals. For the test of serial correlation on FD regressions, Wooldridge gives the value –0.50 as the true value of the coefficient of correlation. Wooldridge (2002) also notes that the FE estimates are more efficient than the FD estimates when the error terms are serially uncorrelated.

Table 3: Ordinary Least Squares (OLS) and Fixed Effect (FE) Estimations

Dependent Variable: ln$(ltrade)^{ij}_t$						
	OLS Estimation using the Prais–Winsten Transformation			FE Estimation		
Regressor	**Coefficient**	**Robust standard error**	**P-value**	**Coefficient**	**Robust standard error**	**P-value**
FTA^{ij}_{t}	0.054	0.054	0.321	0.185	0.054	0.001
FTA^{ij}_{t-1}	-0.280	0.072	0.000	0.316	0.065	0.000
FTA^{ij}_{t-2}	-0.327	0.067	0.000	0.073	0.061	0.231
FTA^{ij}_{t-3}	-0.196	0.083	0.018	0.045	0.077	0.561
$FTAHUB^{ij}_{t}$	0.183	0.074	0.014	0.221	0.092	0.016
$FTAHUB^{ij}_{t-1}$	0.416	0.094	0.000	0.421	0.096	0.000
log*(RGDPexporter)*	0.801	0.067	0.000	1.233	0.085	0.000
log*(RGDPimporter)*	0.709	0.066	0.000	0.710	0.100	0.000
log*(distance)*	-1.357	0.029	0.000			
Common Language	1.003	0.072	0.000			
Adjacent countries	0.633	0.109	0.000			
Country-and- time dummies	Yes			Yes		
No. of observations	31985			31985		
F-statistic	1867.27		0.000	14.83		0.000
ATE				1.143		
Test of serial correlation	0.615	0.005	0.000	-0.108	0.006	0.000
Test of strict exogeneity	-0.301	0.044	0.000	-0.065	0.043	0.131

Note: The superscripts i and j refer to Country i (exporter) that exports its goods to country j (importer). Trade between exporter i and importer j excludes zero values.

Source: Authors' estimates.

Table 4: First Differenced (FD) Estimation

Dependent Variable: dln$(ltrade)^{ij}_{t-(t-1)}$			
	FD Estimation		
Regressor	**Coefficient**	**Robust Standard Error**	**P-value**
$dFTA^{ij}_{t-(t-1)}$	0.326	0.049	0.000
$dFTA^{ij}_{(t-1)-(t-2)}$	0.293	0.058	0.000
$dFTA^{ij}_{(t-2)-(t-3)}$	0.052	0.041	0.202
$dFTA^{ij}_{(t-3)-(t-4)}$	0.106	0.060	0.078
$dFTAHUB^{ij}_{t-(t-1)}$	0.005	0.063	0.934
$dFTAHUB^{ij}_{(t-1)-(t-2)}$	0.217	0.103	0.036
$d\ln(RGDPexporter)_{t-(t-1)}$	-0.794	9.747	0.935
$d\ln(RGDPimporter)_{t-(t-1)}$	-0.978	9.746	0.920
$d(Country\text{-}and\text{-}time\ dummies)_{t-(t-1)}$	Yes		
No. of observations	22960		
F-statistic	9.29		0.000
ATE	0.836		
Test of serial correlation	-0.299	0.012	0.000
Test of strict exogeneity	-0.095	0.060	0.112

Notes: The superscripts i and j refer to Country i (exporter) that exports its goods to country j (importer). Trade between exporter i and importer j excludes zero values. d indicates that the variable is differenced. The first difference estimation is described in Baier and Bergstrand (2007).

Source: Authors' estimates.

4. Empirical Results

Tables 3 and 4 above also report our results for the pooled OLS, FE, and FD regressions. For our purposes, the most relevant coefficient estimates are those of the FTA and the FTA hub variables, so we will focus upon those variables in our discussion of the results of the three regressions in Tables 3 and 4. For the pooled OLS regressions, we include Baier and Bergstrand's (2007) explanatory variables such as ln(*RGDP exporter*), ln(*RGDP importer*), ln(*distance*), the dummies for adjacency and common language, and country-and-time dummy variables. The pooled OLS results show that the gravity equation explanatory variables are significant with the correct signs. FTA^{ij} has a significant and positive impact on bilateral trade in the first year, but a negative impact in the next 5–15 years. That is, pairs of countries that belong to an FTA trade more with each other than with other countries only in the first year of the FTA. The coefficient estimate of $FTAHUB^{ij}_{t}$ is 0.183, while the coefficient estimate of $FTAHUB^{ij}_{(t-1)}$ is 0.416. Both coefficients are significant at the 5% level. The pooled OLS results thus lend some support to a positive effect of hub-and-spoke FTAs on trade but, as noted earlier, those results suffer from possible endogeneity of the three FTA-related variables and a violation of the strict exogeneity assumption.

The FE regressions, as Baier and Bergstrand (2007) argue, do not suffer from endogenous FTA-related variables. The results of FE regression indicate that FTA^{ij} has a significant and positive impact on bilateral trade. The average treatment effect of an FTA, which refers to the notion that bilateral trade will differ based on whether or not the two countries share an FTA, is 0.501 after 15 years. The coefficient estimate of $FTAHUB_t^{ij}$ is 0.221, while the coefficient estimate of $FTAHUB_{(t-1)}^{ij}$ is 0.421, with both coefficients significant at the 1% level. The total average treatment effect, or the sum of the FTA effect and the hub-and-spoke FTA effect, is 1.143 over 15 years. The FE results thus lend strong support to a positive effect of hub-and-spoke FTAs on trade. As noted earlier, the FE regressions have residuals that are serially uncorrelated so the coefficient estimates are efficient. Furthermore, the FE regressions do not violate the strict exogeneity assumption.

As argued by Baier and Bergstrand, the FD regressions do not suffer from endogeneity. Our tests also show that the FD regressions are serial uncorrelated and do not violate strict exogeneity. The FD results indicate that the average treatment effect of FTAs at the 5% significance level, or the sum of FTA^{ij} coefficients that are significant at the 5% level, is 0.619 over 15 years. The coefficient estimate of $dFTAHUB_{t-(t-1)}^{ij}$ is insignificant at 0.005, while the coefficient estimate of $dFTAHUB_{(t-1)-(t-2)}^{ij}$ is 0.217 with a p-value of 3.6%. This suggests that a hub-and-spoke FTA has a significant positive impact on trade. If we incorporate the hub-and-spoke nature of FTAs, the average treatment effect of FTAs rises further to 0.836. In other words, under a hub-and-spoke FTA the export of an FTA-hub country grows by 5.57% per year and doubles after 12.4 years. By way of comparison, Baier and Bergstrand's (2007) FD estimates did not account for the hub-and-spoke feature of FTAs. Their estimate of ATE of FTA is 0.61 over 15 years, which translates to a 4.1% annual growth rate of bilateral trade between FTA members and implies a doubling of trade after 17 years. This is similar to our results holding constant the FTA-hub effect on trade. The fact that the annual growth rate of exports is substantially larger if we incorporate the hub-and-spoke nature of FTAs provides empirical support for the notion that being an FTA hub is beneficial for exports.

Overall, our empirical analysis based on FE and FD regressions yields two main findings. First, FTAs have a positive and significant impact on bilateral trade between FTA members. Our results thus confirm the presence of average treatment effects for FTAs, i.e., whether two countries having an FTA matters for the volume of bilateral trade. Furthermore, the positive and significant effect does not seem to materialize immediately, but rather with a time lag. Second, the hub-and-spoke nature of FTAs appears to reinforce and augment the positive and significant effect of FTAs on trade. That is, in addition to the direct trade-liberalizing effect of FTAs, the hub-and-spoke nature of FTAs has an additional positive effect on trade.

5. Concluding Remarks

Although the concept of hub-and-spoke trade systems is not new to the trade literature, what has been rare in the literature is a systematic empirical analysis of their effects. We hope that our paper helps to address this shortcoming. More specifically, we apply the concept of hubs and spokes to FTAs and use a panel data set comprising 96 countries and covering 41 years (1960–2000) to empirically examine the effect of FTA hubs and spokes on trade. Our point of departure is an increasingly prominent stylized fact of international trade in the real world: the overlapping of free trade agreements (FTAs), which gives rise to hub-and-spoke FTAs. Intuitively, an FTA hub belonging to two FTAs, e.g., Y and Z, enjoys a competitive advantage in exporting its goods vis-à-vis FTA spokes that belong to only one of the two FTAs. The hub has a price advantage vis-à-vis Y-only countries in the Z market and price advantage vis-à-vis Z-only countries in the Y market. To the extent that this advantage results in higher exports and trade, we can expect the hub-and-spoke feature of overlapping FTAs to increase trade above and beyond the direct, trade-liberalizing effects of FTAs. For example, as explained in the Appendix, when there is no trade diversion this additional, the positive impact of an FTA-hub position on trade becomes clear.

Indeed, one of our two main empirical findings is that the hub-and-spoke nature of FTAs in a world of overlapping FTAs does have a positive and significant effect on bilateral trade among FTA members. More precisely, our results imply an average annual growth rate of trade of 5.57% between FTA members and a doubling of bilateral trade after 12.4 years. Out of the 5.57%, if we hold constant the FTA-hub effect on trade, the estimated growth rate of trade is only 4.12%. This implies that some governments pursue multiple FTAs so as to achieve or reinforce their FTA-hub status. Our evidence indicates that countries that are FTA hubs are able to export more than other countries, giving countries a strong incentive to become FTA hubs. Our results thus help to explain an interesting stylized fact of global trade: the proliferation of RTAs and overlapping FTAs.

Given the large and growing role of FTAs in international trade, it is of utmost importance to measure their impact as accurately as possible. This suggests that there is plenty of scope for useful future research. For one, in this paper we fail to incorporate rules of origin (ROOs). These rules are an essential part of FTAs and define the conditions under which the importing country will view a product as originating in an FTA partner. ROOs entail costs—e.g., a Mexican firm's costs of certifying the Mexican origins of its exports to the US under NAFTA—which introduce a protectionist bias. Lloyd and MacLaren (2004) mention that the hub country can face a very complex tariff structure of three (or more) columns. In the hub country, the importers face multiple sets of ROOs that can lead to added verification costs, which, in turn, can restrain trade creation. Wonnacott (1996) also argues that a hub-and-spoke arrangement can reduce efficiency and collective income in the region below levels that can be achieved by an FTA due to rent-seeking behavior and excess costs associated with ROO compliance, among other factors. This can further compromise our key finding of a strong incentive for countries to become FTA hubs in a world of overlapping FTAs.[10] The presence of inactive FTAs is

[10] We appreciate an anonymous referee who alerted us to the additional costs incurred in complex systems of rules of origin. Indeed, we agree that there is a possibility that one may get a different

another potential issue for future research. For example, an FTA may exist in name only if firms forgo FTA-based preferential treatment and act as if they were from outside the FTA area. Including inactive FTAs in the empirical analysis distorts the estimation of FTA's trade effects. However, operationalizing ROOs and inactive FTAs for empirical purposes would be far from straightforward.

Appendix A: A Theoretical Model of Hub and Spoke FTAs

This model, based on Bagwell and Staiger (1999), is a simple product endowment model of trade without trade diversion. Consider three countries denoted by $i \in \{A,B,C\}$. We assume that country i has a representative, identical consumer who consumes three goods denoted by x^i_j with $j \in \{a,b,c\}$ and a numeraire good denoted by Z^i. The utility function of each consumer takes a standard quadratic function that is separable among the four goods.

$$U^i = Z^i + \sum_{j=a,b,c} \left[x^i_j - \frac{1}{2}(x^i_j)^2 \right] \text{ for } i \in \{A,\ B,C\}$$

Z^i is a traded numeraire good and the marginal utility of its consumption is one. This enables us to focus on the partial equilibrium model for the three non-numeraire goods—a, b and c—for which the demand functions are linear. The inverse demand function of the consumer for each non-numeraire product can be derived as: $p^i_j = 1 - x^i_j$ for $i \in \{A,B,C\}$ and $j \in \{a,b,c\}$.

On the supply side, for sectors a, b, and c we assume that country A is endowed with zero units of a and one unit of b and c; country B with zero units of b and one unit of a and c; and country C with zero units of c and one unit of b and c. A country imports the goods which it does not have and imports from the other two countries rather than only one country. This is because we assume there are no price arbitrage opportunities. For example, if country A imports from country B only, suppliers in country C will offer a lower price and country A will switch to country C. Country B suppliers will offer an even lower price in response. The price of the good will fall until it is equal in all three countries and there is no arbitrage opportunity.

Each country charges a specific tariff on imports so that the local market price is the export price plus the tariff rate. Let us denote the tariff rate ${}_{-i}\tau^i_j$ as "a tariff rate τ imposed by country i against good j from country $-i$," where $-i$ is defined as a country other than i. We assume that throughout the paper the world markets are perfectly competitive in the sense that each market is free from price arbitrage. Also, world endowments are equalized with world demand. With these assumptions, we can easily determine the nine equilibrium market prices. This price system will determine all other variables such as imports, exports, and domestic consumption. For instance, country A's imports are $M^A_a = x^A_a(p^A_a)$, its exports to country B are $E^A_b = 1 - x^A_b(p^A_b)$, and exports to country C are $E^A_c = 1 - x^A_c(p^A_c)$. The same relationships apply for the other two countries. Note that if tariff rates

conclusion from ours if such costs are included into a more accurate regression model.

are to be non-prohibitive, the sum of the tariffs imposed on exporting countries should not exceed two. For instance, country A imports $x^A_a(p^A_a)$, which is equal to $1\text{-}p^A_a$ (from the inverse demand function). So, from the perspective of equilibrium prices [i.e. $p^A_a=(1+{}_B\tau^A_a+{}_C\tau^A_a)/3$], it must be that ${}_B\tau^A_a+{}_C\tau^A_a\leq 2$ if the tariffs are to be non-prohibitive. The same applies for the other two countries.

We assume throughout the paper that each country's government tries to maximize national welfare, which is the sum of consumer surplus, economic rents from its endowments, and tariff revenues. Consumer surplus is the sum of the consumer's marginal utility from consumption. National endowments are evaluated on the basis of the market values of the endowed goods. Tariff revenues are the government's income from tariffs imposed on imports. The government chooses the tariff rate that maximizes national welfare.

Now, we compare three different trade regimes: (i) the benchmark scenario of no trade agreement; (ii) a bilateral free trade agreement (FTA) between country A and B; and (iii) overlapping bilateral FTAs between A and B, and between A and C. Note that we ignore global free trade agreements among the three countries in order to focus on preferential free trade agreements. Using the same model, Saggi and Yildiz (2007) show that the global free trade agreement is a coalition proof (stable) Nash equilibrium. However, with asymmetric endowments, overlapping bilateral FTAs may be a stable Nash equilibrium. Our analysis ignores this possibility and instead highlights incentives for a country to become a hub country of overlapping FTAs. We compare exports and welfare levels under the three different trade regimes.

Case 1: No FTA

The optimal tariff rates under no FTA are ${}_B\tau^A_a={}_C\tau^A_a=1/4$. Due to the symmetry of the model, the optimal tariff rates for the other two countries are the same. That is, ${}_A\tau^B_b={}_C\tau^B_b=1/4$ for country B and ${}_A\tau^C_c={}_B\tau^C_c=1/4$ for country C.

Case 2: A–B FTA

We assume that countries A and B form an FTA and eliminate their tariffs against each other.

$$\text{FTA: } {}_B\tau^A_a = {}_A\tau^B_b = 0.$$

We assume that the FTA is sustainable in the long run and both countries adhere to the FTA. After eliminating their tariffs against each other, Country A and B will choose the same optimal tariff (${}_C\tau^A_a = {}_C\tau^B_b$) against non-FTA country C, which will continue to choose the same optimal tariff rate as before. Then the optimal tariff rates are ${}_C\tau^A_a={}_C\tau^B_b=1/11$ and ${}_A\tau^C_c={}_B\tau^C_c=1/4$

Case 3: A–B FTA and A–C FTA

We assume that country A formed an FTA with country B and another FTA with country C. Both FTAs eliminate tariffs so that

$$\text{FTA (A and B): } {}_B\tau_a^A = {}_A\tau_b^B = 0,$$
$$\text{FTA (A and C): } {}_C\tau_a^A = {}_A\tau_c^C = 0.$$

We assume that the two FTAs are sustainable in the long run and all countries adhere to their FTAs. The optimal tariff rates are ${}_C\tau^B{}_b = {}_B\tau^C{}_c$ =1/11.

Having computed the optimal tariff rates, we can easily calculate each country's welfare level and the total exports as follows.

No FTA: W^i=1.3125, E^i=0.5 where i=A,B,C
A-B FTA: W^A = W^B =1.3246, W^C =1.3244, and E^A = E^B =0.6136, E^C =0.5455
A-B FTA and A-C FTA: W^A=1.3545, W^B=W^C =1.3200, and E^A= 0.7273, E^B = E^C=0.6061

From this simple calculation, we can verify numerically that total exports, and thus the average amount of exports of country A, which is a hub of the two FTAs, increased. The individual exports of country A to country B and country C are also increased respectively in this model. To see this more clearly, we can further calculate the exports of country A as follows.

No FTA: E^{AB}= E^{AC} =0.25
A–B FTA: E^{AB} =0.3636 and E^{AC} =0.25
A–B FTA and A–C FTA: E^{AB} =0.3636 and E^{AC} =0.3636

Appendix B: List of 132 Regional Trade Agreements, 1958–2005

1958: European Community (EC)

1960: European Free Trade Association (EFTA)

1961: Central American Common Market (CACM)

1970: EFTA accession of Iceland

1971: EC–Overseas Countries and Territories (OCTs)

1973: EC–Switzerland and Liechtenstein; EC accession of Denmark, Ireland and United Kingdom; EC–Iceland; EC–Norway; Caribbean Community and Common Market (CARICOM)

1976: EC–Algeria

1977: Agreement on Trade and Commercial Relations Between the Government of Australia and the Government of Papua New Guinea (PATCRA); EC–Syria

1981: EC accession of Greece

1983: Closer Trade Relations Trade Agreement (CER)

1985: United States (US)–Israel

1986: EC Accession of Portugal and Spain

1991: EC–Andorra: Southern Common Market (MERCOSUR)

1992: EFTA–Turkey

1993: EFTA–Israel; Armenia–Russian Federation; Kyrgyz Republic–Russian Federation; EC–Romania; EFTA–Romania; Faroe Islands–Norway; Faroe Islands–Iceland; EFTA–Bulgaria; EC–Bulgaria

1994: North American Free Trade Agreement (NAFTA); Georgia–Russian Federation

1995: Romania–Moldova; EC accession of Austria, Finland and Sweden; Faroe Islands–Switzerland; Kyrgyz Republic–Armenia; Kyrgyz Republic–Kazakhstan; Armenia–Moldova

1996: EC–Turkey; Georgia–Ukraine; Armenia–Turkmenistan; Georgia–Azerbaijan; Kyrgyz Republic–Moldova; Armenia–Ukraine

1997: EC–Faroe Islands; Canada–Israel; Turkey–Israel; EC–Palestinian Authority; Canada–Chile; Eurasian Economic Community (EAEC); Croatia–Former Yugoslav Republic of Macedonia (FYROM)

1998: Kyrgyz Republic–Ukraine; Romania–Turkey; EC–Tunisia; Kyrgyz Republic–Uzbekistan; Mexico–Nicaragua; Georgia–Armenia

1999: Bulgaria–Turkey; Central European Free Trade Agreement (CEFTA) accession of Bulgaria; EFTA–Palestinian Authority; Georgia–Kazakhstan; Chile–Mexico; EFTA–Morocco

2000: Georgia–Turkmenistan; EC–South Africa; Bulgaria–FYROM; EC–Morocco; EC–Israel; Israel–Mexico; EC–Mexico; Southern African Development Community (SADC); Turkey–FYROM

2001: Croatia–Bosnia and Herzegovina; New Zealand–Singapore; EFTA–FYROM; EC–FYROM; Romania–Israel; EFTA–Mexico; India–Sri Lanka; US–Jordan; Armenia–Kazakhstan

2002: Bulgaria–Israel; EFTA–Jordan; EFTA–Croatia; Chile–Costa Rica; EC–Croatia; EC–Jordan; Chile–El Salvador; Albania–FYROM; FYROM–Bosnia and Herzegovina; Canada–Costa Rica; Japan–Singapore

2003: EFTA–Singapore; EC–Chile; CEFTA accession of Croatia; EC–Lebanon; Panama–El Salvador; Croatia–Albania; Turkey–Bosnia and Herzegovina; Turkey–Croatia; Singapore–Australia; Albania–Bulgaria; Albania–UNMIK (Kosovo); Romania–Bosnia and Herzegovina

2004: Romania–FYROM; Albania–Romania; People's Republic of China (PRC)–Macao, China; PRC–Hong Kong, China; US–Singapore; US–Chile; Republic of Korea–Chile; Moldova–Bosnia and Herzegovina; EU Enlargement; Bulgaria–Serbia and Montenegro; EC–Egypt; Croatia–Serbia and Montenegro; Romania–Serbia and Montenegro; Moldova–Serbia and Montenegro; Albania–Serbia and Montenegro; Moldova–Croatia; Albania–Moldova; Bulgaria–Bosnia and Herzegovina; Moldova–FYROM; Moldova–Bulgaria; Albania–Bosnia and Herzegovina; EFTA–Chile

2005: Thailand–Australia; US–Australia; Japan–Mexico; Turkey–Palestinian Liberation Organization (PLO); EFTA–Tunisia; Thailand–New Zealand; Turkey–Tunisia

Appendix C: List of 96 Countries

Albania; Algeria; Angola; Argentina; Australia; Austria; Bangladesh; Belgium–Luxembourg; Bolivia; Brazil; Bulgaria; Burkina Faso; Cameroon; Canada; Chile; China, People's Republic of; Colombia; Congo, Democratic Republic of; Congo, Republic of; Costa Rica; Cote D'Ivoire (Ivory Coast); Cyprus; Denmark; Dominican Republic; Ecuador; Egypt; El Salvador; Ethiopia; Finland; France; Gabon; Gambia; Germany; Ghana; Greece; Guatemala; Guinea–Bissau; Guyana; Haiti; Honduras; Hong Kong, China; Hungary; India; Indonesia; Iran; Ireland; Israel; Italy; Jamaica; Japan; Kenya; Korea; Madagascar; Malawi; Malaysia; Mali; Mauritania; Mauritius; Mexico; Morocco; Mozambique; Netherlands; New Zealand; Nicaragua; Niger; Nigeria; Norway; Pakistan; Panama; Paraguay; Peru; Philippines; Poland; Portugal; Romania; Saudi Arabia; Senegal; Sierra Leone; Singapore; Spain; Sri Lanka; Sudan; Sweden; Switzerland; Syrian Arab Republic; Thailand; Trinidad & Tobago; Tunisia; Turkey; Uganda; United Kingdom; United States; Uruguay; Venezuela; Zambia; and Zimbabwe.

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Do Hub-and-Spoke Free Trade Agreements Increase Trade? A Panel Data Analysis

In this paper, Joseph D. Alba, Jung Hur and Donghyun Park use panel data consisting of 96 countries and covering the period 1960–2000 to investigate the effects of free trade agreements (FTAs) and hub-and-spoke systems of FTAs on exports. Their empirical results imply an annual growth rate of 5.57% in exports, leading to a doubling of exports after 12.4 years, between FTA partners. Non-overlapping FTAs account for 4.12%, while hub-and-spoke FTAs account for 1.45% of the estimated export growth rate. This indicates that in addition to the direct trade liberalizing effect of FTAs, the hub-and-spoke nature of FTAs has an additional positive effect on trade.

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ADB's vision is an Asia and Pacific region free of poverty. Its mission is to help its developing member countries substantially reduce poverty and improve the quality of life of their people. Despite the region's many successes, it remains home to two-thirds of the world's poor: 1.8 billion people who live on less than $2 a day, with 903 million struggling on less than $1.25 a day. ADB is committed to reducing poverty through inclusive economic growth, environmentally sustainable growth, and regional integration.

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