Evaluating the Trade Effect of Developing Regional Trade Agreements: a Semi-parametric Approach

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Abstract

Many recent papers have pointed to ambiguous trade effects of developing regional trade agreements, calling for a reassessment of their economic merits. This paper focuses on 22 RTAs involving mostly developing countries and covering all the continents and use trade flows over the period 1962-2006. It proposes a two-step estimation approach to assess their trade impact: first estimate a gravity equation excluding the RTA variables, and then use the trade residuals estimated to run a kernel regression for each of the RTAs. This approach allows capturing the non-monotonic trade effects of the RTAs over time while imposing minimal structure on the model, and is flexible enough to be extended to any new RTA. As existing RTAs are deepened and new ones are being negotiated, ensuring that trade creation dominates trade diversion will be essential, particularly in the post-crisis world where resources will be limited for all countries.

• **JEL Classification:** F11, F15, O50

• **Key Words:** regional trade agreement, kernel regression, two-step estimation, trade impact, gravity model

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I. Introduction

At the beginning of the 1990s, the WTO was reporting 40 regional and bilateral agreements. Nineteen years later, this number has grown to more than 200, most of the agreements being signed by developing countries. The WTO General Council established the Committee on Regional Trade Agreements to examine individual agreements and consider their systemic implications on the multilateral trading system. The World Bank has engaged a research program on regionalism and development which led to the publication of a Policy Research Report offering a set of ideas to better manage regionalism worldwide.¹ The UNCTAD also funded a study on regionalism and Africa's development which proposed an intensification of Africa's efforts on regional and Sub-regional economic integration.² With the multilateral trade agenda in a stalemate since the failure of the Cancun negotiation in 2003, more and more regional and bilateral trade agreements are to be expected.

This new interest in regionalism has also inspired researchers to prospect more rigorous approaches to estimate the trade impact of these regional agreements. Since Aitken (1973) who estimated the trade creation and trade diversion effects of the European Community by including some Regional Trade Agreement (RTA henceforth) dummy variables in a gravity model, this model has been the workhorse used by trade economists to analyze the trade impact of RTAs. Baier and Bergstrand (2002), Anderson and Van Wincoop (2003) and Feenstra (2004) among others have presented a rigorous theoretical derivation of the gravity model and its extension to include RTA variables. Many papers have discussed the econometric tools used to estimate gravity equations. Matyas (1997), Matyas (1998), and Egger (2000) among others showed that a panel approach yields better results than a cross-section approach since it allows capturing the overall business cycle phenomenon faced by the trading partners and helps to disentangle time-invariant country-specific effects. They argue that these country-specific effects should be assumed fixed if the sample only includes a predetermined subset of countries and random if a larger sample including any country at random is used. Martinez-Zarzoso and Nowak-Lehmann (2003), Egger and Pfaffermayr (2003), and Cheng and Wall (2005) among others show that a panel specification including exporter, importer and time effects is only a restricted version of a more general model allowing for country-pair heterogeneity. Carrere (2006) suggests using a

¹Maurice Schiff and Alan Winters (2003).

²UNCTAD (2000).

Hausman-Taylor specification including three RTA dummy variables covering countries' exports, imports and intra-regional trade flows to properly estimate the trade effect of RTAs. Baldwin and Taglioni (2006) suggests that the best approach is to use unidirectional trade flows and include country-pair and time dummy variables, or country-time dummy variables to correct for the inadequate deflation of the trade flows and partially correct for omission of a multi-lateral resistance factor.

Certainly, many ongoing papers are still trying to propose the most relevant econometric approach to estimate the trade impact of RTAs. The more sophisticated these approaches and the larger the set of RTAs to be evaluated, the more challenging it is to have a single specification encompassing all the existing RTAs. For instance, we tried to use the Hausman-Taylor specification proposed by Carrere (2006) including three RTA variables for the 22 RTAs we identified as relevant but we failed because it required more computation capacity than what our quite powerful computer were able to provide. With these capacity limitations, it will be more and more difficult to include in a single regression all the RTAs existing and to be signed, hence a lack of common ground that allows comparing the trade impact of these RTAs. To provide such common ground to assess RTAs' trade impact, this paper suggests a two-step estimation approach combining the estimation of a gravity equation with a kernel regression. We first propose for each RTA three variables (import, export and intra-trade specific) based on the count of the number of years each member has participated, hence helping to capture the cumulative effect of being an RTA member over time.³ We then use the fixed effects specification proposed by Baldwin and Taglioni (2006) and the random effects specifications proposed by Carrere (2006) to estimate a gravity equation excluding the RTA variables. Our choice of considering both approaches (random and fixed effects) is to move beyond the random vs. fixed effects debate (see brief literature review above on estimation techniques) and propose a practical way to confidently estimate the trade impact of any RTA irrespective of the initial choice of a random or a fixed effect approach. The trade residuals of these two regressions are then extracted and used as dependent variables in a kernel regression for each of the RTA-variables of 22 well-known RTAs.⁴ In addition to the practicality of this

³This approach is inspired by Freund and McLaren (1999) who introduced an alternative way of looking at RTAs trade effect by focusing on the dynamic of trade orientation when a country joins a regional trade agreement and over the number of years of membership.

⁴Appendix 1 describes these RTAs.

semi-parametric approach, the kernel regression captures the non-linearity of the trade impact of RTAs by imposing a minimal specification structure.

The trade impacts estimated by the fixed effects specifications appear to be slightly higher than those obtained with the random effects specifications, and almost all these RTAs appear to have at least induced more intra-RTA trade, except for BIMSTEC, CACM, CEMAC, EEU and GCC. The remainder of the paper first review the RTAs considered in section II, and then describes the semi-parametric estimation approach in section III. Section IV presents the empirical analysis and discusses the trade impacts estimated for these RTAs. Section V concludes the paper.

II. Review of the RTAs

Of the 218 regional and bilateral trade agreements reported to the WTO, 118 are bilateral agreements; 54 are agreements between a country or a regional grouping with another regional grouping, and 56 are “pure” regional trade agreements. In this paper, we focus on 22 of these regional trade agreements based on their member commitment to the regional trade agenda. Four of them involve East and South Asian and Pacific countries: the ASEAN Free Trade Agreement (AFTA, entered into force in 1992), the South Asian Preferential Trade Agreement (SAPTA, entered into force in 1993), the Bangladesh India Myanmar Sri Lanka Thailand Economic Cooperation (BIMSTEC, entered into force in 1997), and the South Pacific Regional Trade and Economic Cooperation Agreement (SPARTECA, entered into force in 1981). Six of them comprise Western Hemisphere countries: the Central American Common Market (CACM, entered into force in 1990)⁵, the Andean Community (CAN, entered into force in 1988)⁶, the Caribbean Community and Common Market (CARICOM, entered into force in 1973)⁷, the Group of Three (GOT, entered into force in 1995), the Common Market of the Southern Cone (MERCOSUR, entered into force in 1991), and the North America Free Trade Agreement (NAFTA, entered into force in 1994). Six of them have been signed by Sub-Saharan African countries: the Economic

⁵In fact, the CACM was initially created in 1958 but had suffered many downturns until its revival in 1990 with an increased cooperation with the EU.

⁶Note that in 2006, Venezuela withdrew from the CAN complaining about the bilateral free trade agreements between Colombia and Peru with the US.

⁷The CARICOM replaced the CARIFTA (Caribbean Free trade Area) which existed from 1965 to 1973.

Community of West African States (ECOWAS, entered into force in 1975)⁸, the Southern African Development Community (SADC, entered into force in 1992), the Economic and Monetary Community of Central Africa (CEMAC, entered into force in 1999)⁹, the East African Community (EAC, entered into force in 2000)¹⁰, the Southern Africa Customs Union (SACU, entered into force in 1970), and the West Africa Economic and Monetary Union (WAEMU, entered into force in 1994)¹¹. Three of them regroup Middle East and North Africa countries: the Arab Free Trade Agreement (ArFTA, entered into force in 1997), the Arab Maghreb Union (AMU, entered into force in 1989), and the Gulf Cooperation Council (GCC, entered into force in 2003)¹². Finally, three of them involve European and Central Asian countries: the European Union (EU, entered into force in 1957)¹³, the Commonwealth of Independent States (CIS, entered into force in 1991), and the Eurasian Economic Union (EEU, entered into force in 2000). See the membership of all these regional trade agreements in Appendix.

Existing studies evaluating the trade impact of RTAs are selective in the agreements included. For instance, Gosh and Yamarik (2004) include twelve of them: AFTA, ANZCERTA, APEC, CACM, CAN, CARICOM, EEA, EFTA, EU, LAIA, MERCOSUR, and NAFTA.¹⁴ Carrere (2006) considers only seven: AFTA, CACM, CAN, EU, LAIA, MERCOSUR, and NAFTA. Baier, Bergstrand and Vidal (2006) focus also on seven: CACM, CAEIA, CARIFTA, CARICOM, GOT, MERCOSUR and NAFTA.¹⁵ Furthermore, many studies of the trade impacts of developing RTAs come to different conclusions. For instance, AFTA, LAIA¹⁶ and MERCOSUR appear to have been net trade creating in some studies and net trade diverting in others (Table 1). These studies use different estimation methods,

⁸Mauritania withdrew from ECOWAS in 1999 after a military coup. Since then, the country has been informally involved in economic and political cooperation with the other ECOWAS countries.

⁹In fact, the CEMAC has existed since 1964 as a currency union but were less involved in regional trade until 1999 when the members decided to form a Customs Union.

¹⁰The first initiative to have an Eastern African Cooperation collapsed in 1973 upon political and economic disagreements between Kenya, Tanzania and Uganda.

¹¹The WAEMU has existed since 1964 as a currency union, but became an economic and monetary union in 1994 with a stronger commitment of its members to economic integration.

¹²Council has existed since 1981, but became a customs union in 2003.

¹³The EC has experienced 5 waves of enlargements since its creation in 1957, the largest being in 2004 with 10 new members and the most recent being in 2007 with Bulgaria and Romania.

¹⁴APEC stands for Asia-Pacific Economic Cooperation; EEA stands for European Economic Area; EFTA stands for European Free Trade Area.

¹⁵CAIEA stands for Central America Economic Integration Agreement. Baier, Bergstrand and Vidal (2006) focus more on bilateral free trade agreements.

¹⁶LAIA: Latin America Integration Agreement.

Table 1. Contradicting Trade Impact of Some Developing RTAs

	Net Trade Creation	Net Trade Diversion
AFTA	Carrère (2004) Elliott & Ikemoto (2004) Gosh & Yamarik (2004) Cernat (2001)	Dee & Gali (2003) Soloaga & Winters (2000)
LAIA	Dee & Gali (2003) Gosh & Yamarik (2004) Soloaga & Winters (2000)	Carrère (2004) Soloaga & Winters (2000)
MERCOSUR	Gosh & Yamarik (2004) Cernat (2001) Soloaga & Winters (2000)	Carrère (2004) Dee & Gali (2003) Krueger (1999)

different databases and different dynamic specifications to measure trade impacts, and they focus on the number of years these RTAs have existed to estimate their trade impact. This paper expands the list of RTAs ever included in a single study to 22 and provides an estimation approach making it easier to extend the analysis to any new regional agreement.

III. Semi-parametric Estimation of the Trade Impact of RTAs

To properly measure the trade effect of an RTA, we focus on the export flows of its trading partners in a global framework as described in Figure 1. The subset RTA comprises the member countries of the RTA under consideration and the subset ROW represents all the remaining countries in the world. This helps to define the set of three variables characterizing any RTA.

Figure 1. Geography of World Trade Flows

Table 2. Number of Years of Participation of AFTA Members

	Years of participation: $YP(i,t)$		Year: t
	2000	2005	
Brunei	9	14	
Indonesia	9	14	
Malaysia	9	14	
Philippines	9	14	
Singapore	9	14	
Thailand	9	14	
Vietnam	6	11	
Laos	4	9	
Myanmar	4	9	
Cambodia	2	7	
Member: i			

A. Defining a New Set of RTA Variables

The usual RTA's dummy variable assesses the impact of the RTA year after year. We propose a variable designed to assess the impact of the RTA after a given period of membership. The variable we propose is based on the count of the number of years each member has participated, combining the expansion dimension of the RTA (the evolution of the membership over time) and the cumulative cooperation experience of the members over time. For instance, let us consider the membership of the AFTA (see Appendix for the members and their date of accession). Let us call $YP(i,t)$ the number of years of participation of member country i in the RTA at date t . Table 2 illustrates AFTA members' participation in 2000 and 2005.

The traditional RTA dummy variables bunch up the observations in two groups: group 0 for non-members, group 1 for members. Focusing on the number of year of participation helps to bunch up the observations in T groups, T being the number of years the RTA has existed. For instance, Table 2 shows that Brunei in year 2000 will be bunch up with Laos in year 2005, so that the average trade residuals corresponding to 9 years of participation will include a very specific group of country-pairs depending of the evolution of the RTA's membership. This helps to evaluate the effect of being member of the RTA for one more year based on the full information available from all its members.

To compute the RTA variables, we distinguish between the exporter (country i) and the importer (country j). Each RTA is thus characterized by three variables

representing respectively export flows from a member to a non-member ($V_{RTA-ROW}$), export flows from a non-member to a member ($V_{ROW-RTA}$), and export flows between members ($V_{RTA-RTA}$). These variables depend on i, j and t :

$$V_{RTA-ROW}(i, j, t) = YP(i, t), \text{ if } i \text{ belong to } RTA \text{ and } j \text{ does not} \\ = 0, \text{ otherwise} \quad (1)$$

$$V_{ROW-RTA}(i, j, t) = YP(j, t), \text{ if } j \text{ belong to } RTA \text{ and } i \text{ does not} \\ = 0, \text{ otherwise} \quad (2)$$

$$V_{RTA-RTA}(i, j, t) = \text{Min}\{YP(i, t), YP(j, t)\}, \text{ if } i \text{ and } j \text{ belong to } RTA \\ = 0, \text{ otherwise} \quad (3)$$

To take account of anticipation effects from the beginning of the negotiation of the RTA to the end of the first year of existence, we have to start the analysis a certain number of years before the date of entry into force. We arbitrarily choose ten years, which is sufficient to capture any anticipation effect.¹⁷ Under this hypothesis, the RTA variables become:

$$\tilde{V}_{RTA-ROW}(i, j, t) = YP(i, t) + 10, \text{ if } i \text{ belongs to } RTA \text{ and } j \text{ does not} \\ = 0, \text{ otherwise} \quad (4)$$

$$\tilde{V}_{ROW-RTA}(i, j, t) = YP(j, t) + 10, \text{ if } j \text{ belongs to } RTA \text{ and } i \text{ does not} \\ = 0, \text{ otherwise} \quad (5)$$

$$\tilde{V}_{RTA-RTA}(i, j, t) = \text{Min}\{YP(i, t), YP(j, t)\} + 10, \text{ if } i \text{ and } j \text{ belong to } RTA \\ = 0, \text{ otherwise.} \quad (6)$$

B. The Two-step Estimation Approach

We propose a two-step estimation approach in which a gravity model not including any RTA variables is estimated in the first-step, and then the trade residuals are extracted and used in second step to run a kernel regression using the RTA variables. As discussed in the introduction, many recent papers have revisited the econometric tools to rigorously estimate the gravity equation. This paper takes

¹⁷Freund and McLaren (1999) estimate this period to be approximately 12 years.

stock of these developments and uses the state-of-the-art fixed-effects and random-effects formulations for the first-step. This approach provides the flexibility necessary to update the trade effects of any RTA as trade economists continue to explore the best way to estimate the gravity model.

The fixed-effects specification of the gravity model generally provides efficient and consistent estimators, although the impact of some trade determinants is ripped out depending on the specific fixed-effects included in the gravity equation. For instance, a country-pair fixed effects will rip off geographical variables like bilateral distance, common language, common currency... Baldwin and Taglioni (2006) propose the following improvements to the way the fixed-effect gravity model are specified: use unidirectional trade flows and include country-pair and time dummy variables, or country-time dummy variables. Their preferred specification is to include both country-pair and country-time dummy, although they acknowledge that since most of the trade policies examined by trade economists are country-pair specific, this approach alters the estimation of the trade impact of these policies. Against this backdrop, we propose an exporter-year fixed-effects specification with the inclusion of some bilateral geographical variables to partially control for the omitted country-pair dummies:

$$\ln X_{ijt} = a_0 \ln Dist_{ij} + a_1 \ln GDP_{jt} + a_2 \ln POP_{jt} + a_3 \ln INFRA_{jt} + a_4 \ln REM_{jt} + a_5 \ln RER_{ijt} + \sum_k b_k Geo_{ij}^k + c_0 FE_{it} + \delta_0 + \varepsilon_{ijt} \quad (7)$$

where X_{ijt} is country i 's export to country j at period t , $Dist_{ij}$ is the distance between country i and j , GDP_{jt} is the GDP of country j in year t , POP_{jt} is the population of country j in year t , $INFRA_{jt}$ is a proxy for country's j infrastructure stock in year t , REM_{jt} is remoteness variable suggested by Baier and Bergstrand (2002), RER_{ijt} is a measure of the real exchange rate between country i and j in year t , FE_{it} is the exporter-year fixed effects, Geo_{ij}^k is a set of k geographical variables, d_0 is an

¹⁸We use the formulation proposed by Carrere (2006) to estimate the remoteness variable:

$$REM_{jt} = \left[\sum_{k=1, k \neq j}^N GDP_{kt} \times (Dist_{ik})^{1-\sigma} \right]^{1/1-\sigma}, \text{ with } N \text{ being the total number of countries and } \sigma = 4.$$

The real exchange rate variable is inspired by Soloaga and Winters (2000):

$RER_{ijt} = (e \times \Pi_{US,t} / \Pi_{i,t}) \cdot (e \times \Pi_{US,t} / \Pi_{j,t})$ where e is the value of 1 US \$ evaluated in the currency of country i and Π is the GDP deflator. Note that GDP_{it} , POP_{it} and $INFRA_{it}$ are not included in equation (7) because their effects are ripped off by the inclusion of the exporter-year fixed effects FE_{it} .

intercept common to all years and country-pairs and ε_{ijt} is the error term.¹⁸ The geographical variables included are: contiguity, landlockedness, common colonizer, and common language.

Because some time-invariant variables cannot be estimated in a fixed-effects specification, their effects are compounded in the error term, which would affect our proposed evaluation of the RTAs trade impact using trade residuals. Carrere (2006) proposes a Hausman-Taylor specification using country-specific random effects and correcting for the endogeneity of some regressors to ensure that the random effects are not correlated with them. Furthermore, she proposes to add three selection variables to correct for the unbalancedness of the panel: the number of years each country-pair is present in the database ($PRES_{ij}$), a dummy variable indicating that a country-pair is present in the database for the entire period (DD_{ij}), and a dummy variable indicating that a country-pair in the database in year t was also in the database in $t-1$ (PA_{ijt}).¹⁹ The specification used is the following:

$$\begin{aligned} \ln X_{ijt} = & \alpha_0 \ln Dist_{ij} + \alpha_1 \ln GDP_{it} + \alpha_2 \ln GDP_{jt} + \alpha_3 \ln POP_{it} + \\ & \alpha_4 \ln POP_{jt} + \alpha_5 \ln INFRA_{it} + \alpha_6 \ln INFRA_{jt} + \alpha_7 \ln REM_{it} + \\ & \alpha_8 \ln REM_{jt} + \alpha_9 \ln RER_{ijt} + \alpha_{10} PRES_{ij} + \alpha_{11} DD_{ij} + \alpha_{12} PA_{ijt} + \\ & \delta_1 + \sum_k \beta_k Geo_{ij}^k + c_1 RE_{ij} + \eta_{ijt} \end{aligned} \quad (8)$$

where RE_{ij} represents the random effects and η_{ijt} is the error term. The estimated residuals of equations (7) and (8) are extracted and used in the second step for the non-parametric part of the estimation.

To simply describe the kernel regression used in the second step, let us imagine a scatter plot depicting the estimated trade residuals ($\hat{\varepsilon}_{ijt}$ and $\hat{\eta}_{ijt}$) against one of the three RTA variables ($\tilde{V}_{RTA-ROW}(i, j, t)$, $\tilde{V}_{ROW-RTA}(i, j, t)$, or $\tilde{V}_{RTA-RTA}(i, j, t)$). When the RTA variable equals to 1, consider the average trade residuals for all the country-pairs bunched up as described in subsection A of this section. For the RTA variable equal to 2, consider the average trade residuals for all the country-pairs bunched up, and so on. As for these average trade residuals, the goal of the kernel regression is to evaluate the non-parametric function $f(\cdot)$ underlining the variation of $\hat{\varepsilon}_{ijt}$ ($\hat{\eta}_{ijt}$) in accordance with $\tilde{V}_{RTA-ROW}(i, j, t)$, $\tilde{V}_{ROW-RTA}(i, j, t)$, or $\tilde{V}_{RTA-RTA}(i, j, t)$ by using a kernel estimator, that is defined as:

¹⁹We also include these three variables in the fixed-effects specification for the sake of comparability of the estimated trade residuals.

$$E(\varepsilon_{ijt}|V_{RTA-ROW}(i, j, t)) = \hat{f}(V_{RTA-ROW}(i, j, t)) \quad (9)$$

$$E(\varepsilon_{ijt}|V_{ROW-RTA}(i, j, t)) = \hat{f}(V_{ROW-RTA}(i, j, t)) \quad (10)$$

$$E(\varepsilon_{ijt}|V_{RTA-RTA}(i, j, t)) = \hat{f}(V_{RTA-RTA}(i, j, t)) \quad (11)$$

with:

$$\hat{f}(x) = \frac{\sum_{i=1}^n K(x_i) \cdot \hat{\varepsilon}_{ijt} / \gamma_n}{\sum_{i=1}^n K(x_i) / \gamma_n} \quad (12)$$

where n is the number of observations, γ_n is an a-priori chosen sequence of positive numbers called the window width parameter and $K(\cdot)$ is an a-priori chosen real function called the kernel, and satisfying $\int |K(x)| dx < \infty$ and $\int |K(x)| dx = 1$. Bierens (1994) analyses the asymptotic property of this estimator, and shows that it is asymptotically normal, that is:

$$\sqrt{n}[\hat{f}(x) - f(x)] \rightarrow N(0, V(x)) \quad (13)$$

where $V(x)$ depends on the characteristics of the kernel function $K(x)$. Bierens (1994) shows that the specific choice of the kernel function is not crucial since any Gaussian kernel would be relevant.²⁰ More important is the choice of the bandwidth that controls the trade-off between bias and variance of the estimated trade effects. Since the RTA variables are discrete variables (number of years of participation), we choose a bandwidth $\gamma_{n=1}$ so as to smooth trade effects over a one-year period. We also run the kernel regression using $\gamma_{n=0.5}$ and $\gamma_{n=1.5}$ for robustness check. Bierens (1994) describes in detail how to use equation (13) to directly build the Confidence Interval of the estimated trade effects, which we use to build the confidence interval of our estimated trade impacts.

IV. Empirical Analysis

Our database encompasses the IMF DOTS trade database over 1962-2006 with

²⁰It could be argued that the asymptotic properties derived by Bierens do not necessarily holds for an estimated variable such as the trade residuals used here. The alternative is to use a bootstrap approach to replicate the estimated residuals and then derive the confidence interval. We conducted this approach for a subset of RTAs and the derived confidence interval were barely different from those obtained using Bierens asymptotic results.

the following data from the World Bank WDI database: GDP, population, exchange rates and number of telephone lines used as a proxy for countries' stock of infrastructures.²¹ The missing observations of the WDI variables were replaced by approximating them using the trend of the time series whenever enough data allowed it. This provides the largest database ever used to evaluate the trade impact of RTAs: 24,014 country-pairs over 45 year with some gaps for some country-pairs, yielding 428,374 observations. The final database is an unbalanced panel containing 176 exporters and 180 importers over the period 1962-2006.

Since unbalanced panels can induce some selection bias in the estimated trade effects, we use the correction method proposed by Nijman and Verbeek (1992) and used in Carrere (2006) to correct the trade impact of RTAs from this bias by including the three selection variables $PRES_{ijt}$, DD_{ijt} and PA_{ijt} as in equation (8). Furthermore, because the time-span of the panel we use is quite long (45 years), we need to make sure that any unit root problem is ruled out since such situation would lead to spurious estimates. We tested the GDP, population, real exchange rates and infrastructure series by simply running an $AR(1)$ model of these series and using a Wald test to test for a correlation coefficient different from 1, which helped to rule out the existence of unit roots. Finally, we tested the endogeneity of regressors as requested by a Hausman-Taylor specification by performing a Durbin-Wu-Hausman endogeneity test on all the regressors. The GDP and infrastructures variables were found to be the time-dependent endogenous regressors, while the variables distance, contiguity, common colonizer and common languages were found to be the time-invariant endogenous regressors. The Hausman-Taylor specification corrects for these endogeneity problems.

In the second step, we extracted the estimated trade residuals from equations (7) and (8), and run a kernel regression as described in subsection B of section III. We then used equation (13) to build the confidence interval as follows: for each grid point, we consider the standard deviation (σ) from equation (13) and use it to compute the 95% confidence interval of the trade effects defined as $\pm 1.96 \times \sigma$, where $\sigma = \sqrt{1/(12n)}$, n being the total number of years of existence of a given RTA and $1/12$ being the variance of the uniform distribution.²² The results are presented graphically in Appendix. For the sake of robustness check, we also run the kernel regressions using respectively a bandwidth of 0.5 and 1.5 and found

²¹We did not use the composite infrastructure used by Carrere (2006) following Limao and Venables (2001) because we couldn't replicate them for period 1962-2006 due to too many missing observations.

²²See Bierens (1994) for a full explanation of this process.

Table 3. Estimations of the Gravity Equation

	Dependent variable: $\text{Ln}X_{ijt}$	
	Fixed-Effects	Hausman-Taylor
lnDist_{ij}	-1.23 ^a (-283.03)	-2.17 ^a (-7.70)
lnGDP_{it}		1.47 ^a (107.31)
lnGDP_{jt}	0.55 ^a (118.90)	0.60 ^a (61.31)
lnPOP_{it}		-0.67 ^a (-32.69)
lnPOP_{jt}	-0.04 ^a (-14.88)	0.13 ^a (7.77)
lnINFRA_{it}		0.19 ^a (27.07)
lnINFRA_{jt}	0.23 ^a (56.93)	0.20 ^a (32.60)
lnREM_{it}		0.23 ^a (10.26)
lnREM_{jt}	0.01 ^b (3.01)	0.01(1.20)
lnRER_{ijt}	-0.01 ^a (-13.47)	-0.06 ^a (-34.60)
PRES_{ij}	0.05 ^a (102.96)	0.04 ^a (5.77)
DD_{ij}	0.29 ^a (27.13)	0.65 ^a (2.61)
PA_{ijt}	1.11 ^a (71.38)	0.49 ^a (62.69)
LL_i		-0.13(-0.70)
LL_j	-0.55 ^a (-59.93)	-1.21 ^a (-6.60)
Contiguity	0.65 ^a (32.67)	15.97 ^a (3.44)
Com_colonizer	0.66 ^a (47.32)	25.52 ^a (8.18)
Com_language	0.56 ^a (58.92)	-9.79 ^a (-6.08)
Constant	0.44 ^a (6.51)	-21.54 ^a (-9.57)
Specific effects	Export-year FE	Country-pair RE
Observations	427,727	427,727
R^2	0.36	
ρ		0.97
P -value	0.00	0.00

Note: ρ is the share of the variance explained by country-pair effects

very similar results, which imply that for $\gamma_n \in [0.5; 1.5]$, the estimated trade effects are similar to the one presented in Appendix.

A. The Gravity Equation Results

The estimation results of the gravity equations are reported in Table 3. The first specification corresponds to equation (7) including exporter-year fixed effects and the second specification corresponds to equation (8) using the Hausman-Taylor specification. A parameter with an upper index a is significant at the 1% level, that with an upper index b is significant at the 5% level and that with an upper index c is significant at the 10% level. The t - or z -statistics are in brackets.

The distance and GDP variables are statistically significant and depict the

expected sign: distance negatively impacts bilateral trade flows while higher GDP induce higher trade. The Hausman-Taylor specification yields a larger trade friction due to distance than the fixed-effects estimator, but their GDP coefficients are of the same magnitude. The population variable yields different signs for both specifications, but their interpretations can be reconciled. Indeed, the fixed-effects estimator suggests that the larger the population of the importing country, the lower its imports which highlights the existence of home market discrepancy. On the other hand, the Hausman-Taylor specification indicates that the larger the population of the exporting country, the lower its exports which also suggests a home market bias. However, the Hausman-Taylor specification also shows that a larger population in the importing country boosts the exports of the exporting country given the larger demand it faces.

The infrastructure proxy confirms that the better the level of infrastructure of each trading partners, the larger trade flows through improved accessibility. The remoteness variable yields less intuitive positive coefficients, while the negative coefficient for the real exchange rate illustrates the competitiveness effect of a low exchange rate. The selection-bias variables yield statistically significant positive estimates, which suggest the relevance of their inclusion to correct for the upward bias induced by an unbalanced panel over-representing countries with a larger capacity to export. The geographical variables yield statistically significant coefficients with the expected sign, except for the unusual negative estimate of the common language dummy variable in the Hausman-Taylor specification.

Given the central place of the trade residuals in the semi-parametric approach proposed in this paper, it is very important to make sure that these residuals are not affected by omitted variables problems. The Hausman-Taylor specification is therefore a better approach since it allows controlling for all the relevant trade determinants we can think of. We tried to run a Hausman-Taylor specification including all the 22 RTAs with the three variables as described in subsection A of section III, but our quite powerful computer lacked enough capacity to do it. The semi-parametric approach proposed in this paper provides a rigorously estimated trend based on the whole database for each of the 22 RTAs. It also provides a confidence interval for each of these trends.

B. The Trade Effect of RTAs

Equation (7) and (8) are estimated respectively with an exporter-year fixed-effects estimator and a random effect (Hausman-Taylor) estimator, and the trade

residuals are extracted and used with the RTA variables to run a series of kernel regressions. Each RTA variable is computed to reflect the 10 years of anticipation suggested by Freud and McLaren (1999). The results for the 22 RTAs are presented in Appendix. In these graphs, the dashed lines represent the estimated 95% confidence interval. We also plot a bold vertical line corresponding to the date of accession of any RTA member, and a fine vertical line corresponding to 5 years before this accession. For the sake of conciseness, the following comments focus in more detail on the 9 RTAs that depict a negative intra-RTA when included in equation (8) and then overview some of the well-known RTAs. Since RTAs are expected to at least increase intra-regional trade, these nine cases help to explore more this unusual pattern.

The graphs for ArFTA indicate a positive and slightly increasing trend for the intra-RTA residuals with the exporter-year fixed effects estimator yielding a larger effect than the Hausman-Taylor specification. However, given that the fixed-effects estimator excludes all the variables that are specific to each exporter-year, we will use the Hausman-Taylor estimator as our preferred specification. ArFTA appears to have barely generated intra-regional trade while it has been having a significantly negative impact on its members' imports from the rest of the world, which suggests that it has been more trade diverting than trade creating. ArFTA exports to the rest of the world have also been negative, although with an upward trend. The graphs also suggest a slight anticipation effect on intra-ArFTA exports five year before the agreement entered into force.

BIMSTEC appears to have had an increasing negative impact on intra-BIMSTEC exports, compounded with a slightly negative trend of BIMSTEC's imports from the rest of the world. However, the RTA exports to the rest of world have a slightly positive and increasing trend, which suggests that the agreement have been more beneficial for the rest of the world than for the members. The graphs even suggest an anticipation effect on BIMSTEC exports ten years before its date of entry into force.

Intra-CACM exports appear to have been below potential for the entire existence of the RTA, whereas the RTA's imports from the rest of the world have been slightly positive and increasing, with a five-year anticipation effect. The RTA seems to have had an increasing negative impact on its members' exports to the rest of the world, suggesting a globally ineffective RTA in terms of trade impact.

CARICOM appears to have had a positive impact on its intra-regional exports and its exports to the rest of the world during its 15 first years of existence, and

then started to have a negative impact. The RTA seems to have had no impact on its members' imports from the rest of the world. The initial positive impact of the RTA on its intra-regional exports appears to have been anticipated five years before its date of entry into force.

CEMAC appears to have had a negative impact on its members' intra-regional exports as well as on their exports to and imports from the rest of the world. No anticipation effect is detectable. The graphs also show a large variability in the intra-regional trade residuals ten years before the date of entry into force of the RTA, probably reflecting the large macroeconomics imbalances that led to the devaluation of the common currency of CEMAC members in the 1990s.

Given that most of the CIS countries were part of the Soviet Union before 1990, their bilateral trade flows can not be traced for a longer period as with the other countries. Our estimations suggest that CIS have had a positive impact on its members' intra-regional early at the creation of the RTA, but faltered over time to be slightly negative. Its impact on their imports from the rest of the world seems to have been positively increasing although close to zero, and no impact is detected on its members' exports to the rest of the world.

SADC impact on its members trade appears to have been fluctuating around zero ten years before its creation and thereafter. SAPTA seems to have had a slightly positive impact on its members' intra-regional exports, but a slightly negative impact on their imports from the rest of the world. Its impact on their exports to the rest of the world appears to be null. WAEMU seems to have had a positive impact on its members' intra-regional exports although decreasing in the beginning before starting to increase 8 years after its creation. Its impact on their exports to the rest of the world was positive in the beginning, and then turned negative. These variations are probably due to the socio-political instability the leading country of this RTA (Cote d'Ivoire) has been facing from 1998 to 2003. WAEMU impact on its members' imports from the rest of the world has been slightly negative, suggesting a trade diversion.

The ASEAN free trade area appears to have had a positive impact on its members intra- and extra-regional exports, combined with a positive impact on their imports from the rest of the world during 6 years and then a null effect. This suggests that AFTA has been a quite successful RTA mostly trade creating and positively impacting the rest of the world through its extra-regional exports. The CAN and MERCOSUR also depict such positive outcome, with their impact on their members' intra-regional exports much higher than AFTA. NAFTA appears to

have been trade creating with a positive impact on its members' intra-regional exports and imports from the rest of the world. Its impact on their exports to the rest of the world is less clear-cut. The Group of Three agreement involving Colombia, Mexico and Venezuela also appears to have been a successful RTA with an estimated positive impact on its members' intra- and extra-regional exports as well as on their imports from the rest of the world. The EU appears to have had a positive impact on its members' intra-regional exports, but a less clear-cut impact on their imports to or exports from the rest of the world. By and large, the trade impacts plotted in Appendix show that most of the RTAs have had at least a slightly positive impact on their intra-regional exports. The exceptions are BIMSTEC, CACM, CEMAC, EEU and GCC.

V. Conclusion

This paper proposes two contributions to the evaluation of RTAs' trade impacts. First, we use an RTA variable that takes into account the number of years each member has participated instead of the usual RTA dummy variable. Second, we combine traditional gravity regressions with non-parametric estimation techniques so as to capture the non-monotonic trade effects while imposing minimal structure on the model. This approach provides a common ground to evaluate the trade impact of RTAs since it can easily be adjusted to the state-of-the-art technique to estimate the gravity equation and allow including any new RTA in a straightforward way.

We focus on a panel of 22 RTAs mostly involving developing countries and covering all the continents. Except for BIMSTEC, CACM, CEMAC, EEU and GCC, all these RTAs appear to have had a positive impact on their members' intra-regional exports. This work is based on the up-to-date estimation techniques of the gravity equation and the proposed semi-parametric estimation approach can be easily implemented to rigorously assess the trade impact of developing RTAs. Given the increasing number of RTA signed by developing countries with sometime a low technical capacity to deal with the complexity of computable general equilibrium trade models, this approach can be a key accessible and rigorous diagnostic tool to evaluate the prospected gains from these agreements.

Acknowledgments

I thank Jeffrey Bergstrand, Paul Brenton, Marius Brühlhart, Celine Carrère, Renato Flores, Lionel Fontagné, Guillaume Gaulier, Thierry Mayer, Daniel Mirza, Eric Toulemonde for helpful comments and suggestions at the various stages of this paper.

Received 12 April 2009, Revised 13 July 2009, Accepted 17 July 2009

Appendix

1. A Panel of Developing RTAs

South and East Asian and Pacific RTAs

Agreement	Full Name	Membership Evolution	Type
AFTA	ASEAN Free Trade Agreement	1992: Brunei Darussalam	Political Association
		1992: Indonesia	
		1992: Malaysia	
		1992: Philippines	
		1992: Singapore	
		1992: Thailand	
		1995: Vietnam	
		1997: Laos	
		1997: Myanmar	
		1999: Cambodia	
Agreement	Full Name	Membership Evolution	Type
SAPTA	South Asia Preferential Trade Agreement	1993: Bangladesh	Preferential Agreement
		1993: Bhutan	
		1993: India	
		1993: Maldives	
		1993: Nepal	
		1993: Pakistan	
		1993: Sri Lanka	
Agreement	Full Name	Membership Evolution	Type
BIMSTEC	Bangladesh India Myanmar Sri Lanka Thailand Economic Cooperation	1997: Bangladesh	Preferential Agreement
		1997: Myanmar	
		1997: India	
		1997: Sri Lanka	
		1997: Thailand	

Agreement	Full Name	Membership Evolution	Type
SPARTECA	South Pacific Regional Trade and Economic Cooperation Agreement	1981: Australia	Preferential Agreement
		1981: Cook Islands	
		1981: Fiji	
		1981: Kiribati	
		1981: Marshall Islands	
		1981: Micronesia	
		1981: Nauru	
		1981: New Zealand	
		1981: Papua New Guinea	
		1981: Solomon Islands	
		1981: Tonga	
		1981: Vanuatu	
		1981: Samoa	

Western Hemisphere RTAs

Agreement	Full Name	Membership Evolution	Type
CACM	Central American Common Market	1990: El Salvador	Customs Union
		1990: Guatemala	
		1990: Honduras	
		1990: Nicaragua	
		1990: Dominican Republic	
		1990: Costa Rica	

Agreement	Full Name	Membership Evolution	Type
CAN	Andean Community	1988: Bolivia	Preferential Arrangement
		1988: Columbia	
		1988: Ecuador	
		1988: Peru	
		1988: Venezuela	

Agreement	Full Name	Membership Evolution	Type
MERCOSUR	Southern Common market	1991: Argentina	Customs Union
		1991: Brazil	
		1991: Paraguay	
		1991: Uruguay	

Agreement	Full Name	Membership Evolution	Type
CARICOM	Caribbean Community and Common Market	1973: Antigua and Barbuda	Political Association
		1973: Bahamas	
		1973: Barbados	
		1973: Belize	
		1973: Dominica	
		1973: Grenada	
		1973: Guyana	
		1973: Haiti	
		1973: Jamaica	
		1973: Montserrat	
		1973: St. Vincent and the Grenadines	
		1973: St. Kitts and Nevis	
		1973: St. Lucia	
		1973: Suriname	
		1973: Trinidad and Tobago	

Agreement	Full Name	Membership Evolution	Type
GOT	Group of Three	1995: Colombia	Preferential Agreement
		1995: Mexico	
		1995: Venezuela	

Sub-Saharan African RTAs

Agreement	Full Name	Membership Evolution	Type
ECOWAS	Economic Community of West Africa	1975: Benin	Political Association
		1975: Burkina Faso	
		1975: Cape Verde	
		1975: Côte d'Ivoire	
		1975: Gambia	
		1975: Ghana	
		1975: Guinea	
		1975: Guinea Bissau	
		1975: Liberia	
		1975: Mali	
		1975: Niger	
		1975: Nigeria	
		1975: Senegal	
		1975: Sierra Leone	
		1975: Togo	

Agreement	Full Name	Membership Evolution	Type
SADC	South African Development Community	1992: Angola	Political Association
		1992: Botswana	
		1992: DR Congo	
		1992: Lesotho	
		1992: Malawi	
		1992: Mauritius	
		1992: Mozambique	
		1992: Namibia	
		1992: Seychelles	
		1992: South-Africa	
		1992: Swaziland	
		1992: Tanzania	
		1992: Zambia	
		1992: Zimbabwe	
Agreement	Full Name	Membership Evolution	Type
CEMAC	Economic and Monetary Community of Central Africa	1999: Cameroon	Preferential Arrangement
		1999: Central African Republic	
		1999: Chad	
		1999: Congo	
		1999: Equatorial Guinea	
		1999: Gabon	
Agreement	Full Name	Membership Evolution	Type
EAC	East African Community	2000: Kenya	Free trade Arrangement
		2000: Tanzania	
		2000: Uganda	
		2000: Burundi	
		2000: Rwanda	
Agreement	Full Name	Membership Evolution	Type
SACU	Southern Africa Customs Union	1970: Botswana	Customs Union
		1970: Lesotho	
		1970: Namibia	
		1970: South Africa	
		1970: Swaziland	

Agreement	Full Name	Membership Evolution	Type
WAEMU	West Africa Economic and Monetary Union	1994: Benin 1994: Burkina Faso 1994: Cote d'Ivoire 1994: Guinea Bissau 1994: Mali 1994: Niger 1994: Senegal 1994: Togo	Economic Union
Middle East and North Africa RTAs			
Agreement	Full Name	Membership Evolution	Type
ArFTA	Arab Free Trade Area	1997: Bahrain 1997: Egypt 1997: Iraq 1997: Jordan 1997: Kuwait 1997: Lebanon 1997: Libya 1997: Morocco 1997: Qatar 1997: Saudi Arabia 1997: Syria 1997: Tunisia 1997: United Arab Emirates	Free trade agreement
Agreement	Full Name	Membership Evolution	Type
GCC	Gulf Cooperation Council	1981: Bahrain 1981: Kuwait 1981: Oman 1981: Qatar 1981: Saudi Arabia 1981: United Arab Emirates	Political Association
Agreement	Full Name	Membership Evolution	Type
AMU	Arab Maghreb Union	1989: Morocco 1989: Algeria 1989: Tunisia 1989: Mauritania 1989: Libya	Political Association

Europe and Central Asian RTAs

Agreement	Full Name	Membership Evolution	Type
CIS	Commonwealth of Independent States	1991: Armenia	Political Association
		1991: Azerbaijan	
		1991: Belarus	
		1991: Georgia	
		1991: Kyrgyzstan	
		1991: Moldova	
		1991: Russia	
		1991: Tajikistan	
		1991: Ukraine	
		1991: Uzbekistan	
		1991: Kazakhstan	
		1991: Turkmenistan	
Agreement	Full Name	Membership Evolution	Type
EEU	Eurasian Economic Union	2000: Russia	Political Association
		2000: Armenia	
		2000: Kazakhstan	
		2000: Kyrgyzstan	
		2000: Tajikistan	

2. Graphs

AFTA Estimated Trade Impact

SAPTA Estimated Trade Impact

BIMSTEC Estimated Trade Impact

SPARTECA Estimated Trade Impact

CACM Estimated Trade Impact

CAN Estimated Trade Impact

MERCOSUR Estimated Trade Impact

NAFTA Estimated Trade Impact

CARICOM Estimated Trade Impact

GOT Estimated Trade Impact

ECOWAS Estimated Trade Impact

SADC Estimated Trade Impact

CEMAC Estimated Trade Impact

EAC Estimated Trade Impact

SACU Estimated Trade Impact

WAEMU Estimated Trade Impact

ArFTA Estimated Trade Impact

GCC Estimated Trade Impact

AMU Estimated Trade Impact

EU Estimated Trade Impact

CIS Estimated Trade Impact

EEU Estimated Trade Impact

References

- Aitken, N.(1973), "The Effect of the EEC and EFTA on European Trade: a Temporal Cross-Section Analysis", *American Economic Review*, 63, pp. 881-892.
- Anderson, J. E., van Wincoop, E.(2003), "Gravity with Gravitas: a Solution to the Border Puzzle", *American Economic Review*, 93, pp. 170-192.
- Baier, S. L., Bergstrand, J. H.(2002), "On the Endogeneity of International Trade Flows and Free Trade Agreements", *American Economic Association Annual Meeting*.
- Baier, S. L., Bergstrand, J. H., Vidal, E.(2007), "Free Trade Agreements in the Americas: are the Trade Effects Larger than Anticipated?", *World Economy*, 30(9), pp. 1347-77.
- Bierens, H. J.(1994), *Topics in Advanced Econometrics*, Cambridge University Press.
- Baldwin, R., Taglioni, D.(2006), "Gravity for Dummies and Dummies for Gravity Equations", *NBER working papers* No. 12516.
- Carrere, C.(2006), "Revisiting the Effects of Regional Trade Agreements on Trade Flows with Proper Specification of the Gravity Model", *European Economic Review*, 50, pp. 223-247.
- Cernat, L.(2001), "Assessing Regional Trade Arrangements: Are South-South RTAs More Trade Diverting?", *Global Economy Quarterly*, 2(3), pp. 235-59.
- Cheng, I. H., Wall, H. J.(2005), "Controlling for Heterogeneity in Gravity Model of Trade

- and Integration", *The Federal Reserve Bank of St. Louis Review*, 87(1), pp. 49-63.
- Dee, ph., Gali, J.(2003), "The Trade and Investment Effect of Preferential Trade Arrangements", *NBER Working Paper* No. 10160, 2003.
- Egger, P.(2000), "A Note on the Proper Econometric Specification of the Gravity Equation", *Economics Letters*, 66(1), p. 25-31.
- Egger, P., Pfaffermayr, M.(2003), "The Proper Panel Econometric Specification of the Gravity Equation: a Three-Way Model with Bilateral Interaction Effects", *Empirical Economics*, 28(3), p. 571-80.
- Elliot, R., Ikemoto, K.(2004), "AFTA and the Asian Crisis: Help or Hindrance to the ASEAN Intraregional Trade?", *Asian Economic Journal*, 18(1), p. 1-10.
- Feenstra, R.(2004), *Advanced International Trade: Theory and Evidence*, Princeton, N.J.: Princeton University Press.
- Freund, C. L., McLaren, J.(1999), "On the Dynamics of Trade Diversion: Evidence from Four Trade Blocs", *International Finance Discussion Paper* no. 637.
- Ghosh, S., Yamarik, S.(2004), "Are Regional Trading Arrangements Trade Creating? An application of Extreme Extreme Bounds Annalysis", *Journal of International Economics*, 63(2), pp. 369-395.
- Krueger, A.(1999), "Trade Creation and Trade Diversion under NAFTA", *NBER Working Paper* No. 7429.
- Limao, N., Venables, A. J.(2001), "Infrastructure, Geographical Disadvantage, Transport Costs, and Trade", *World Bank Economic Review*, 15(3), pp. 451-79.
- Martinez-Zarsoso, I., Nowak-Lehman, F.(2003), "Augmented Gravity Model: an Empirical Application to MERCOSUR-EU Trade Flows", *Journal of applied economics*, 6(2), pp. 291-316.
- Matyas, L.(1997), "Proper Econometric Specification of the Gravity Model", *The World Economy*, 20, p. 363-368.
- Matyas, L.(1998), "The Gravity Model: Some Econometric Considerations", *The World Economy*, 21(3), p. 397-401
- Nijman, T., Verbeck, M.(1992), Incomplete Panels and Selection Bias, In: Matyas, L., Sevestre, P. (Eds), *The Econometrics of Panel Data*. Kluwer, Dordrecht, pp. 262-302.
- Rose, A.(2003), "Does the WTO Make Trade More Stable?", *NBER Working Paper* No. 10207.
- Schiff, M., Winters, A.(2003), *Regional Integration and Development*, World Bank and Oxford University Press.
- Soloaga, I., Winters, A. L.(2000), "Regionalism in the Nineties: What Effect on Trade?", *North American Journal of Economics and Finance*, 12(1), pp. 1-29.
- UNCTAD(2000), *Globalization, Regionalism and Africa's Development Agenda*. Geneva.