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An Evaluation of Swiss Free Trade Agreements Using Matching Econometrics*

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To date, most estimates of the effects of free trade agreements (FTAs) on international trade flows have used the gravity equation in international trade, but have often yielded highly “fragile” estimates. This paper instead employs a non-parametric “matching” statistical estimation technique of BAIER and BERGSTRAND (2009), using methods developed by ABADIE and IMBENS (2006), to evaluate *ex post* the impact of Swiss FTAs on Swiss trade flows, including notably the recent Switzerland-Mexico Free Trade Agreement (FTA) on Swiss-Mexico trade flows. The main empirical finding is that the Swiss-Mexico FTA of 2001 increased bilateral trade about 37 percent, after only four years in place. This result is consistent with the impacts (over 10–15 years) of other Swiss FTAs. Moreover, these results are consistent with the findings in BAIER and BERGSTRAND (2007) using parametric panel techniques and with those in BAIER and BERGSTRAND (2009) using matching econometrics that the likely impact of such an agreement on Swiss-Mexico trade after 10–15 years should be approximately 100 percent.

JEL Codes: F10, F13, F15

Keywords: International Trade, Free Trade Agreements, Matching Econometrics

Introduction

Switzerland’s economic welfare is very dependent on international trade and consequently Switzerland benefits from an economic policy that encourages open and predictable market access to economies around the world. Swiss trade policy currently rests upon three main pillars: World Trade Organization (WTO) membership, bilateral agreements with the European Union (EU), and bilateral agreements with non-EU countries. Hence, free trade agreements (FTAs) with non-EU countries are important dimensions of Swiss trade policy, especially since there has been a proliferation of regional and bilateral FTAs around the world since the late 1980s among countries with which Switzerland competes economically that provides potential diversion of trade from Switzerland by such countries. Currently Switzerland has several FTAs with countries in Europe and on other continents.

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However, the “formation” of an FTA is not a costless process, requiring extensive negotiations and commitments of economic resources to attain these. With approximately 200 countries in the world, a “roadmap” for pursuing future FTAs that can have the greatest potential economic gains for Switzerland would be useful. Clearly, the goal of an FTA is to enlarge trade. Hence, a productive new FTA should maximize “trade creation” (or new trade among members) and minimize “trade diversion” (the reduction of existing trade of members with non-members).

Such a roadmap is provided by examining *ex post* the effects of past Swiss FTAs on Swiss trade (and potentially then on national economic output). Heretofore, many countries have examined the *ex ante* effects of FTAs on countries’ trade using computable (theoretical) general equilibrium models (“theory with numbers”). However, economic research on the *ex post* evaluation of FTAs has advanced considerably in the past decade, providing additional insights on the “effects” of FTAs on trade flows, holding constant other factors that might influence trade. Thus, the potential exists for using estimates of past agreements’ effects on trade to help predict the trade increases associated with future agreements, generating useful information toward finding a “roadmap” for future Swiss FTAs.

This paper summarizes the results of an *ex post* evaluation of the effects of Swiss bilateral FTAs on Swiss bilateral trade flows and, in particular, the effect of the Switzerland-Mexico FTA on trade between that pair of countries. The methodology employs a (non-parametric) “matching” statistical estimation technique; this technique is similar to that used in medical studies to determine the effects of new drugs on patients. The researcher compares the outcome of (ideally) identical individuals – one with the treatment and one without the treatment – to ascertain the “effect” of the treatment on individuals. Clearly, a critical issue is finding individuals that are “identical” in order to examine the pure effect of treatment.

The remainder of this note has three sections. Section II describes in more detail the statistical technique, and compares its ability to isolate the “treatment effect” against alternative parametric techniques. Section III provides the baseline results of estimating the *ex post* effect of the Switzerland-Mexico FTA on the two countries’ trade. Section IV provides three results: an *ex post* estimate of the effect of all Swiss FTAs on Swiss trade; an *ex ante* estimate of the effect of the Switzerland-Mexico FTA on their trade *assuming* Mexico’s real gross domestic product (GDP) was twice its actual level;

and an *ex ante* estimate of the effect of a (potential) Switzerland-Colombian FTA. Section V concludes.

Methodology

Recent research has started to explore in more systematic detail using econometric techniques and data from the past fifty years the (*ex post*) effects of FTAs on (bilateral) trade flows. There are two (exhaustive) categories for such investigation: parametric methods and non-parametric methods. Parametric methods use standard regression techniques, notably ordinary least squares (OLS) employing year-by-year cross-sectional data or panel data (over time and across country-pairs). OLS regressions typically have specifications generated by “gravity equations,” which now have well-developed general equilibrium economic theoretical foundations for explaining trade flows, cf., ANDERSON (1979), BERGSTRAND (1985), EVENETT and KELLER (2002), ANDERSON and VAN WINCOOP (2003), BAIER and BERGSTRAND (2009a); see ANDERSON and VAN WINCOOP (2004), EVENETT and HUTCHINSON (2002), FEENSTRA (2002), and BAIER, BERGSTRAND, EGGER and MCLAUGHLIN (2008) for useful surveys.

For estimating the effects of FTAs on trade flows, two important issues have surfaced this past decade that required due attention for estimating precise and robust measures of the effect of FTAs on trade flows. First, traditional (parametric) gravity equations typically focused on a pair of countries’ GDPs, bilateral distance, and some other measures of bilateral trade costs for explaining trade flows, including a binary (or “dummy”) variable to represent the presence or absence of an FTA. Most estimation ignored (basically, assumed away) that bilateral trade flows are influenced by economic factors in the *rest-of-the-world* (ROW). FEENSTRA (2002), ANDERSON and VAN WINCOOP (2003) and BAIER and BERGSTRAND (2007, 2009a) provide methods based upon economic theory for addressing systematically this estimation shortcoming, cf., BAIER, BERGSTRAND, EGGER and MCLAUGHLIN (2008) for a useful discussion. Second, one cannot treat the FTA dummy variable as “exogenous” to the trade flows; pairs of countries whose governments form FTAs do so because of the expected changes in trade flows. That is, country-pairs *self-select* into FTAs based upon existing (and expected future) trade patterns. By not accounting for self-selection, traditional methods for estimating trade-effects of FTAs underestimate their impact. Using parametric techniques, evidence indicates that the best way to alleviate selection bias is to use panel data, cf., BAIER and BERGSTRAND

(2007) and BAIER, BERGSTRAND, EGGER and MCLAUGHLIN (2008). Most parametric methods for addressing selection bias using (long-run) cross-sectional data (such as instrumental variables) can lead to unstable results, cf., BAIER and BERGSTRAND (2007).

An alternative method for estimating long-run (partial) effects of FTAs on trade flows using cross-sectional data is to use “non-parametric” techniques. Non-parametric techniques are common to the medical literature. Take two individuals who are (ideally or virtually) identical in every characteristic except treatment (say, taking a new drug), provide one with treatment, and monitor both of their outcomes. The same method can be applied to pairs of countries. If one could identify, say, two pairs of countries that are virtually identical in all economic characteristics (that essentially matter for determining trade flows) but only one pair has an FTA and the other no FTA (a “No-FTA” pair), then in theory the difference in their trade flow levels should estimate the “effect” of an FTA. This is the principle behind the exercise in this study.

While the concept of measuring an FTA “treatment effect” appears simple, as one saying goes “the devil is in the details.” Two major issues have precluded the actual implementation of non-parametric estimation of FTA effects. First, while the literature on matching econometrics is well established, the large-sample properties of matching estimators were not established until just recently, cf., ABADIE and IMBENS (2006). However, ABADIE and IMBENS (2006) advanced our understanding of the large-sample properties of such estimators. Second, the determination of pairs of economies with “virtually identical” economic characteristics (that essentially matter for determining trade flows) except for treatment requires some theoretical guidance. However, advances in the theoretical general equilibrium economic foundations for the “gravity equation” for explaining bilateral international trade flows provide guidance for identifying pairs of countries that “match” (or “matched pairs”), cf., BAIER and BERGSTRAND (2009a, 2009b). Essentially, one can largely identify the economic determinants of bilateral trade flows between country-pairs using the product of their GDPs, dummy variables for a common land border and common language, bilateral distance, and (simple- or GDP-weighted) averages of each country’s distance, adjacency, and language with respect to the *ROW*, cf., BAIER and BERGSTRAND (2009a, 2009b) for a detailed economic and statistical discussion.

Baseline Empirical Results

For the purposes of this study, the baseline empirical results use the methodology just discussed (econometric details in BAIER and BERGSTRAND, 2009b) for an application first to evaluate of the Switzerland-Mexico FTA; in the next section, we examine results for other Swiss FTAs using the sample described in BAIER and BERGSTRAND (2009b). In this section, we discuss three alternative estimates of the (*ex post*) effect of the Switzerland-Mexico FTA, which was implemented in 2001. The first is based upon selecting Switzerland-Colombia as a matched pair. The second is based upon the Abadie-Imbens “matching” estimator. The third is based upon an alternative non-parametric estimator referred to as a “propensity-score” approach.

The most recent year for which systematic data on bilateral trade flows (the IMF’s *Direction of Trade Statistics*) is 2005; full data for 2006–2008 were not yet available. This means that any empirical estimate for an FTA only captures an effect *after 4 years*. As discussed in BAIER and BERGSTRAND (2007, 2009b), it takes about 10–15 years for an FTA’s effect on trade to likely fully surface, as most FTAs are “phased-in” over a period of several years¹ and also the trade responses of producers and consumers to different terms-of-trade take several years to fully manifest. Also, BAIER and BERGSTRAND (2007, 2009b) show that the typical (partial) effect of an FTA is 100 percent after 10-15 years. (Moreover, previous estimates indicate only a permanent level, not growth, effect.) Hence, any estimates in this section would tend to *underestimate* their full (partial) effects by 50–67 percent, since 4 years is approximately one-half to one-third of a 10–15 year period.²

At first glance, Switzerland-Colombia appears to be a reasonable control pair because one of the countries is Switzerland itself and each of the other countries (Mexico, Colombia) is approximately the same bilateral distance from Switzerland and has a different primary language than Switzerland. However, a comparison of the (sum of the) bilateral trade flows in 2005 of the two country pairs reveals that Switzerland-Mexico trade was (US) \$1231

1 In the case of the Switzerland-Mexico FTA, we are using the EFTA-Mexico Agreement that went into force July 1, 2001. Article 6 states that customs duties on products were eliminated immediately, with the exception of products listed in Annexes III, IV, and V.

2 The term “partial effect” means “excluding any general equilibrium effects.” In general, a bilateral FTA changes – not just relative prices of the pair’s trade flows but – prices throughout the world economy, now often termed “multilateral resistance (or price)” levels. The changes in these multilateral prices would tend to dampen (or offset) the partial effects; addressing these general-equilibrium effects is beyond the scope of this note. See ANDERSON and VAN WINCOOP (2003) and BAIER and BERGSTRAND (2009a) for general-equilibrium estimates accounting for such multilateral resistance changes.

million but Switzerland-Colombia trade was \$328 million. This implies that the partial effect of the Switzerland-Mexico FTA was 275 percent, which seems infeasible after 4 years (and even after 10–15 years). The infeasibility of this estimate suggests a more economically and statistically grounded empirical estimate is warranted.

The first alternative estimate considered is based upon the Abadie-Imbens (A-I) matching estimator. While the economic and statistical details for this methodology are discussed in BAIER and BERGSTRAND (2009b), we summarize intuitively the approach. First, country pairs with FTAs tend to be larger and more similar in economic sizes (GDPs), tend to be closer, tend to have common languages and land borders (adjacency), and tend to have similar “multilateral resistance” levels (discussed earlier). Consequently, appropriate matched pairs for Switzerland-Mexico would be ones with these similar economic characteristics (that both theory and empirical analysis suggest explain trade flows). Using the A-I matching estimator, 4 country-pairs that are the best matches³ (the so-called “nearest neighbors”) are China-Venezuela, France-Venezuela, Syria-USA, and Mexico-Turkey (all without FTAs). The trade of these four nearest neighbors in 2005 was \$901 million. Compared with Switzerland-Mexico trade of \$1232 million, this suggests a partial effect of 37 percent (after 4 years). Such an estimate seems quite plausible, in light of the short-time-period since the FTA’s formation and the omission of general equilibrium effects.

To evaluate the robustness of this approach, we also considered an alternative non-parametric approach, the so-called “propensity-score” (P-S) technique. The P-S technique is similar to the A-I technique, except that “matching” country-pairs (with and without FTAs) is based upon a single metric, the “propensity score,” which is estimated in a first stage. The propensity score is a (nonlinear probit or logit) function of several observable variables and essentially measures the probability of being in an FTA, cf., BAIER and BERGSTRAND (2004). The economic variables determining the probability are the same as those upon which pairs are “matched” using the A-I technique (that is, the economic determinants of trade flows). The benefit of the P-S approach is that matching is done based upon a single variable, avoiding the “curse of (high) dimensionality.” The potential cost of the approach is being a less precise matching procedure. However, it does provide an estimate of the robustness of the A-I estimate. Using the P-S matching estimator, 4 country-pairs that are the best matches (“nearest

3 The best matches are determined using the Mahalanobis minimum-distance metric.

neighbors”) are Argentina-Thailand, Egypt-Singapore, Spain-Australia, and Turkey-Nigeria. The trade of these four nearest neighbors in 2005 was \$673 million. Compared with Switzerland-Mexico trade of \$1232 million, this suggests a partial effect of 83 percent (after 4 years). Such an estimate is considerably higher than that using the A-I estimator and less plausible economically.

We believe that the most reasonable estimate of the FTA effect is the A-I estimate of 37 percent. However, recall that this is based upon 4 years only. A ready estimate of the full (partial) effect would be about three times this (or 111 percent), based upon previous papers’ results that the full effect takes about 10–15 years to manifest. However, as discussed briefly in footnote 2, such effect (111 percent) could be considerably lower once general-equilibrium considerations are accounted for (but these are outside the scope of this particular study). Nevertheless, the prediction that the Swiss-Mexico FTA would have a (partial, or direct) effect of roughly 100 percent on Swiss-Mexico trade after 10–15 years is well within the estimates found in this emerging literature, cf., BAIER and BERGSTRAND (2007, 2009b).

Sensitivity Analysis and Other Results

In this section, we discuss three additional results. First, we discuss an *ex post* estimate of the effect of all Swiss FTAs on Swiss trade. Second, we provide an *ex ante* estimate of the effect of the Switzerland-Mexico FTA on their trade *assuming* Mexico’s real gross domestic product (GDP) was twice its actual level. Third, we discuss an *ex ante* estimate of the effect of a (potential) Switzerland-Colombian FTA.

The methodology can be applied to other Swiss FTAs. We provide here only estimates based upon the A-I estimator. First, as mentioned above, evidence from earlier studies indicates that it takes about 10–15 years for a bilateral FTA to have its full (partial-equilibrium) effect on bilateral trade. The typical effect is about 100 percent after 10–15 years. Because we use data from BAIER and BERGSTRAND (2009b) to generate FTA treatment effects, a constraint is that the last year of data for that large sample of countries is year 2000. Since FTAs likely take 10–15 years to generate their effects, we only considered FTAs that were entered into *prior to 1990*. This included the 1960 European Free Trade Association (EFTA) agreements and the FTAs signed between Switzerland and the European Community (EC) members in 1973; we do not examine the 1962 admission of Finland into EFTA nor

the Iceland-Switzerland 1970 FTA (due to data constraints). Since EFTA was signed and implemented in 1960, we examine trade flows in 1975 using the technique above (which allows a 15-year effect). Using the A-I estimator, the effect of EFTA was to increase Swiss trade with those partners by 108 percent. This is very close to the typical estimate of 100 percent among all FTAs and to the 17-year effect we found specifically for the original EEC-6 members' 1958 treaty by 1975 (123 percent), cf., BAIER and BERGSTRAND (2009b). For the Switzerland-EC members' FTAs which entered into force in 1973, we examine trade flows in 1985. Based upon the A-I estimator, the effect of Swiss FTAs with the original EEC-6 members plus Ireland was 203 percent, notably due to a very large effect of trade with Germany (295 percent) along with Swiss-German trade being very large.

Second, we considered an *ex ante* estimate of what the FTA effect would be from a Switzerland-Mexico FTA *assuming Mexico's GDP was twice as large* (100 percent greater) in 2005. The methodology we used necessitated first estimating what the Swiss-Mexico bilateral trade volume would be assuming Mexico's GDP was twice as large. As we know from our knowledge of determinants of bilateral trade flows and the "gravity equation" in international trade, the potential impact of a doubling of one country's GDP size on the value of bilateral trade between two countries *everything else constant* is a doubling of the two countries' trade flow, cf., BAIER, BERGSTRAND, EGGER and MCLAUGHLIN (2008) and BAIER and BERGSTRAND (2009a). We use this conjecture to estimate the value of the trade flows between Switzerland and Mexico in 2005 (assuming Mexico's GDP is twice as large). In the second step, we use the A-I estimator to find the four "nearest (country-pair) neighbors" to Switzerland-Mexico without FTAs and compare our theoretical trade flow to the actual trade flows of the (new) nearest neighbors. The results indicated that the effect of the FTA would have been to increase trade (over four years) by 14 percent. This is a little less than half the 37 percent increase discussed earlier. Table 1 summarizes the results of this exercise. We note that it is common to find (using parametric techniques) that (partial-equilibrium) FTA effects on trade flows (in percent) tend to be smaller for country pairs that are larger; this is an empirical finding that has not been examined systematically yet. We note that only one of the nearest neighbors was the same as in the original estimates (Mexico-Turkey); the other three nearest neighbors were China-Argentina, Korea-Spain, and Argentina-Italy.

Table 1: An *ex ante* estimate of the Swiss-Mexico FTA for 2005 IF Mexico's GDP was TWICE as large as it actually was in 2005

- Step 1: We double the GDP for Mexico and recalculate the distance.
 Step 2: We extrapolate what trade would likely be if GDP doubled.
 Step 3: We search for the nearest neighbor using A-I matching.

Step 1: If GDP from Mexico doubled, the sum of logged GDP increases from 39.47259 to 40.16366.

Step 2: Given the standard finding of most gravity estimates a 1% increase in GDP leads 1% increase in trade flows. Therefore, if Mexican GDP doubled we would expect the log of trade to increase by $\ln(2)$. In 2005, IMF reports trade was from Switzerland to Mexico was 1121.88 and trade from Mexico to Switzerland was 109.54. The increase in GDP would increase Switzerland's exports to 2243.76 and imports to 219.08. The log of the sum would increase from 7.1159233 to 7.809070181.

Step 3: Compare the new A-I matching data to the four nearest neighbors.

Country 1	Country 2	Log of Summed trade	A-I difference
Switzerland	Mexico	7.81	0.00
Argentina	China, P.R.: Mainland	8.71	0.03
Spain	Korea	8.29	0.06
Mexico	Turkey	6.14	0.09
Italy	Argentina	7.57	0.10
Average Country 1	Average Country 2	7.67	

According to this measure trade would be about 14% higher. This assumes that OLS gravity estimates can be used to extrapolate the growth in trade.

Third, another potential FTA being considered is a Switzerland-Colombia FTA. We adapted the matching procedure in the following way. Since Switzerland and Colombia do not have an FTA, we compared their ("No-FTA") trade flow to the four nearest neighbors that *had* an FTA in 2005; these four pairs all included Chile (Chile-Austria, Chile-Belgium/Luxembourg, Chile-Sweden, and Chile-Switzerland). Using this methodology, we estimated that a Switzerland-Colombia FTA would increase trade (over four years) by 13 percent. Table 2 summarizes the results of this exercise.

Table 2: An *ex ante* estimate of the Swiss-Colombia FTA for 2005 IF
Colombia and Switzerland had a FTA

- Step 1: Compute the A-I distance measure for all country pairs relative to the Switzerland- Colombia bilateral pair.
- Step 2: Compare the four bilateral pairs that have an FTA whose A-I distance measure is closest to Switzerland-Colombia A-I distance.
- Step 3: Compare the new A-I matching data to the four nearest neighbors.

Country 1	Country 2	Log of Summed trade	A-I difference
Switzerland	Colombia	5.79	0.00
Switzerland	Chile	5.20	0.02
Belgium- Luxembourg	Chile	6.15	0.04
Austria	Chile	5.62	0.05
Sweden	Chile	6.69	0.05
Average Country 1	Average Country 2	5.91	

According to this measure trade would be about 13% higher. This assumes that OLS gravity estimates can be used to extrapolate the growth in trade.

Concluding Caveats

We conclude with some caveats. It is important to note (as in footnote 2) that the treatment-effect estimates provided are “partial-equilibrium” effects. That is, they hold constant feedback effects of changes in relative prices on other prices and trade flows; that is, they ignore “general-equilibrium” effects. There are two ways now to incorporate such partial effects into (theoretical, computable) general-equilibrium models. One way is to incorporate them into large established computable general-equilibrium models such as the GTAP model or the Michigan Model of World Trade. Second, and somewhat easier, is to incorporate them into smaller, focused general equilibrium models such as discussed in ANDERSON and VAN WINCOOP (2003); however, even these require non-linear solving techniques. Third, BAIER and BERGSTRAND (2009a) provide a procedure to approximate more easily the general-equilibrium effects discussed in ANDERSON and VAN WINCOOP (2003) that do not require non-linear solvers; however, all these methods go beyond the scope of this particular note.

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