Do free trade agreements affect tariffs of non-member countries? A theoretical and empirical investigation

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Abstract

We investigate the effects of free trade agreements (FTAs) on tariffs of non-member countries. In our multi-country model, the formation of an FTA leads members to reduce their exports to the rest of the world. Such external trade diversion weakens the ability of non-members to manipulate their terms of trade vis–à–vis FTA members, a mechanism that induces them to lower their tariffs on FTA members. We empirically confirm this insight using industry-level trade data for 192 importing and 253 exporting countries, along with information on all FTAs formed in the world during 1989-2011.

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1 Introduction

Preferential trade agreements (PTAs) are a feature of the global trade policy landscape like never before. Much attention has been devoted to how such trade agreements might affect tariff policies of member countries towards not only each other but also non-members. However, to the best of our knowledge, we know little about whether and how the formation of PTAs affects the trade policies of non-member countries. In fact, in both theoretical and empirical analyses of PTAs, it is customary to either completely ignore the trade policies of non-members or assume that they are unaffected by PTA formation. For reasons we explain below, this is an important omission from a conceptual as well as a practical perspective. In this paper, we investigate both theoretically and empirically the effects of free trade agreements (FTAs) – the most commonly occurring type of PTA – on the tariffs of non-member countries. Our empirical work is motivated by a simple theoretical framework based on Horn, Maggi, and Staiger (2010).

Existing literature has shown that the formation of an FTA can induce member countries to lower their tariffs on non-members: this is the so called *tariff complementarity* effect (Bagwell and Staiger, 1997). The intuition underlying this surprising effect is quite robust and clean. As Maggi (2014) notes, if two countries possessing market power sign an FTA, they start to import more from each other and less from non-members and this trade diversion reduces their incentives to manipulate their terms of trade vis-a-vis non-members, which ultimately results in lower external tariffs on their part. Empirical support for this type of tariff complementarity has been provided by Bohara, Gawande, and Sanguinetti (2004), Estevadeordal, Freund, and Ornelas (2008), Calvo-Pardo, Freund, and Ornelas (2009), and Mai and Stoyanov (2015).[1]

The key insight of our paper is that the logic underlying the tariff complementarity effect for member countries ought to apply to the optimal tariffs of non-member countries as well. If tariffs set by a country on imports from different sources are complementary to each other, as is the case for FTA member countries, then the tariffs applied by different countries on imports from the same source should also be complementary. In such a case, a reduction in tariff by one importer should induce the other importers of the same good to lower their tariffs. In a world with increasing production costs, if two countries undertake bilateral trade liberalization via an FTA, their mutual trade increases while their exports to other countries fall. This change in

[1] The review by Limão (2016) describes a strong evidence for substitution for developed countries and weak evidence of complementarity for some developing countries, including Latin America. Crivelli (2016) uses the data and basic approach in Estevadeordal, Freund, and Ornelas (2008) and finds that the strength of the tariff complementarity depends on the initial tariff levels.

the pattern of international trade reduces the ability and the incentive of non-member countries to manipulate their terms of trade vis-a-vis FTA members, a mechanism that ought to induce non-members to voluntarily *lower* their tariffs on FTA members. To the best of our knowledge, this insight regarding the effect of FTAs on tariffs of non-member countries has been generally overlooked in the literature.

In this paper, we first formally develop this insight in a simple economic framework based on Horn, Maggi, and Staiger (2010) and then provide empirical evidence in its support. The theoretical framework is a classical partial equilibrium set-up comprising an arbitrary number (n) of countries who produce a single numeraire good v_0 and n non-numeraire goods, where the marginal cost of production of each non-numeraire good increases with output. The pattern of comparative advantage is such that each country exports a unique good to all its trading partners, i.e., the underlying trade pattern is one in which there are $n-1$ *competing importers* of each non-numeraire good. An important feature of this economic framework is that if two countries liberalize trade towards one another, their mutual imports increase while the exports (of their respective comparative advantage goods) to the rest of the world decrease – a phenomenon we call the *external trade diversion*.

We first derive optimal tariffs in the absence of any trade agreement and then consider how the formation of an FTA amongst m countries, $m < n$, affects the tariffs of a typical non-member country. We show that the export supply elasticities facing non-member countries increase with the size of the FTA (as measured by the number of FTA partners m) as well as the external tariff preference margin enjoyed by a typical FTA member. Thus, the formation of an FTA reduces the export supply elasticities facing non-member countries which in turn induces them to lower their tariffs on FTA members.

However, bringing this prediction from the theoretical model directly to the data is problematic because we do not observe variation in export supply elasticities across countries and industries over time. Thus, we base our empirical framework on another related prediction of the model which links unobservable changes in export supply elasticities to observable changes in trade flows between FTA member countries. Specifically, the model predicts that the increase in the export supply elasticities of non-members is bigger and the reduction in their external tariffs deeper when the effect of an FTA on preferential trade between member countries is larger. To operationalize this prediction, for every country in our sample we construct a measure of a trade-weighted average change in preferential trade flows of its main trade partners. This measure, which we call *preferential export share*, has a strong theoretical relationship to the elasticities of export supply, and the data reveals that it indeed reflects over-time variation in export supply elasticities. In particular, when we split our sample of countries into two halves by time, we find that an increase in the preferential export share of a country's average partner between the two periods is associated with an increase in its export supply elasticity, estimated using the Broda and Weinstein (2006) methodology.

Building on the insights of the model, we empirically investigate whether countries indeed adjust trade policies in response to FTA formation by other countries. Our main empirical focus is on the relationship between changes in MFN tariff rates of countries and preferential export shares. To construct a measure of the annual change in the preferential export share of a country's average trade partner, we use industry-level bilateral trade data for 192 importing and 253 exporting countries, along with the information on all FTAs formed between 1989 and 2011.

Our estimation results support the external trade diversion hypothesis. We find that the formation of an FTA by a group of countries and the associated increase in the share of trade between them induces other countries to lower MFN tariffs. The results are both statistically significant and economically sizable. For example, in our benchmark specification, if a country's preferential exports increase by 10% as a result of a new FTA, and its share in imports of a non-member country is 10%, the latter reduces its MFN tariff by 0.08 percentage points. This result is remarkably robust to the inclusion of a broad set of fixed effects, including country-year and country-industry fixed effects. Moreover, the effect is the most pronounced for trade-creating FTAs which increase the share of preferential trade between members and, according to the theory, result in greater increase in the export supply elasticities for non-members.

We pay close attention to endogeneity issues and use several instrumental variables strategies to determine whether the effect of FTAs on tariffs of non-member countries is causal. The first endogeneity concern arises from the simultaneity between MFN tariffs and import shares. We address this problem by instrumenting for a country's export pattern using a geography-based gravity model in the spirit of Frankel and Romer (1999). The second source of endogeneity is the presence of omitted variables which could affect trade flows between FTA member countries for reasons unrelated to agreement formation. In order to better isolate variation in preferential trade shares that is driven by the formation of preferential trade agreements, we instrument preferential export shares with pre-determined geographic variables using the insights of Baier and Bergstrand (2004). Overall, our IV estimates point to an even stronger external trade diversion effect of FTAs. Moreover, the dynamics of the effect are also consistent with our expectations: we find external trade diversion to be the strongest in the second and the third years of FTA implementation – the period of the most intense trade liberalization for most agreements – but not in the subsequent years when the effect of preferential liberalization on trade have largely been exhausted. Also, the effect of FTAs on tariffs of non-members is insignificant in the first year, suggesting that countries do not immediately adjust their trade policies in response to changes in trade patterns induced by policy changes in rest of the world.

The policy implications of our results are clear as well as important. If the formation of FTAs can cause trade liberalization to spillover to excluded countries, an important welfare gain accruing from their formation has been ignored thus far in not just the academic literature but also in policy analysis. For example, the important and influential literature addressing whether FTAs are building or stumbling blocs for further liberalization in the world economy has tended to focus primarily on the effects FTAs have on the incentives for further liberalization of member countries – see, for example, Krishna (1998) and Bagwell and Staiger (1997). Our analysis shows that the scope of this line of inquiry needs to be broadened to also include the effects that FTAs might have on the policies of non-member countries.

Terms of trade effects play a central role in our analysis, and the results of our study complement the empirical research investigating the role of terms of trade motives in determining trade policy. Broda, Limão, and Weinstein (2008) confirm that non-WTO countries indeed manipulate their terms of trade by setting higher tariffs on goods that are supplied inelastically. Several recent studies identify the terms of trade effect from trade policy re-negotiations imposed by multilateral agreements. Bagwell and Staiger (2011) focus on changes in tariff rates resulting from a country's accession to the WTO and Ludema and Mayda (2013) examine variation in MFN tariffs resulting from the Uruguay Round of trade negotiations. In line with the predictions of the terms of trade theory, both studies find that countries reduce tariffs to a deeper degree in industries in which they have greater market power. Using data on import tariffs imposed by the United States on 49 countries during 1997-2006 under anti-dumping and safeguard laws, Bown and Crowley (2013) provide an empirical confirmation of the managed trade theory of Bagwell and Staiger (1990) in which countries play a repeated game and any trade agreement between them has to be self-enforcing. Our paper contributes to this literature by identifying FTAs as a source of exogenous shocks to the terms of trade of all non-members countries. We demonstrate that non-member countries reduce their MFN tariffs in response to negative terms of trade shocks associated with FTAs. By so doing, we uncover a new empirical domain within which implications of terms of trade theory for optimal tariffs can be investigated. This is important because the formation of an FTA between a few countries can be reasonably interpreted as an exogenous event from the perspective of the rest of the world.

2 Theoretical model

Our motivating economic framework is a suitably adapted version of the two-country model of Horn, Maggi, and Staiger (2010). We consider a perfectly competitive world comprising n large countries that produce n (non-numeraire) goods and a single numeraire good v_0. We first describe the underlying economic structure and then derive optimal tariffs in the absence as well as the presence of a free trade agreement (FTA) comprised of an arbitrary number of countries.

On the demand side, the representative citizen's utility function is given by:

$$U(\mathbf{v}, v_0) = u(\mathbf{v}) + v_0, \tag{1}$$

where $\mathbf{v}$ is the consumption vector for the n non-numeraire goods, and v_0 denotes consumption of the numeraire good. We assume $u(\mathbf{v})$ is quadratic and additively separable in non-numeraire goods so that demand for good g in country z is given by

$$d_z^g(p_z^g) = \alpha - p_z^g \tag{2}$$

where p_z^g is the consumer price of good g in country z. Assuming that population in each country is a continuum of measure one, we can write the consumer surplus associated with good g in country z as:

$$CS_z^g(p_z^g) = u_z^g[d_z^g(p_z^g)] - p_z^g d_z^g(p_z^g) \tag{3}$$

On the supply side, as in Horn, Maggi, and Staiger (2010), the production of one unit of the numeraire requires one unit of labour (l). The supply of labor is assumed to be large enough that the numeraire good is always produced in a positive amount and the equilibrium wage is equal to one.

The production technology for non-numeraire goods is subject to diminishing returns. In particular, the production function for (non-numeraire) good g in country z is $Q_z^g = \sqrt{2\lambda_z^g l_g}$, where Q_z^g is the output of good g in country z and l_g is employment in industry g. The corresponding supply function of good g in country z is as follows:

$$s_z^g(q_z^g) = \lambda_z^g q_z^g \tag{4}$$

where q_z^g denotes the producer price for good g in country z.[2]

The structure of comparative advantage is assumed to be symmetric across countries: $\lambda_z^Z = 1 + \lambda$ while $\lambda_z^g = 1$ for $g \neq Z$. In other words, each country has a comparative advantage in a single good that is indexed by the same uppercase letter as the identity of the country (i.e. country z has comparative advantage in good Z) while having a comparative disadvantage in the remaining $n-1$ goods. Thus, there are $n-1$ *competing importers* for each non-numeraire good. Country z's producer surplus in good g is equal to

$$PS_z^g(q_z^g) = \int s_z^g(q_z^g)dq_z^g = \frac{1}{2}\lambda_z^g(q_z^g)^2 \tag{5}$$

As a representative case, consider good Z, i.e. the good in which country z has a comparative advantage. Let t_z^g be the MFN tariff imposed by country z on its imports of good $g \neq Z$.[3] Given that all countries are large, the world price of good g depends on tariffs of all importing countries. However, to simplify notation, we suppress the dependence of prices on tariffs and simply denote the price of good g in country z by p_z^g.

Since country z imposes no tariff on good Z, the consumer and producer prices of good Z in country z are equal: $q_z^Z = p_z^Z$. Similarly, as there is no domestic taxation of the import competing sectors, producer and consumer prices are also equal: $q_z^g = p_z^g$, where $g \neq Z$. Ruling out prohibitive tariffs yields the following no-arbitrage conditions for good Z in importing country c:

$$p_c^Z = p_z^Z + t_c^Z,\ c \neq z \tag{6}$$

Let m_c^Z be imports of good Z by country c:

$$m_c^Z = d(p_c^Z) - s_c^Z(p_c^Z),\ c \neq z \tag{7}$$

Similarly, let x_z^Z denote country z's exports of good Z to country c:

$$x_{zc}^Z = s_z^Z(p_z^Z) - \sum_{\tilde{c} \neq z,c} d(p_{\tilde{c}}^Z) \tag{8}$$

Market clearing for good Z requires that country z's export to country c equals the imports of that country:

$$x_{zc}^Z = m_c^Z \tag{9}$$

[2] In Appendix B we extend the model to allow for more general demand and supply functions.

[3] We assume that tariff revenues for each good are redistributed unifomly to all individuals.

Country c's welfare is defined as the sum of consumer surplus, producer surplus, and tariff revenue over all goods:

$$w_c = \sum_g CS_c^g(p_c^g) + \sum_g PS_c^g(p_c^g) + \sum_{g \neq C} t_c^g m_c^g \tag{10}$$

In the absence of any trade agreements, each country chooses its tariffs to maximize its welfare.[4] To derive optimal tariffs, we follow the approach of Feenstra (2004) and Broda, Limão, and Weinstein (2008). Consider country c's tariff problem for good Z. Differentiating w_c with respect to t_c^Z, we obtain:

$$\frac{\partial w_c}{\partial t_c^Z} = t_c^Z \frac{\partial m_c^Z}{\partial p_c^Z} \frac{\partial p_c^Z}{\partial t_c^Z} - m_c^Z \frac{\partial p_z^Z}{\partial t_c^Z} \tag{11}$$

The first term of the above first order condition captures the efficiency cost of the tariff (i.e. the marginal deadweight loss of the tariff) and the second term captures the terms of trade effect, that is, the reduction in the world price of good Z that accrues to country z multiplied by the quantity of country c's imports from country z.

The optimal tariff is computed where (11) equals zero:

$$\frac{\partial w_c}{\partial t_c^Z} = 0 \Rightarrow \frac{t_c^Z}{p_z^Z} = \frac{\frac{\partial p_z^Z}{\partial t_c^Z} \frac{m_c^Z}{p_z^Z}}{\frac{\partial m_c^Z}{\partial p_c^Z} \frac{\partial p_c^Z}{\partial t_c^Z}} \tag{12}$$

Since $m_c^Z = x_{zc}^Z$, we must have

$$\frac{\partial m_c^Z}{\partial p_c^Z} \frac{\partial p_c^Z}{\partial t_c^Z} = \frac{\partial x_{zc}^Z}{\partial t_c^Z}$$

Substituting this into (12) shows that country c's optimal ad-valorem tariff on good Z equals the inverse of the elasticity of the export supply curve faced by country c for that good, denoted by ε_c^Z:[5]

$$\frac{t_c^Z}{p_z^Z} = \frac{1}{\varepsilon_c^Z} = \left[\frac{\partial x_{zc}^Z}{\partial p_z^Z} \frac{p_z^Z}{x_{zc}^Z} \right]^{-1} \tag{13}$$

Using the demand and supply functions in equations (2) and (4), as well as the no arbitrage and market clearing conditions in (6) and (9), we can obtain the equilibrium price, exports, and imports of good Z.

[4]In Appendix C we show that the main predictions of our model continue to hold when countries set trade policies cooperatively (in the sense that each country takes the effects of its tariffs on other countries into account) so long as each country weighs foreign welfare less than domestic welfare.

[5]In the empirical section, we use an equivalent ad-valorem tariff.

To derive the implications of FTA formation on MFN tariffs of excluded countries, suppose country z forms an FTA with $m-1$ countries, so that the FTA is of size m, and country c is a non-member.[6] Let $\widehat{t^Z}$ denote the preferential internal tariff on good Z within the FTA imposed by country z's FTA partners; $t^Z_{\tilde{c}}$ denote the tariff of a typical non-member country other than country c, and φ^Z_{ext} denote the external tariff preference margin enjoyed by members within an FTA relative to tariffs they face in non-member countries: $\varphi^Z_{ext} \equiv t^Z_{\tilde{c}} - \widehat{t^Z}$.[7]

It is easy to show that country z's export supply function of good Z to country c is as follows:

$$x^Z_{zc} = [2(n-1)+\lambda]p^Z_z - (n-1)\alpha + 2(n-2)t^Z_{\tilde{c}} - 2(m-1)\varphi^Z_{ext} \tag{14}$$

Before deriving optimal tariffs in the presence of an FTA, it is useful to highlight an important feature of our economic framework. If two countries liberalize trade towards one another in our model, they import more from each other and start exporting *less* to other countries owing to the fact that the marginal cost of production is increasing – a phenomenon we call *external trade diversion*. As we demonstrate below, this reduction in the volume of exports of members to excluded countries has implications for their optimal tariffs.

It is immediate from (14) that the formation of an FTA affects country z's export supply function through two key channels: the size of the FTA (as measured by the number of FTA partners m) and the external tariff preference margin φ^Z_{ext}. These two channels represent the extensive and intensive margins of preferential trade liberalization respectively. Along the extensive margin, the export supply of country z to country c decreases with the size of FTA : $\frac{\partial x^Z_{zc}}{\partial m} < 0$. Similarly, along the intensive margin, the export supply of country z to country c also decreases in the FTA's external tariff preference margin φ^Z_{ext}: $\frac{\partial x^Z_{zc}}{\partial \varphi^Z_{ext}} < 0$.

Given the export supply function above, the export supply elasticity ε^Z_c faced by the non-member country c can be calculated as follows:

$$\varepsilon^Z_c = \frac{[2(n-1)+\lambda][n\alpha + 2(m-1)\varphi^Z_{ext} - 2(n-2)t^Z_{\tilde{c}} - 2t^Z_c]}{\alpha\lambda - [4(n-1)+2\lambda]t^Z_c - 4(m-1)\varphi^Z_{ext} + 4(n-2)t^Z_{\tilde{c}}} \tag{15}$$

Note that the export supply elasticity ε^Z_c increases in both m and φ^Z_{ext}:

$$\frac{\partial \varepsilon^Z_c}{\partial m} > 0 \text{ and } \frac{\partial \varepsilon^Z_c}{\partial \varphi^Z_{ext}} > 0 \tag{16}$$

[6] When $m = 1$, we are back to the status quo of optimal tariffs in the absence of an FTA.

[7] Here, for the sake of clarity, we report country c's optimal tariff as a function of exogenously given internal and external tariffs of other countries. We report the export supply elasticity and optimal tariff expressions in the Appendix A.

It also proves useful to consider how the two main attributes of an FTA (i.e. m and φ^Z_{ext}) affect its overall trade pattern. Suppose country z negotiates an FTA with $m-1$ other countries. The share of country z's exports of good Z flowing to its $m-1$ FTA partners equals:

$$PXS^Z_z = \frac{\sum\limits_{j\in(m-1)} x^Z_{zj}}{\sum\limits_{j\neq z} x^Z_{zj}} \tag{17}$$

We refer to PXS^Z_z as country z's *preferential export share.*

In the absence of any FTA (which we denote as regime ϕ), due to symmetry, the share of country z's exports of good Z flowing to any $m-1$ countries is $PXS^Z_z(\phi) = \frac{m-1}{n-1}$. In other words, when country z is not a participant in any FTA, the share of its exports going to any $m-1$ countries equals $PXS^Z_z(\phi)$.

Following the formation of the FTA (letting $\widehat{t^Z} = 0$), it is straightforward to show that the preferential export share of country z in good Z becomes:

$$PXS^Z_z = \frac{(m-1)[\lambda\alpha + 4(n-m)\varphi^Z_{ext}]}{\alpha\lambda(n-1) - 2(\lambda+2)(n-m)\varphi^Z_{ext}} \tag{18}$$

where direct calculations show that

$$\frac{\partial PXS^Z_z}{\partial m} > 0 \text{ and } \frac{\partial PXS^Z_z}{\partial \varphi^Z_{ext}} > 0 \tag{19}$$

Therefore, both the preferential export share of a typical FTA member country z and the export supply elasticities facing non-member countries increase with both the size of the FTA (m) and the tariff preference margin (φ^Z_{ext}).

From here on, we utilize parameters m and φ^Z_{ext} to capture changes in both the preferential export share and the export supply elasticity. The change in the preferential export share of country z due to the formation of an FTA equals:

$$\Delta PXS^Z_z = PXS^Z_z - PXS^Z_z(\phi) = \frac{2(m-1)(n-m)(\lambda+2n)\varphi^Z_{ext}}{(n-1)[\alpha\lambda(n-1) - \varphi^Z_{ext}[2(\lambda+2)(n-m)]} > 0 \tag{20}$$

Note that for any given FTA of size m, the greater the external tariff preference margin, the larger the increase in the preferential export share: $\frac{\partial \Delta PXS^Z_z}{\partial \varphi^Z_{ext}} > 0$.[8] A similar analysis holds for country c's optimal tariff. Using (13) and (15), non-member country c's optimal tariff when country z forms an FTA with $(m-1)$ other countries is equal to:

$$t^Z_c(t^Z_{\tilde{c}}) = \frac{2\alpha\lambda + 8[(n-2)t^Z_{\tilde{c}} - m\varphi^Z_{ext}]}{[2(n-1)+\lambda][4(n+1)+2\lambda]} \tag{21}$$

[8] Note that PXS^Z_z rises with m at increasing rate when m is sufficiently small. As m approaches $n-1$, we approach the global free trade in good Z and thus PXS^Z_z converges to $PXS^Z_z(\phi) = \frac{m}{n-1}$.

It is immediate from above that the tariffs imposed by different non-member countries on the same good are *strategic complements* in our model:

$$\frac{\partial t_c^Z}{\partial t_{\sim c}^Z} > 0 \tag{22}$$

The intuition for why tariffs of different countries end up being strategic complements is that an increase in $t_{\sim c}^Z$ increases the volume of country z's exports to country c thereby increasing the latter's ability to manipulate its terms of trade.

Note that as the preferential export share rises either due to an increase in either the size of the FTA (m) or the preference margin (φ_{ext}^Z), the external trade diversion caused by the FTA induces the non-member country to lower its tariffs on members:

$$\frac{\partial t_c^Z}{\partial m} < 0 \text{ and } \frac{\partial t_c^Z}{\partial \varphi_{ext}^Z} < 0 \tag{23}$$

The optimal pre-FTA MFN tariff of country c can be found by setting $\varphi_{ext}^Z = 0$ in (21), which yields:

$$t_c^Z(\phi) = \frac{2\alpha\lambda + 8[(n-2)t_{\sim c}^Z]}{[2(n-1)+\lambda][4(n+1)+2\lambda]} \tag{24}$$

Using (21) and (24), we can directly calculate the response of the optimal MFN tariff of non-member country c to FTA formation by its trade partners a function of m and φ_{ext}^Z:

$$\Delta t_c^Z = t_c^Z(\phi) - t_c^Z = \frac{m\varphi_{ext}^Z}{[2(n-1)+\lambda][4(n+1)+2\lambda]} \tag{25}$$

where $\frac{\partial \Delta t_c^Z}{\partial m} > 0$ and $\frac{\partial \Delta t_c^Z}{\partial \varphi_{ext}^Z} > 0$. The following proposition summarizes our central theoretical finding:

Proposition 1: *The larger the increase in the preferential export share of FTA member countries, the greater the reduction in the external tariffs of non-member countries.*

The intuition for this proposition is clear: the greater the degree of external trade diversion caused by an FTA, the weaker the ability of non-members to manipulate their terms of trade via import tariffs. Proposition 2 in the Appendix B shows that the same result holds under a general demand and supply structure as long as the inverse supply function is log-concave. Moreover, Appendix C extends our theoretical model to allow for tariff cooperation. Specifically, we have derived optimal trade policy for the case when each governments' objective function is a weighted average of national welfare and the welfare of other countries. We find that our main result in Proposition 1 fully extends into the cooperative tariff setting and holds for all levels of cooperation.

3 Empirical framework

Our main empirical specification is based on Proposition 1 which builds a theoretical relationship from unobservable changes in elasticities to observable changes in trade shares. Intuitively, a greater increase in trade between FTA member countries implies stronger external trade diversion and therefore a larger increase in ε_{cit}, which translates into reductions in tariffs of non-member countries. Using this insight, the simplest structure to study the relationship between FTA formation and MFN tariffs of excluded countries is

$$\Delta MFN_{cit} = \beta \Delta \overline{PXS}_{cit} + \upsilon_{cit} \tag{26}$$

where ΔMFN_{cit} is the change in the MFN tariff rate of country c in industry i at time t, and $\Delta \overline{PXS}_{cit}$ is the change in the preferential export share of country c's average trade partner.

Given that each country has multiple trading partners, we construct $\overline{PXS}_{cit}$ as a weighted average of preferential exports of country c's partners using their import shares as weights:

$$\Delta \overline{PXS}_{cit} = \left(\sum_{p \neq c} imp\_share_{cpi} \cdot \Delta PXS_{pit} \right) \tag{27}$$

$$\Delta PXS_{pit} = \sum_{j \neq i} FTA_{pjt} \cdot \Delta exp\_share_{pjit}$$

where imp_share_{cpi} is the share of country p in total imports of industry i by country c, exp_share_{pjit} is the share of country p's exports of good i to country j, FTA_{pjt} is a binary variable that takes the value of one if countries p and j have an FTA in year t and zero otherwise, and PXS_{pit} is the share of country p's exports of good i to its FTA partner countries excluding c. Note that import shares, used as weights in equation (27), are constructed as averages over the entire sample period for each country-pair and industry. This is done in order to reduce measurement error and to bring the empirical specification closer to our theoretical model, which predicts that the effect of trade agreements operates through changes in preferential export share of a country's trade partners. Therefore, the variation in $\overline{PXS}_{cit}$ measure over time for each country-pair-industry is driven only by the variation in preferential export shares of a country's trade partners rather than by the variation in its own trade structure.

In equation (26), $\beta < 0$ would provide support for the argument that countries lower their import tariffs in response to an increase in the share of preferential exports of their trade partners. However, equation (26) only captures contemporaneous correlation between the change in the MFN tariff and the change in preferential export share of an average partner country. To capture the dynamic response of MFN tariffs to FTA formation by other countries, we analyze the differential effect of the change in preferential export shares by trade partners within the first five years of FTA formation:

$$\Delta MFN_{cit} = \sum_{T=-3}^{6} \beta_T \Delta \overline{PXS}\left(T\right)_{cit-T-1} + \gamma_{ct} + \gamma_{ci} + \upsilon_{cit} \tag{28}$$

$$\Delta \overline{PXS}\left(T\right)_{cit-T-1} = \left(\sum_{p} imp\_share_{cpi} \cdot \Delta PXS\left(T\right)_{pit-T-1} \right) \tag{29}$$

$$\Delta PXS\left(T\right)_{pit-T-1} = \sum_{j \neq c} FTA\left(T\right)_{pjt} \cdot \left(exp\_share_{pjit} - exp\_share_{pjit-T-1}\right) \tag{30}$$

where $FTA\left(T\right)_{pjt}$ is a binary variable that takes the value of one if an FTA between countries p and j came into force in year $(t-T)$. Thus, for all countries that formed FTAs with country p in year $(t-T)$, $\Delta PXS\left(T\right)_{pit-T-1}$ measures the change in p's exports of product i to these countries relative to the reference year $(t-T-1)$. The effect of agreements formed more than five years ago is combined into one general category $\overline{PXS}\left(T=6\right)$. We also include two leads of the explanatory variable in equation (28) and use pretrends to confirm that the effect of an FTA on non-members' tariffs materializes after commencement of the agreement.[9]

The benchmark specification (28) includes country×year fixed effects γ_{ct} to control for general episodes of country-specific trade liberalization, accession to the WTO and regional trade agreements, changes in fiscal and monetary policies, and other macroeconomic characteristics that affect general changes in tariff policies in specific countries and periods. Country×industry fixed effects γ_{ci} control for economic and political factors that may affect the average changes in the level of protection in different industries within a country. In particular, γ_{ci} capture a government's potential reluctance to liberalize trade in certain sensitive industries and the possibility for more rapid tariff reductions in other industries.

3.1 Addressing endogeneity of import shares

The key assumption underlying identification of β_T coefficients from equation (28) is that the decision to form an FTA is independent of future changes in trade policies of other countries.[10]

[9] In the Appendix Table 3A we show results with six leads of the explanatory variable.

[10] We believe this is a plausible assumption because trade agreements usually take many years to negotiate. By the time an agreement is implemented, MFN tariffs of third countries would have already responded to any

However, the other two components of $\overline{PXS}(T)$ variables – import shares and preferential export shares – may not be fully exogenous. Although the broad set of fixed effects allows us to control for many possible unobservables and remove most of the omitted variables, this does not resolve all potential endogeneity issues with various components of the explanatory variables. Using import shares as weights in the construction of $\overline{PXS}(T)$ variables is particularly problematic because of simultaneity with import tariffs. This concern would be even more serious if reductions in import tariffs were to have differential impact on imports from partners with different preferences for regional trade liberalization. For example, if countries that are more actively involved in preferential trade benefit more from trade liberalization by others, than a reduction in import tariffs will increase the share of imports from those countries, thus raising the value of our explanatory variables and causing simultaneity bias in β_T. Another concern with using import shares is that they may partially offset the effect of FTAs on preferential export shares. If an FTA between a pair of countries redirects their exports from third countries towards each other's markets, as the theory predicts, an increase in preferential export shares of the FTA member countries will go hand-in-hand with a decrease in import shares of other countries from that FTA, reducing the value of $\overline{PXS}(T)$ and causing a bias in the estimates.

We address the endogeneity of import shares via an instrumental variable strategy and construct the following instruments, one for each $\Delta_{T-1}\overline{PXS}(T)$:

$$IV^S(T)_{cit} = \left(\sum_p \widehat{imp\_share}_{cpi} \cdot \Delta PXS(T)_{pit-T-1} \right). \tag{31}$$

The terms $\widehat{imp\_share}_{cpi}$ in (31) are the import shares predicted from various versions of the gravity model that help isolate variation in import shares stemming from changes in either expected MFN tariff changes or preferential trade shares of partner countries. Constructed this way, instruments $IV^S(T)$ allow us to obtain estimates of β_T which are based on the variation in import shares arising from the geographical determinants of trade flows only, and thus are free from any policy influences.

Our benchmark gravity specification to obtain $\widehat{imp\_share}_{cpi}$ is based on Do and Levchenko (2007), who extend the methodology of Frankel and Romer (1999) to industry-level data. Frankel and Romer (1999) rely on the gravity equation to predict trade flows between a pair of countries using their pre-determined geographic characteristics such as distance, population

shocks that could have potentially triggered those negotiations.

and other standard covariates of trade costs used in the gravity model literature:

$$\ln X_{cpit} = Z_{cpit}\beta_i + \varepsilon_{pjit} \tag{32}$$

where X_{cpit} is exports of good i from country c to country p in year t, and the vector Z_{cpit} includes the log of distance between countries c and p, log of population in each country, log of land size, landlock and common border indicators, and the interactions of all of the above variables with the common border dummy variable. These are reasonable instruments because, on one hand, they are powerful determinants of trade flows, as the gravity literature demonstrates.[11] On the other hand, it is difficult to think of any reasons why country's geographic characteristics could affect product-specific tariff changes other than through changes in trade flows. As in Do and Levchenko (2007), we generate cross-industry variation in import shares by allowing the coefficients on the covariates in the gravity model to vary across industries. This approach exploits differential response of trade volumes to geographic characteristics across industries.[12] Following this methodology, we obtain predicted values of trade flows between every country pair for every industry, and use them to construct the predicted "natural" import shares, $\widehat{imp\_share}_{cpi}$. With these values, we use (31) to form the first set of instruments, $IV_1^S(T)$, for $\Delta\overline{PXS}(T)$ variables.

Instruments constructed with trade flows predicted from the gravity model (32) have two limitations. First, Silva and Tenreyro (2006) argue that not accounting for zero trade flows and heteroskedasticity in the log linear gravity models can lead to inconsistent OLS estimates. The authors advocate estimating equation (32) with Poisson pseudo-maximum likelihood (PPML), which they demonstrate to address the above two problems in Monte Carlo simulations. Our second set of instruments, $IV_2^S(T)$, is constructed from (31), for which the import shares are predicted from the gravity model (32) estimated with PPML.

The second limitation of the model (32), illustrated by Anderson and van Wincoop (2003), is that it can produce inconsistent estimates of the gravity variables coefficients due to the omitted multilateral price terms. The standard solution to this problem in the gravity literature is to control for the price terms with two sets of country-industry-year fixed effects. However, this approach prevents separate identification of all country-specific geography variables in equation (32) and reduces the strength of the instruments. As a robustness test for the benchmark IV

[11] The F-test for the joint significance of Z in regression (32) has the p-value of less than 0.01 for all industries and the average R-squared is 0.2.

[12] On our model, 70% of variation in predicted trade values comes from within country-pair-year cells, close to 59% observed in the actual data.

specification, we introduce the full set of exporter-industry-year and importer-industry-year fixed effects into the gravity model (32), and use the information contained in both the fixed effects and in the remaining gravity variables to construct two sets of instruments – $IV_3^S(T)$ from the OLS estimates of the extended gravity model and $IV_4^S(T)$ from the PPML estimates. Such IV strategy not only allows obtaining consistent estimates of the gravity variables coefficients but also results in stronger instruments that can predict the actual trade shares better. The drawback of this IV approach is that the fixed effects introduce economic factors into the predicted trade shares, and the validity of the instruments constructed in such a way relies on a strong identification assumption relative to $IV_1(T)$ and $IV_2^S(T)$.

4 Data and preliminary evidence

The bilateral trade data for this project are taken from the World Integrated Trade Solutions (WITS) database, maintained by the World Bank, and cover the time period from 1989 to 2011. The data that we use to construct trade share variables is a four-dimensional unbalanced panel covering 192 importing countries, 253 exporting countries, 98 2-digit HS industries, and spanning 22 years.[13]

The binary variable that measures the presence or absence of an FTA in a given year is constructed for all pairs of countries in our sample using the WTO database on Regional Trade Agreements which includes information on the date of notification and the date when the agreement entered into force. We record FTA as being formed in year t if it came into force between July of $(t-1)$ and June of t. Since the membership structure of some FTAs vary over time and the WTO database does not always keep track of those changes, the data on bilateral FTA structure was complemented with information from other sources such as official web sites of these agreements. The resulting database covers all complete FTAs that were formed between 1989 and 2011 and includes $2,513$ country pairs trading under an FTA clause in 2011, or 9% of all country-pairs in our sample. Without information on coverage of each FTA, we assume that FTAs apply to trade in all industries between their members. Using equation (29) and the data on bilateral trade flows and FTA membership, we construct nine measures for changes in preferential export shares of an average partner for every country, industry, and

[13] We exclude China from the sample because China's increasing ability to penetrate other markets results in a reduction in trade shares between members of most FTAs. However, keeping China in the sample does not materially affect our results, as we show below in the robustness section xx.

year. We combine this information on preferential trade of an average partner country with the MFN and preferential tariff data from the WITS. In the analysis that follows we remove observations with twenty or more percentage points change in the MFN tariffs in a single year (approximately 0.5% of observations in each tail of the ΔMFN distribution).

In order to construct instruments for import and preferential export shares, we merge trade data with geography variables obtained from the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII). This database contains information on bilateral distance between each pair of countries, land size of each country, and information on whether two countries are land-locked and share a border. The data on population are taken from the Penn World Tables.

Table 1 reports the basic descriptive statistics for our key variables on the estimation sample. The mean ad-valorem MFN tariff is 10.35 percentage points and is decreasing annually by 0.2 percentage points. The average country in our sample does not experience any substantial change in preferential export shares of its average trade partner. Changes in $\overline{PXS}\,(T)$ variables fluctuate around zero during the first five years of FTAs formed by its trade partners, and is equal to -0.24 for older trade agreements. This pattern reflects the regularity, observed in most country-pairs and industries, that the share of trade between FTA member countries, averaged across industries, does not change much over time despite preferential access to each other's markets.

Figure 1 displays the dynamics of MFN tariffs and FTA prevalence over our sample period.

—[Figure 1 here]—

The time period of study overlaps with intense multilateral tariff reductions, negotiated during the Uruguay Round (UR) of the WTO and phased in between 1996 and 2001. Because countries committed to these tariff reductions in early 1990s, they are predetermined relative to subsequent FTAs. However, Figure 1 shows that decrease in the global trade-weighted average MFN tariff was more intense in the decade after the UR, 1.74 percentage point reduction from 2002 to 2011 versus 0.95 from 1992 to 2001, and the pattern is similar for a simple unweighted average MFN rate (that is independent of compositional changes in trade flows). This observation suggests that a substantial part of tariff reductions in our sample, especially after 2001, were not affected by institutional constraints implied by the WTO. Figure 1 also shows a steady increase in FTA formation throughout the sample period, measured by the share of country-pairs trading under an FTA, although the process intensified after 1999. In terms of the share of global trade covered by FTAs, the increase was particularly pronounced after 2004 and coincided with the rapid decline in the simple average MFN tariff rate.

Figure 2 plots kernel densities for changes in MFN tariffs in industries with various exposure to changes in partner countries' preferential exports (PPX). We measure this exposure with a cumulative change in preferential exports of a country's average trade partner over the first five years of FTA formation.

—[Figure 2 here]—

The figure shows that in industries with negative and zero changes in the PPX, the distributions of ΔMFN_{cit} are very similar. In contrast, for industries with positive changes in the PPX, the distribution of tariff changes shifts slightly to the left. Furthermore, for industries that are exposed to the greatest increases in partner's preferential exports (top decile of the PPX distribution), the distribution of tariff changes shifts further to the left: the probability of a tariff reduction in industries in the top decile of PPX distribution is 27%, as opposed to only 19% in industries with no change in the PPX. This suggests that an increase in preferential trade between FTA member countries is associated with a subsequent reduction in MFN tariffs by non-member countries.

To demonstrate how this association evolves over time, we plot the OLS estimates of β_T coefficients from model (28) in Figure 3, where T stays for the number of years since FTA formation.

—[Figure 3 here]—

Because changes in the partner country's preferential exports are measured relative to the year before FTA came into force, the coefficient estimates for $T = -1$ are unavailable. Figure 3 shows a clear pattern: in the first four years after the formation of an FTA, the MFN tariffs of non-member trading partners tend to decline, before leveling off in the following years.

Along with cross-country variation in FTAs, our analysis relies on variation in preferential export shares of member countries and import shares of non-members. Here we demonstrate the importance of these two sources of variation in the relationship between FTAs and non-members' tariffs. First, to isolate the role of import shares, we re-construct the explanatory variables (29) as simple rather than import-weighted averages of preferential export shares.

Most of the post-FTA coefficients remain negative (Panel A of Figure 4), but a substantial decline in magnitudes and significance levels demonstrate that weighing country's preferential export shares by its importance as a trade partner is critical for identification. Second, we reconstruct explanatory variables as import-weighted average of the number of FTAs formed by a country's trade partners, disregarding the extent of trade creation within FTAs. Results with these explanatory variables, presented in Panel B of Figure 4, show no relationship between FTAs and tariffs of non-member countries. This result can be rationalized by our model since it is the increase in preferential trade that increases export supply elasticities of non-members and lowers their optimal tariffs, and weighing all FTAs equally eliminates a key source of variation in the explanatory variables.

—[Figure 4 here]—

As another demonstration of the importance of trade creation within FTAs for our results, in the next exercise we focus on FTAs that lead to more trade between members. The baseline specification (28) assumes that both positive and negative changes in preferential export shares are equally important for tariffs of other countries, i.e. $\beta_T < 0$ in equation (28) implies that a decline in trade following an FTA formation would induce other countries to increase their tariffs. This result cannot be rationalized by our theoretical framework which predicts that preferential trade liberalization always redirects FTA members' trade flows towards each other. In practice, however, various other determinants of trade flows between member countries may outweigh trade agreement's potential to generate new trade between members, in which case there will be no increase in the export supply elasticities and no effect on tariffs of other countries. Therefore, we are more likely to observe countries lowering their tariffs in response to FTAs that result in stronger trade creation.

Figure 5 illustrates this point by plotting OLS regression coefficients for equation (28) but with changes in partner countries' preferential export shares calculated separately for positive and negative changes.[14] Specifically, each circle point in Figure 5 corresponds to a regression coefficient on variables analogous to (29) but calculated only over those country pairs and industries for which FTAs resulted in a positive change in preferential share. Similarly, the diamond points represent regression coefficients on $\Delta\overline{PXS}\,(T)$ constructed only for observations with negative changes in preferential export shares. If only trade-creating FTAs lead to a long-run increase in the export supply elasticity, as the theory predicts, then we would expect the

[14] Later, we address the issue of identification of the effect of FTAs on tariffs more formally with an IV strategy.

coefficients on positive changes in $\Delta PXS\,(T)$ to be negative and larger in absolute value than the coefficients on the negative changes.

—[Figure 5 here]—

Figure 5 shows that the relationship between the formation of an FTA and the tariff reductions implemented by non-members is stronger in those cases when the FTA triggers an increase in the share of preferential trade between member countries. The figure illustrates three points consistent with our expectations. First, the effect of future changes in $\overline{PXS}$ variables, constructed for both positive and negative changes in preferential export shares, has no relationship with past changes in non-members tariffs. Second, tariffs tend to decline only in response to FTAs that increase the share of trade within an agreement: the coefficients on $\Delta\overline{PXS}\,(T)$ constructed only for positive changes in preferential export share are negative and statistically significant for the first four years of the agreement, while the coefficients negative $\Delta\overline{PXS}\,(T)$ are never statistically different from zero. And lastly, the effect of trade agreements occurs on impact and lasts for four years. The finding that not all FTAs lead to trade policy adjustments by outside countries also highlights the importance of isolating the effect of FTAs on preferential export shares from other influences, which we do in a more structural manner in Section 6.

5 Baseline results

Figure 6 presents the IV-GMM estimation results for equation (28). Full estimation results, including some first-stage diagnostic statistics, are provided in Table 2. All standard errors are clustered both at country-industry level to correct for serial correlation in the error term and at country-year level to correct for country-wide policy changes correlated across industries.

—[Figure 6 here]—

Panel A of Figure 6 plots β_T coefficient estimates from (28) for $-3 \leq T \leq 6$, using the benchmark instruments $IV_1^S\,(T)$. The instruments perform well in the first stage of the estimation procedure. The t-statistics from the test of the significance of $IV_1^S\,(T)$ in the first stage regressions for $\Delta\overline{PXS}\,(T)$ range from 4.7 for $T = 2$ to 13.8 for $T = 6$. Since we have multiple endogenous variables, we use Angrist-Pischke statistics, designed specifically to address this issue, to assess the strength of our instruments (Angrist and Pischke, 2009). The associated p-values for all endogenous regressors are always below 0.05, indicating that the weak instruments is unlikely to be a problem. However, the conventional F-statistics for instrument exclusion, reported in the lower part of Table 2, are fairly low.[15]

The second stage estimates show that an increase in preferential exports of a product by a country's trade partners is associated with a subsequent reduction in its MFN tariffs. As shown in Panel A of Figure 6, there is no indication of a negative trend in coefficients on $\Delta\overline{PXS}(T)$ prior to FTA formation, and a clear pattern for the coefficients to decrease right after. For all $0 \leq T \leq 5$, β_T coefficients are negative and three of them are statistically significant at least at 90% confidence level. The pattern is very similar in Panel B, where trade share instruments are obtained from the gravity model estimated with the PPML. It should be noted that the estimation results are robust to the inclusion of various fixed effects and the magnitude of the coefficients is fairly stable across specifications.[16]

Results with instruments $IV_3^S(T)$ and $IV_4^S(T)$, illustrated in Panels C and D respectively, reveal even more pronounced discontinuity in β_T coefficients around the year of FTA establishment – the coefficient drops sharply in the year of FTA formation and then increases gradually until becoming insignificant in the fifth year of an FTA. As previously discussed, the main advantage of $IV_3^S(T)/IV_4^S(T)$ instruments over $IV_1^S(T)/IV_2^S(T)$ is the inclusion of the country-industry-year fixed effects in the gravity equation that predicts trade shares for the former. Not only these fixed effects correct the omitted variable bias in the gravity variables, but also substantially improve the fit of the gravity model itself, making the relationship between the instruments and the endogenous regressors much stronger. One can see that the first stage F-statistics in columns (3) and (4) of Table 2 are substantially greater than those in columns (1) and (2). However, the disadvantage of this approach is that the fixed effects can absorb potentially endogenous unobservable determinants of trade. In column (5) of Table 2 we use both $IV_1^S(T)$ and $IV_3^S(T)$ to instrument changes in preferential export shares, and perform a standard Hansen-J overidentification test to assess the quality of instruments. The test passes

[15] We cannot apply Stock-Yogo weak identification test since the critical values for this test are only available when the number of endogenous regressions does not exceed three. Using the conventional "rule of thumb" by Staiger and Stock (1997), all F-statistics are close or above 10, suggesting that weak identification could in fact be a problem.

[16] A possible alternative to using $IV^S(T)$ instruments to break simultaneity of import shares of MFN tariffs is to use import shares from the first year of the sample. In Appendix D we show that such approach provides only partial solution to endogeneity problem.

easily, and we cannot reject the hypothesis of exogeneity of instruments. The same is true in column (6) when $IV_2^S(T)$ and $IV_4^S(T)$ are used jointly as instruments for $\Delta\overline{PXS}(T)$.

The dynamic response of tariff changes to FTA formation in Figure 6 relies on two sources of data variation, captured by the two components of $\Delta\overline{PXS}(T)$ variables in equation (30). The first component, $FTA(T)_{pjt}$, captures the delay in tariff response to an FTA shock. The second component, $(exp\_share_{pjit} - exp\_share_{pjit-T-1})$, captures the intensity of the external trade diversion of an FTA, and measures the strength of the FTA shock for each country and industry. As T increases in Figure 6, $\Delta\overline{PXS}(T)$ changes because both the time elapsed since FTA formation and the strength of trade diversion within an FTA change. In the next exercise we isolate the first effect from the second by fixing the change in preferential trade share within an FTA. Specifically, we fix the second component in equation (30) to the cumulative change over the first five years of the agreement: $(exp\_share_{pj,T=5} - exp\_share_{pji,T=-1})$. The three panels of Figure 7 reproduce results of panels B, D, and E of Figure 6 using fixed preferential export shares to construct $\Delta\overline{PXS}(T)$. The figure confirms that tariff reductions are the most pronounced in years 2 to 4 after FTA formation, and the magnitude of the effect is similar to the previous estimates.

—[Figure 7 here]—

The estimates from Figure 6 and Table 2 point to a potentially non-negligible economic impact of FTAs on tariffs of non-members. For ease of interpretation of the magnitudes of the effects, we estimate the cumulative effect of FTAs over the first five years of implementation using the variation of equation (30):

$$\Delta_5 MFN_{cit} = \beta\Delta_6\overline{PXS}(T=5)_{cit} + \gamma_{ct} + \gamma_{ci} + \upsilon_{cit} \tag{33}$$

where the dependent variable is the change in the MFN tariff between years t and $(t-5)$, and $\Delta_5\overline{PXS}(T=5)$ is the change in preferential export share between t and $(t-6)$ resulting from FTAs formed in year $(t-5)$. The estimation results for equation (33) using different sets of instruments, presented in Table 3, confirm that the cumulative effect of FTAs on non-member tariffs is negative and significant for all but one specification. Taking -0.401 as the estimate of β from column (1), it implies that if a country's preferential exports increase by 10% as a result of a new FTA, and the share of this country in imports of another country is 10%, the latter will reduce its MFN tariff by 0.401 percentage points in the first five years of the agreement. This result is comparable to what we obtain from Table 2 by summing statistically significant coefficients for $\beta_0 - \beta_5$ $(0.103 + 0.090 + 0.088 + 0.127 = 0.408)$. However, because most FTAs do not lead to substantial increase in trade shares between member countries,[17] the link between preferential trade shares of FTA members and MFN tariff reductions by an average non-member country in our sample is quantitatively not very strong. In particular, a one standard deviation increase in $\Delta_6\overline{PXS}\,(T = 5)$ variable is associated with a reduction in the MFN tariff by $0.03-0.04$ standard deviations, or by 0.1 percentage points, and industries in 90th percentile of $\Delta_6\overline{PXS}\,(T = 5)$ distribution have on average 0.076 percentage points lower MFN tariff relative to industries in the 10th percentile.

6 Results with instruments for preferential export shares

The empirical strategy of the previous section addresses endogeneity concerns that may arise if import shares are correlated with the error term in equation (28). Another identification issue with equation (28) relates to the preferential export shares that are used in the construction of the main explanatory variables as proxies for unobservable changes in the export supply elasticities. The theoretical model predicts that FTAs affect both the export supply elasticities and the preferential export shares positively, so that changes in the latter can be used to infer changes in the former. However, a change in the share of a country's exports to its FTA trade partners is an imperfect measure of a change in the export supply elasticity since trade shares may vary for a variety of other reasons.

In the presence of the measurement error in the export supply elasticities, identification of the effect of trade agreements on trade policies of excluded countries in model (28) rests on two assumptions. First, the variation in preferential export shares must to some extent reflect changes in the export supply elasticities. We provide some evidence in support of this assumption in Appendix D where we use Feenstra's (1994) methodology to estimate country-industry-specific export supply elasticities for two time periods: 1988-2001 and 2002-2011. Consistent with our theory, we find a positive and statistically significant relationship between changes in the export supply elasticities and changes in preferential export shares over these two periods.

The second assumption that is necessary to obtain consistent estimates of β_T from model

[17] For 89% of all country-pairs and industries in our sample, an increase in the share of preferential trade in total trade of FTA member countries does not exceed one percentage point in the first four years of the agreement.

(28) is that the portion of variation in preferential export shares that is unexplained by changes in the export supply elasticities must be unrelated to the error term in (28). In particular, this assumption requires that there are no shocks that affect both the trade structure within FTAs and the MFN tariffs of excluded countries other than country-industry and country-year specific shocks.[18] Furthermore, large measurement error in preferential export shares may lead to the attenuation bias in β_T estimates.

To address these endogeneity concerns, we instrument for $\Delta\overline{PXS}(T)$ using the following IVs:

$$\begin{aligned} IV^X(T)_{cit} &= \left(\sum_p \widehat{imp\_share}_{cpi} \cdot \Delta\widehat{PXS(T)}_{pit-T-1}\right) \\ \Delta\widehat{PXS(T)}_{pit-T-1} &= \sum_{j\neq c} FTA(T)_{pjt} \cdot \Delta\widehat{exp\_share}_{pjit} \end{aligned} \tag{34}$$

where $\Delta\widehat{exp\_share} = \left(\widehat{exp\_share}_{pjit} - \widehat{exp\_share}_{pjit-T-1}\right)$ capture the part of variation in preferential trade shares that is orthogonal to the error term in (28). We build on theoretical frameworks to obtain $\Delta\widehat{exp\_share}$ measures, and then use these measures to construct two alternative sets of instruments $IV^X(T)$ that rely on different sources of identifying variation in preferential export shares. For $\widehat{imp\_share}$ we can use any of the gravity models discussed in section 3, but our most favoured specifications are the ones estimated with the PPML, both with and without country-industry-year fixed effects.

Obtaining $\Delta\widehat{exp\_share}$ requires instruments for changes in preferential export shares which are correlated with the effect of a trade agreements on trade flows between member countries but uncorrelated with both the MFN tariffs of third countries and possible common shocks. The first sets of instruments that isolate the variation in preferential export shares due to regional trade agreements is motivated by Baier and Bergstrand (2004), who constructed a general equilibrium model of trade with two monopolistically competitive industries, two factors of production, six countries, and three continents. Using this model, Baier and Bergstrand identify several factors that contribute to larger effect of an FTA on trade volumes between member countries. Specifically, they find that FTAs lead to more trade between member countries when trade partners are 'natural' (i.e. when trade costs between them are low), more remote from the rest of the world, are larger and more similar in size. They also show that FTAs create

[18] This assumption also requires that preferential trade shares of FTA member countries do not respond to future changes in trade policies of third countries. For example, one may argue that future reductions in MFN tariffs can divert trade flows of third countries away from their FTA partners to the extent that those changes are expected.

more trade when the difference in factor endowments is large between member countries and small between members and the rest of the world. As with the instrumental variables strategy for import shares, we begin by focusing on geographic determinants of trade only, and add differences in factor endowments in our analysis later.

To control for trade costs between FTA member countries p and j we use three gravity model variables: logarithm of the bilateral distance ($\ln D_{pj}$), the common border indicator (B_{pj}), and the common language indicator (L_{pj}). The remoteness measure for a pair of countries p and j with respect to the rest of the world is constructed as the simple average of the log of mean distance of country p to its trade partners except for j and the log of mean distance of country j to its trade partners except for p:

$$REMOTE_{pj} = \frac{1}{2}\left[\ln\left(\frac{\Sigma_{k\neq j} D_{pk}}{N-2}\right) + \ln\left(\frac{\Sigma_{k\neq p} D_{jk}}{N-2}\right)\right]$$

where N is the total number of countries. As in Baier and Bergstrand (2004), we use the interaction of the remoteness measure with the same continent indicator variable ($CREMOTE_{pj}$) in order to distinguish inter-continental and intra-continental trade costs. We use the sum of logarithms of two countries' populations as a measure of their economic size ($SIZE_{pj}$) and the absolute difference in the logarithms of population of two countries as a measure of size asymmetry ($DSIZE_{pj}$).

Because we need instruments for preferential export shares at country-pair-industry-year level while the geography variables do not vary within country pair cells, our point of departure is to estimate the dynamic effect of those variables on trade volumes within an FTA. We allow several years for trade volumes between trade partners to converge to the new equilibrium levels in the presence of an FTA. There are at least two reasons to expect a delayed response of trade flows to FTA formation. First, it may take some time for producers to adjust their production plans and capacities to changes in market conditions. Second, many FTAs do not lead to free trade in the first year of the agreement but rather liberalize trade policy gradually by phasing-out preferential tariff reductions over several years. In the presence of dynamic response of trade flows to FTA formation, we allow for the effect of the instruments for preferential trade shares to be time-specific during the first five years of the agreement. We also allow for the effect of these geography instruments on within-FTA trade to vary by industry. As a result, for every industry i we estimate the following regression:[19]

$$\begin{aligned} \Delta exp\_share_{pjit} &= \beta^0_{iT} + \beta^1_{iT} \ln D^T_{pjt} + \beta^2_{iT} B^T_{pjt} + \beta^3_{iT} L^T_{pjt} + \\ &\quad + \beta^4_{iT} REMOTE^T_{pjt} + \beta^5_{iT} CREMOTE^T_{pjt} + \\ &\quad + \beta^6_{iT} SIZE_{pj} + \beta^7_{iT} DSIZE_{pj} + \upsilon_{pjit} \end{aligned} \tag{35}$$

where $x^T_{pjt} = FTA\,(T)_{pjt}\, x_{pj}$ and $-3 \le T \le 6$. As before, we combine all FTAs formed prior to year $(t-5)$ into one category of $T = 6$. Using fitted values from model (35), $\Delta \widehat{exp\_share}$, we predict the effect of FTAs on trade between members from the geography variables only, and this prediction is plausibly independent from other determinants of trade policies of non-member countries. We then use $\Delta \widehat{exp\_share}$ in equation (34) to construct the first set of instruments, $IV^X_1\,(T)$, for $\Delta\overline{PXS}\,(T)$ variables in model (28). These instruments are functions of pre-determined geographic characteristics of a country's trade partners and FTA dummy variables, and provide consistent estimates under the condition that the decision of a pair of third countries to form an FTA is independent of the error term in (28).

Estimation results for model (35) indicate that trade costs, remoteness, and the level and asymmetry in populations of two countries are reasonably good predictors of the effect of an FTA on preferential trade shares. For 94 industries out of 97 we reject the null that the explanatory variables have no effect on changes in preferential export shares at 99% confidence level.[20] The mean F-statistics for the test $\beta^k_{iT} = 0\ \forall k = 1, ..7$ is 9.26, the mean R-square is 0.21, and the correlation between predicted and actual preferential trade shares is 0.27.

Three points about equation (35) need to be emphasized. First, allowing for the effect of FTAs to be dynamic generates variation in $\Delta \widehat{exp\_share}$ over time. This variations captures delayed economic response to terms-of-trade shocks, as well as the possibility of a "phased-in" implementation of the agreement. Second, with the coefficients on the right-hand side variables varying by industry, we obtain cross-industry variation in the predicted preferential trade shares even though the geography variables in (35) vary only by country-pair. To develop intuition for this approach, consider the distance variable. We know that the effect of an FTA on trade flows depends on trade costs and is decreasing in distance. Our earlier results also show that the effect of distance and other gravity model measures of trade costs vary across

[19] The model by Baier and Bergstrand (2004) also proposes economic determinants of trade creation within FTA, such as relative and absolute difference in physical and human capital endowments. However, because these determinants have little predictive power for trade effects of FTAs in the data, we do not use them in our analysis.

[20] For the remaining 3 industries the explanatory variables in (35) are jointly significant at 95%.

industries. Therefore, one would expect the effect of an FTA on trade to be stronger in those industries where transportation costs and distance play lesser role. The relevance of variation in coefficients in equation (35) is supported by the fact that 65% of variation in $\Delta\widehat{exp\_share}$ is coming from the variation within country-pair-year cells and 51% is coming from the variation within country-pair-industry cells. Lastly, we are not trying to predict changes in preferential trade between countries which are not members of any preferential trade agreement. For this reason, equation (35) is estimated only for country pairs which were part of an FTA in year $(t - T)$.

Estimation results with $IV_1^X(T)$ instruments are presented in Figure 8, while Table 2 reports the first-stage statistics.

—[Figure 8 here]—

We report results with import shares obtained from the gravity model (32) without fixed effects (Panel A of Figure 8; column (7) of Table 2) and with country-industry-year fixed effects (Panel B of Figure 8; column (8) of Table 2). In this way, $IV_1^X(T)$ instruments not only isolate variation in preferential export shares changes which can be attributed to the effect of FTAs, but also address the problem of endogeneity of import shares. Although the first-stage F-statistics are somewhat low, the results of Angrist-Pischke test indicate strong correlation between our instruments and the endogenous regressors.

The dynamics of β_T coefficients over the life of an FTA is similar to what was obtained previously without instrumenting for preferential export shares. The MFN tariffs of non-member countries exhibit a negative response to an FTA immediately after the agreement formation. Of the eight second-stage coefficients on $\overline{PXS}(T)$ variables, three remain negative and statistically significant at the 90% confidence level. Specifically, the estimated effect of FTAs on tariff reduction by outside countries is the strongest in years one to three of FTA formation. Although the overall pattern in β_T coefficients is similar to what we obtained previously, the point estimates of these coefficients are notably larger when the changes in preferential export shares are instrumented for, which is consistent with the presence of attenuation bias in the benchmark estimates. Since changes in preferential export shares is an imperfect measure of changes in export supply elasticities, noisy data may bias the coefficient estimates towards zero. Hence, isolating variation in $\overline{PXS}(T)$ variables which is related to trade agreements and changes in export supply elasticity may improve identification of the effect of our interest.

To build the second set of instruments for preferential export shares, we utilize a structural gravity model instead of (35) to obtain predicted changes in preferential export shares. We follow Anderson and Yotov (2016) and estimate the following gravity model with PPML:

$$X_{pjit} = \exp\left[Z_{pjit} \cdot FTA\left(T\right)_{pjt} \beta_{iT} + \gamma_{pit} + \gamma_{jit} + \gamma_{pji} + \varepsilon_{pjit}\right] \tag{36}$$

where X_{pjit} is exports of product i from country p to country j in year t. Z_{pjt} is a set of geography variables that may affect the strength of an FTA on internal trade flows. Specifically, Z_{pjt} includes a constant term, the logarithm of bilateral distance between countries p and j, the common border and the common language indicators, the measure of remoteness of p and j from the rest of the world, the sum of logarithms of the two countries' populations, and the absolute difference in the logarithms of populations of the two countries. Thus, $Z_{pjit} \cdot FTA\left(T\right)_{pjt}$ interactions estimate the dynamic effect of FTAs on bilateral trade. γ_{pit} and γ_{jit} denote importer-industry-year and exporter-industry-year fixed effects that account for multilateral price terms, output, and expenditure. γ_{pji} capture importer-exporter-industry fixed effects, which not only control for time-invariant trade costs at country-pair-industry level, but also alleviate potential endogeneity of $FTA\left(T\right)_{pjt}$ binary variables arising from non-random selection of partner countries for preferential trade liberalization (Baier and Bergstrand, 2007).

We use model (36) to predict both the counterfactual value of trade in the absence of FTAs

$$\widehat{X}^0_{pjit} = \exp\left[\widehat{\gamma}_{pit} + \widehat{\gamma}_{jit} + \widehat{\gamma}_{pji}\right]$$

and trade flows with FTAs

$$\widehat{X}^1_{pjit}\left(T\right) = \exp\left[Z_{pjit} \cdot FTA\left(T\right)_{pjt} \widehat{\beta}_{iT} + \widehat{\gamma}_{pit} + \widehat{\gamma}_{jit} + \widehat{\gamma}_{pji}\right],$$

and construct the second set of instruments, $IV^X_2\left(T\right)$, using (34) and the predicted changes in preferential exports:[21]

$$\Delta\widehat{PXS(T)}_{pit-T-1} = \sum_{j \neq c}\left(\frac{\widehat{X}^1_{pjit}\left(T\right) - \widehat{X}^0_{pjit-T-1}}{\widehat{X}^0_{pjit-T-1}}\right) \tag{37}$$

Because the gravity model (36) accounts for several identification issues that the model (35) cannot address – such as the omitted variables bias, the endogeneity of trade agreements,

[21] Due of the perfect collinearity problem, we have to drop one of the importer-industry-year fixed effects and one of the exporter-industry-year fixed effects. As a result, all γ_{pit} and γ_{jit} are estimated relative to these omitted categories. However, this normalization does not affect the quality of our instruments because the relative ranking of partner countries in their preferential trade shares is preserved.

and the truncation of trade flows at zero – the main advantage of $IV_2^X(T)$ instruments over $IV_1^X(T)$ is the more reliable estimates of the FTA effect on trade. However, the disadvantage is that $IV_2^X(T)$ rely on aggregate trade flows predicted from the structural gravity equation (36). Since these predicted trade flows incorporate information on price indices, expenditure, and other potentially endogenous economic variables, the exclusion restriction for $IV_2^X(T)$ is more likely to fail.

Results with $IV_2^X(T)$ instruments are presented in Panel C of Figure 8 and column (9) of Table 2. The first thing to note is that the instruments $IV_2^X(T)$ are highly relevant. The correlation between preferential export shares predicted from (37) and the actual shares is 0.53, and the F-statistics for joint significance of the instruments in the first stage regressions substantially greater than with $IV_1^X(T)$ instruments. The estimation results from the second-stage are close to the benchmark specification, both in terms of the magnitudes and the overall pattern. All post-FTA coefficients are negative with a sharp reduction in the first year of agreement formation, while the pre-FTA coefficients are close to zeroes. However, estimating equation (28) with $IV_2^X(T)$ instruments gives less precisely estimated regression coefficients, with three out of seven the post-FTA coefficients being statistically significant at 10% and only one of them being significant at 1%.

In Figure 9 we reproduce the results of Figure 8 using time-invariant changes in preferential export shares, as in Figure 7 before. Specifically, we use the change in preferential export shares over the first five years of an FTA, both actual and predicted, to construct $\Delta\overline{PXS}(T)$ variables and their instruments. While in Panel A the effect of FTAs on tariff changes by non-members become stronger and statistically significant in year two and all following years, in Panel B all coefficients become insignificant. With $IV_2^X(T)$ as instruments in Panel C, the estimates have similar magnitudes to those in Figures 6-9 and are statistically significant at 10% confidence level in years 2 to 4.

—[Figure 9 here]—

7 Robustness tests

We conduct a series of robustness tests for the effect of FTAs on non-members' tariffs. First, the time frame of our sample overlaps with the major episode of multilateral tariff reductions, negotiated during the Uruguay round of the WTO negotiations and phased in between 1996 and 2001. One might be concerned that tariff reductions during 1996-2001 period were predetermined and correlated with some unobservable characteristics of countries trade partners through multilateral bargaining process. To verify that our explanatory variables pick up the effect of preferential trade liberalization rather than the WTO-induced tariff reductions, we report the estimation results separately for 1988-2001 and 2002-1011 time periods. We also exclude from the sample all WTO accession countries, which may have negotiated different timing for tariff reductions. Figure 10 shows that the dynamics in β_T coefficients on the two subsamples is similar to the benchmark results.

—[Figure 10 here]—

In Figure 11 we show that our results are robust at a higher level of product disaggregation. Specifically, we show that tariffs respond negatively to an increase in partner countries' preferential trade in 4-digit HS trade and tariff data. The effect is still the strongest in the second and the third years of a trade agreement but the magnitudes are lower with more disaggregated data. When import shares are instrumented for, the coefficient estimates obtained with the 4-digit HS data are smaller than those obtained with 2-digit data, but remain highly significant in the second and third years of the agreement. When both import and preferential export shares are instrumented, the estimates are comparable in magnitude to our previous results but are estimated less precisely, with the coefficients β_1 and β_2 significant only at 10% level. Overall, the results with more disaggregated trade data confirm our previous findings that FTAs stimulate other countries to lower their tariffs.

—[Figure 11 here]—

We perform many additional sensitivity tests and tabulate the key estimates for alternative samples of the data to verify that our results remain stable. We show that the main result remains qualitatively similar when China is included in the sample. Although rapid increase in Chinese exports since 2001 has a strong negative impact on the average change in preferential export share, this effect does not vary systematically across FTAs and keeping China in the sample does not affect the estimates. Results are similar when the model is estimated for countries with different income levels and for different industry groups. Finally, results are also robust to excluding African countries from the sample. Most African countries export mostly primary goods, and regional integration has little potential for trade creation. Yet there are many multilateral trade agreements in Africa and nearly 15% of all country-pairs with FTAs in our sample are between African countries. Excluding those trade agreements from the analysis does not change any of the results.

8 Welfare implications

In this section we examine quantitatively the importance of tariff adjustments by non-member countries for the welfare effects of FTAs. Although our empirical results show that the FTA-induced tariff reduction undertaken by an individual non-member country is fairly small, in this section we show that the combined tariff reductions of all non-member countries can deliver substantial welfare gains.

Let w_z^{adj} and w_z^{no-adj} denote the welfare levels of an FTA member country when non-members do and do not adjust their tariffs, respectively. Then using our theoretical model the welfare gain to member countries from tariff reductions undertaken by non-members can be written as

$$\Delta w_z^{adj} = w_z^{adj} - w_z^{no-adj} = \frac{2(n-m)^2 \Delta t_c^Z t_c^Z(\phi) \left[\alpha\lambda - (\lambda + 2m) t_c^Z(\phi)(2 - \Delta t_c^Z)\right]}{(\lambda + 2n)^2}$$

The effect of an FTA on members' welfare in the absence of tariff adjustments by non-members is

$$\begin{aligned} \Delta w_z^{FTA-noadj} &= w_z^{no-adj} - w_z(\phi) \\ &= \frac{(m-1) t_c^Z(\phi) \left[2(n-m)\alpha\lambda + t_c^Z(\phi)(\lambda^2 + 2(m+1)\lambda + 4(n + (n-m)(n-m-1)))\right]}{(\lambda + 2n)^2} \end{aligned}$$

where $w_z(\phi)$ is welfare under no agreement.

The welfare gain of a member country from an FTA when non-members impose optimal tariffs is the sum of the above welfare gains:

$$\Delta w_z^{FTA} = \Delta w_z^{FTA-noadj} + \Delta w_z^{adj}$$

Consider a single FTA of size m. Using the optimal tariff expressions (24) and (25), we can calculate the welfare gain for member countries from the implied tariff adjustments by non-members as a fraction of the total welfare gain: $\%\Delta w_z^{adj} = 100 \times \frac{\Delta w_z^{adj}}{\Delta w_z^{FTA}}$. Figure 12 plots $\%\Delta w_z^{adj}$ for different sizes of an FTA m, assuming $n = 10$ and $\lambda = \frac{1}{2}$.[22]

[22] The simulation results reported below are not particularly sensitive to variations in λ.

—[Figure 12 here]—

Panel A of Figure 12 demonstrates that tariff adjustments by non-member countries account for over 12% of FTA welfare gains to members when the FTA is small relative to the rest of the world, and this share falls gradually as size of the FTA relative to the rest of the world goes up. In Panel B of Figure 12 we repeat the same exercise but this time we use the elasticity of non-members' tariffs with respect to an FTA estimated from the data rather than the one implied by our model. Specifically, we use the change in the PXS predicted by the model and assume that non-member countries lower their pre-FTA MFN tariffs by 0.319% of the increase in the PXS of their average trade partner, which is the elasticity estimate from our most preferred specification (the sum of all statistically significant coefficients in Column 9 of Table 2). This exercise yields very similar results for the contribution of tariff adjustments to welfare gains for member countries.

Next, we analyze the role of tariff adjustments by non-member countries for the effect of FTAs on their welfare. For non-member country c, the welfare loss from tariff adjustment by all non-member countries equals

$$\Delta w_c^{adj} = w_c^{adj} - w_c^{no-adj} = \frac{m\Delta t_c^Z t_c^Z(\phi)\left[(\lambda+2m)(\lambda+4n-2m)t_c^Z(\phi)(2-\Delta t_c^Z) - 2(n-m)\alpha\lambda\right]}{(\lambda+2n)^2} < 0$$

It is important to note here that while each non-member country optimally reduces its tariff non-cooperatively, the simultaneous reduction in tariffs by other non-member countries increases the price of the imported good and weakens the terms of trade effect, thus lowering the welfare of a typical non-member country.

The welfare effect of an FTA when non-members keep their original tariffs is

$$\Delta w_c^{FTA-noadj} = w_c^{no-adj} - w_c(\phi) = -\frac{2m(m-1)t_c^Z(\phi)\left[\alpha\lambda + 2(n-m-1)t_c^Z(\phi)\right]}{(\lambda+2n)^2} < 0$$

and the total welfare loss for a non-member country from an FTA when non-member countries optimally adjust tariffs is the sum of the above welfare changes: $\Delta w_c^{FTA} = \Delta w_c^{FTA-noadj} + \Delta w_c^{adj}$. Similar to the discussion for member countries, the welfare loss of non-member countries due to tariff adjustment relative to total loss from an FTA is $\%\Delta w_c^{adj} = 100 \times \frac{\Delta w_c^{adj}}{\Delta w_c^{FTA}}$. Panel A of Figure 13 plots $\%\Delta w_c^{adj}$ for different m.

—[Figure 13 here]—

The results show that when FTA is comprised of only two countries, tariff adjustments by non-members account for 12% of the total negative impact of the FTA on non-members' welfare, and the share goes up to 17% when we use the estimated elasticity of non-members tariff with respect to FTAs. Overall our simple simulation exercise reveals that tariff adjustments by individual non-members induced by the formation of an FTA, albeit small in absolute values, can have a substantial collective effect on the welfare of member and non-member countries.

9 Conclusions

We develop a simple theoretical model of endogenous tariffs with an arbitrary number of countries and analyze the effect that the formation of an FTA between a sub-set of countries has on the import tariffs of excluded countries. This model predicts that an FTA re-directs export flows of member countries away from the rest of the world towards each other and thereby reduces the elasticities of export supply curves faced by non-members. As a result, the ability of non-members to manipulate their terms-of-trade via import tariffs is weakened which, in turn, induces them to lower their MFN tariffs on FTA members. We show that this trade liberalization effect of an FTA on non-member countries is stronger when the increase in trade flows between members resulting from the agreement is larger.

Bringing this prediction to the data, we find considerable support for the hypothesis that FTAs reduce the terms-of-trade motive for protection of non-member countries. Using tariff data for 136 countries and information on all FTAs formed in the world between 1990 and 2011, we find that larger trade flows between member countries indeed lead to reductions in MFN tariffs of their non-member trade partners.

In conclusion, we wish to emphasize two fundamental points. First, since the evidence presented in this paper shows that the formation of FTAs can cause trade liberalization to spillover to excluded countries, an important channel of welfare gain resulting from their formation has been overlooked in the existing literature. For example, the literature addressing whether FTAs are building or stumbling blocs for multilateral liberalization has tended to focus primarily on how FTA formation affects the incentives of member countries to undertake further liberalization with respect to excluded countries. Our analysis shows that we also need to pay attention to the effects that FTAs might have on trade policies of non-member countries. The second major point to note is that, by examining the impact of FTAs on tariffs of non-member countries, our results provide rather novel and convincing support for the terms of trade theory of optimal tariffs since the formation of an FTA between a few countries can be reasonably interpreted as an exogenous event from the perspective of the rest of the world.

Appendix

In this section, we provide the necessary supporting calculations, proofs, and discussions.

Appendix A. Welfare components and the optimal tariff

In this section, consistent with the Article XXIV of the GATT, we assume that member countries under an FTA remove their internal tariffs ($\widehat{t^g} = 0$) while imposing external tariffs on the non-member countries independently. As before, suppose that country z forms an FTA with $(m-1)$ countries and country c is a non-member country while $\tilde{c}$ denotes non-members other than country c. Let F denote the set of goods produced by FTA member countries. Next, we report individual welfare components for country c. Consumer surplus equals

$$\begin{aligned} CS_c &= \frac{1}{2}[\alpha - \frac{n\alpha - 2mt_m^C - 2(n-m-1)t_{\tilde{c}}^C}{\lambda + 2n}]^2 \\ &+ \frac{1}{2}\sum_{J \in F}[\alpha - \frac{n\alpha - 2t_c^J - 2(n-m-1)t_{\tilde{c}}^J}{\lambda + 2n} - t_c^J]^2 \\ &+ \frac{1}{2}\sum_{J \notin F, J \neq C}[\alpha - \frac{n\alpha - 2t_c^J - 2mt_m^J - (n-m-1)t_{\tilde{c}}^J}{\lambda + 2n} - t_c^J]^2 \end{aligned}$$

while producer surplus is

$$\begin{aligned} PS_c &= \frac{1+\lambda}{2}[\frac{n\alpha - 2mt_m^C - 2(n-m-1)t_{\tilde{c}}^C}{\lambda + 2n}]^2 \\ &+ \frac{1}{2}\sum_{J \in F}[\frac{n\alpha - 2t_c^J - 2(n-m-1)t_{\tilde{c}}^J}{\lambda + 2n} + t_c^J]^2 \\ &+ \frac{1}{2}\sum_{J \notin F, J \neq c}[\frac{n\alpha - 2t_c^J - 2mt_m^J - (n-m-1)t_{\tilde{c}}^J}{\lambda + 2n} + t_c^J]^2 \end{aligned}$$

Furthermore, tariff revenue equals

$$TR_c = \frac{\sum_{J \in F} t_c^J[\alpha\lambda - 2\lambda t_c^J - 4(n-1)t_c^J + 4(n-m-1)t_{\tilde{c}}^J]}{\lambda + 2n} + \frac{\sum_{J \notin F, J \neq C} t_c^J[\alpha\lambda - 2\lambda t_c^J - 4(n-1)t_c^J + 4mt_m^J + 4(n-m-2)t_{\tilde{c}}^J]}{\lambda + 2n}$$

Under optimal tariffs, the export supply elasticity ε_c^Z is found as:

$$\varepsilon_c^Z = \frac{n\lambda + 2[n(n-1) + m]}{\lambda} \tag{38}$$

Note that the intensive margin is internalized with optimal tariffs and only extensive margin appears in capturing the preferential export share. The formation of an FTA raises ε_c^Z relative to no agreement and it rises more as the FTA has more members (as the preferential export share rises): $\frac{\partial \varepsilon_c^{gz}}{\partial m} > 0$. Country c's optimum external tariff on good Z is found as follows:

$$t_c^Z = \frac{\alpha\lambda}{(\lambda + 2n)^2 - 4(n-m)} \tag{39}$$

Consistent with the export supply elasticity discussion, we find that non-member countries impose lower tariffs with the formation of an FTA and as the size of the FTA expands (i.e. as the preferential export share of a typical FTA member rises), the result gets stronger: $\frac{\partial t_c^Z}{\partial m} < 0$.

Appendix B. General demand and supply

In this section, we examine whether the results obtained under a linear demand and supply framework extend to a more general setting. To this end, we make two fairly unobjectionable assumptions: (i) import demand functions are negatively sloped while export supply functions are positively sloped ; (ii) there exist at least one member country exporting good z while at least one other member country and one non-member country (country c) importing good Z. At a given world price, the formation of an FTA increases the preferential export shares of member countries while simultaneously reducing their export supply to all importing non-member countries. As a result, FTA formation leads to a decrease in $x_{zc}^Z(p_z^Z)$, shifting it parallel leftward and the equilibrium world price of good Z rises while the equilibrium exports of good Z to country c fall.[23] Note that the larger the volume of preferential trade among FTA members relative to the rest of the world, the greater the magnitude of the leftward shift of $x_{zc}^Z(p_z^Z)$.

[23] The same results would obtain even when the shift is non-parallel as long as there is a greater magnitude of shift at higher prices.

The following result, confirms that the main findings of our theoretical model hold under a fairly general setting:

Proposition 2: *Suppose that the (inverse) export supply function $p_z^Z(x_{zc}^Z)$ is log-concave.*[24] *Then the following holds: (i) the formation of an FTA raises ε_c^Z which in turn leads to a reduction in the optimal tariff t_c^Z of a typical non-member country (i.e. country c) and (ii) the larger the increase in the volume of preferential trade among FTA members relative to the rest of the world, the larger is the reduction in the tariffs of non-member countries.*

As mentioned above, following the formation of an FTA, the export supply curve of country z, i.e. $x_{zc}^{Z^0}(p_z^Z)$, shifts parallel leftward to $x_{zc}^{Z'}(p_z^Z)$. As represented in figure 1, at the original equilibrium price $p_z^{Z^0}$, the outputs supplied are $x_{zc}^{Z^0}$ and $\widetilde{x_{zc}^{g_z}}$ along the supply curves $x_{zc}^{Z^0}(p_z^Z)$ and $x_{zc}^{Z'}(p_z^Z)$, respectively.[25] Note that we have the same slope at $p_z^{Z^0}$ along both $x_{zc}^{Z^0}(p_z^Z)$ and $x_{zc}^{Z'}(p_z^Z)$ and thus $\frac{dx_{zc}^Z}{dp_z^Z(x_{zc}^Z)}p_z^Z$ is the same at both $x_{zc}^{Z^0}$ and $\widetilde{x_{zc}^Z}$. Furthermore, the new equilibrium quantity of exports $(x_{zc}^{Z'})$ is smaller relative to the original $(x_{zc}^{Z^0})$: $x_{zc}^{Z'} < x_{zc}^{Z^0}$. Since the inverse export supply function is log-concave, moving from $\widetilde{x_{zc}^Z}$ to new equilibrium export supplied $x_{zc}^{Z'}$, $\frac{dx_{zc}^Z}{dp_z^Z(x_{zc}^Z)}p_z^Z$ rises. As a result, the export supply elasticity at $x_{zc}^{Z'}$ is larger than that at $x_{zc}^{Z^0}$ which in turn induces the non-member country c to reduce its optimal tariff t_c^Z. Finally, the larger the increase in the volume of preferential trade among FTA members relative to the rest of the world, the greater the magnitude of the leftward shift in the export supply curve $x_{zc}^{Z^0}(p_z^Z)$ of member country z and larger the increase in the export supply elasticity facing non-members.

– Figure 3 –

Appendix C. Cooperative tariff setting

In this section, we demonstrate that Proposition 1 continues to hold even when countries do not set their tariffs non-cooperatively. Let $\mu \in [0,1]$ denote the weight each country assigns to

[24] Note from its definition that $p_z^{g_z}(x_{zc}^{g_z})$ is log-concave if and only if $\frac{d^2 \log p_z^{g_z}(x_{zc}^{g_z})}{dx_{zc}^{g_z 2}} < 0$ holds. This condition implies that $\frac{dp_z^{g_z}(x_{zc}^{g_z})}{dx_{zc}^{g_z}}\frac{1}{p_z^{g_z}}$ falls as $x_{zc}^{g_z}$ rises or we can rearrange and argue that $\frac{dx_{zc}^{g_z}}{dp_z^{g_z}(x_{zc}^{g_z})}p_z^{g_z}$ rises as $x_{zc}^{g_z}$ rises. It is important to note that log-concavity of the inverse export supply function is the sufficient but not the necessary condition for our result.

[25] Note that when the inverse export supply function is concave or linear, log-concavity always holds. Therefore, we represent only the case of strictly convex inverse export supply in our figure.

the welfare of other countries in setting its optimal tariffs under any trade policy regime, where μ captures the degree of cooperation across countries. The case where countries set tariffs non-cooperatively arises when $\mu = 0$ while $\mu = 1$ captures full cooperation in tariff setting. The latter case of complete cooperation is uninteresting because when $\mu = 1$, countries fully internalize the effect of their trade policies on their trade partners, and the optimal tariff of every country is equal to zero under any trade regime. In such a situation, there is no need for trade agreements and FTAs would simply not arise. Thus, in what follows, we assume that $\mu \in [0, 1)$.

Focusing on the response of non-member countries' tariffs to formation of FTA of size m, we can calculate the tariff reduction implemented by non-member country c as

$$\Delta t_c^Z(\mu) = -\frac{2(1-\mu)\alpha\lambda(m-1)\left[\alpha\lambda + 2[1+(n-1)\mu]\right]}{\left[(\lambda+2n)^2 - 2(n-1)\left[2(n-1)\mu + \mu\lambda + 2\right]\right]\left[(\lambda+2n)^2 - 2(n-m)\left[2(n-1)\mu + \mu\lambda + 2\right]\right]}$$

Note that $\Delta t_c^Z(\mu) < 0$ for all $\mu \in [0, 1)$. This implies that FTAs reduce export supply elasticities for non-member countries, inducing them to lower tariffs even when countries act cooperatively. Therefore, our main result in Proposition 1 fully extends into the cooperative tariff setting and holds for all levels of cooperation.[26]

Appendix D. Relationship between changes in export supply elasticities and preferential export shares

In the main text we emphasize one key assumption required for the identification of the effect of FTAs on import tariffs of excluded countries using explanatory variables (29) and instruments (31) in the model (28). Specifically, the variation in the trade-weighted average of the preferential export share of a country's trade partners should reflect the variation in the export supply elasticity. In this Appendix we provide some evidence in support of this assumption. We do so by estimating export supply elasticities for every country-industry pair in our sample for two time periods and relating the change in the elasticity to the observed change in preferential export shares of a country's average trade partner.

[26] In fact, we can go one step further and argue that, when the extent of tariff cooperation is not too large, an increase in the degree of cooperation leads to a greater reduction in tariff of non-member countries:

$$\frac{\partial|\Delta t_c^Z(\mu)|}{\partial\mu} > 0 \text{ when } \mu < \overline{\mu}$$

where $\frac{\partial\overline{\mu}}{\partial n} > 0$ and $\frac{\partial\overline{\mu}}{\partial m} < 0$.

We use the approach of Feenstra (1994) and its extension by Broda and Weinstein (2006) to separately identify import demand and export supply elasticities. The presentation here draws heavily on the treatment in Broda and Weinstein (2006), which can be used for a more detailed reference. The approach is based on the following parametrization of the system of import demand and export supply equations:

$$\begin{aligned} x_{civt} &= \left(\frac{p_{civt}}{\phi_{it}}\right)^{1-\sigma_{ci}} \frac{d_{civt} E_{ct}}{p_{civt}} \\ p_{civt} &= \exp\left(\upsilon_{civt}\right) x_{civt}^{\omega_{ci}} \end{aligned} \tag{40}$$

where x_{civt} in the first equation is the demand for variety v of good i consumed in country c in year t derived from the CES utility function which depends on the price (p_{civt}), aggregate income (E_{ct}), the elasticity of substitution between varieties of good i (σ_{ci}), price index for good i (ϕ_{it}), and the random taste parameter (d_{civt}). The export supply function depends on the inverse export supply elasticity (ω_{ci}) and the random technology factor (υ_{civt}) assumed to be independent of d_{civt}. Re-writing quantities in (40) in terms of market shares, taking logs, and time differencing yields

$$\begin{aligned} \Delta \ln s_{civt} &= \varphi_{it} - (\sigma_{ci} - 1)\Delta \ln p_{civt} + u_{civt} \\ \Delta \ln p_{civt} &= \omega_{ci} \Delta \ln x_{civt} + \delta_{civt} \end{aligned}$$

where $\varphi_{it} = (\sigma_{ci} - 1) \ln \left[\phi_{it}/\phi_{it-1}\right]$. In order to eliminate this good-specific unobservable term from the demand equation, both equation are differences with respect to a reference country k. Using superscript k to denote the reference difference operator, the system becomes

$$\begin{aligned} \Delta^k \ln s_{civt} &= -(\sigma_{ci} - 1)\Delta^k \ln p_{civt} + u_{civt}^k \\ \Delta^k \ln p_{civt} &= \omega_{ci} \Delta^k \ln x_{civt} + \delta_{civt}^k \end{aligned} \tag{41}$$

Solving for the error terms in (41) and multiplying them through, we obtain:

$$\begin{aligned} Y_{civt} &= \theta_{1ci} X_{1civt} + \theta_{2ci} X_{2civt} + u_{civt} \\ Y_{civt} &= \left(\Delta^k \ln p_{civt}\right)^2, X_{1civt} = \left(\Delta^k \ln s_{civt}\right)^2, X_{2civt} = \left(\Delta^k \ln p_{civt}\right)\left(\Delta^k \ln s_{civt}\right) \\ u_{civt} &= \frac{u_{civt}^k \delta_{civt}^k}{(1-\rho_{ci})}, \rho_{ci} = \frac{\omega_{ci}(\sigma_{ci} - 1)}{1 + \omega_{ci}\sigma_{ci}} \end{aligned} \tag{42}$$

Feenstra (1994) demonstrates that equation (42) estimated with the 2SLS for every country and industry using indicator variables for varieties as instruments will produce consistent estimates of θ_{1ci} and θ_{2ci}. This estimates, $\widehat{\theta}_{1ci}$ and $\widehat{\theta}_{2ci}$, can be used to calculate elasticity parameters from

$$\begin{aligned}\widehat{\theta}_{1ci} &= \frac{\widehat{\omega}_{ci}}{(1+\widehat{\omega}_{ci})(\widehat{\sigma}_{ci}-1)} \\ \widehat{\theta}_{2ci} &= \frac{\widehat{\omega}_{ci}(\widehat{\sigma}_{ci}-2)-1}{(1+\widehat{\omega}_{ci})(\widehat{\sigma}_{ci}-1)}\end{aligned} \tag{43}$$

The identification of import demand and export supply elasticities in Feenstra (1994) rests on a number of strong assumptions which make it impossible to use them directly in our work. Most importantly for this study, the estimator is asymptotically consistent as the number of time periods approaches infinity. Therefore, changes in the elasticities cannot be obtained for every country-industry-year observation in our sample and are proxied by changes in preferential export shares. In order to assess the quality of this proxy we need to obtain a measure of a change in the export supply elasticity that can be related to changes in preferential export shares. We thus proceed by estimating export supply elasticity ω_{ci} for every country-industry pair in two time periods, 1988-2001 and 2002-2011. Denoting the two periods with T_1 and T_2, we then calculate the change in the average preferential export share between the two periods and regress it on the change in the inverse export supply elasticity:[27]

$$\begin{aligned}\Delta\overline{PXS}_{ci} &= \beta_0 + \beta_1 \Delta\omega_{ci} + e_{ci} \\ \overline{PXS}_{ciT_k} &= \left(\frac{1}{T_k}\sum_p imp\_share_{cpi} \cdot \sum_{t\in T_k} \Delta PXS_{pit}\right),\ k=1,2 \\ \Delta\overline{PXS}_{ci} &= \overline{PXS}_{ciT_2} - \overline{PXS}_{ciT_1},\ \Delta\omega_{ci} = \omega_{ciT_2} - \omega_{ciT_1}\end{aligned} \tag{44}$$

Table A1 presents estimation results for equation (44). The coefficient in column (1) is negative and statistically significant at 5% confidence level. This result implies that, as the theory predicts, a reduction in the inverse export supply elasticity (increase in the level of the export supply elasticity) is associated with an increase in the preferential export share of a country's trade partners. Adding industry fixed effects in column (2) to control for industry-specific trends in preferential trade shares does not affect the results. Column (3) includes country fixed effects to control for country-year specific characteristics such as size and the general structure of trade. Results are broadly similar to the basic specification. Finally, in columns (4)-(6) we reestimate equation (44) using only FTAs formed in 2001-2002 in construction of the dependent variable. These are the FTA which do not affect the estimate of ω_{ci} in period

[27] In this regression we use only observations with $\widehat{\theta}_{1ci} > 0$. We also drop one percent of the observations with the highest and the lowest changes in ω_{ci} in order to minimize the effect of outliers.

T_1 and have potentially the strongest impact on ω_{ci} in period T_2. Although the coefficient β_1 is smaller than in columns (1)-(3), it becomes statistically significant at 1% confidence level.[28]

While the above evidence is consistent with our assumption that changes in preferential export shares reflect changes in the export supply elasticities, these results should be treated with caution. The average number of time periods in the two subsamples are 6.4 and 7.1, respectively, and the estimates of ω_{ciT_2} and ω_{ciT_1} may not be very precise. Indeed, Soderbery (2010) show that in samples of that size the estimates of the export supply elasticity are biased upward by more than 60%.

[28] The variation in $\Delta\overline{PXS}_{ci}$ in columns (4)-(6) is only one sixth of that in columns (1)-(3). For both dependent variables the change in ω_{ci} explains the same share of variation.

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Figure 1. Evolution of MFN tariffs and FTA prevalence

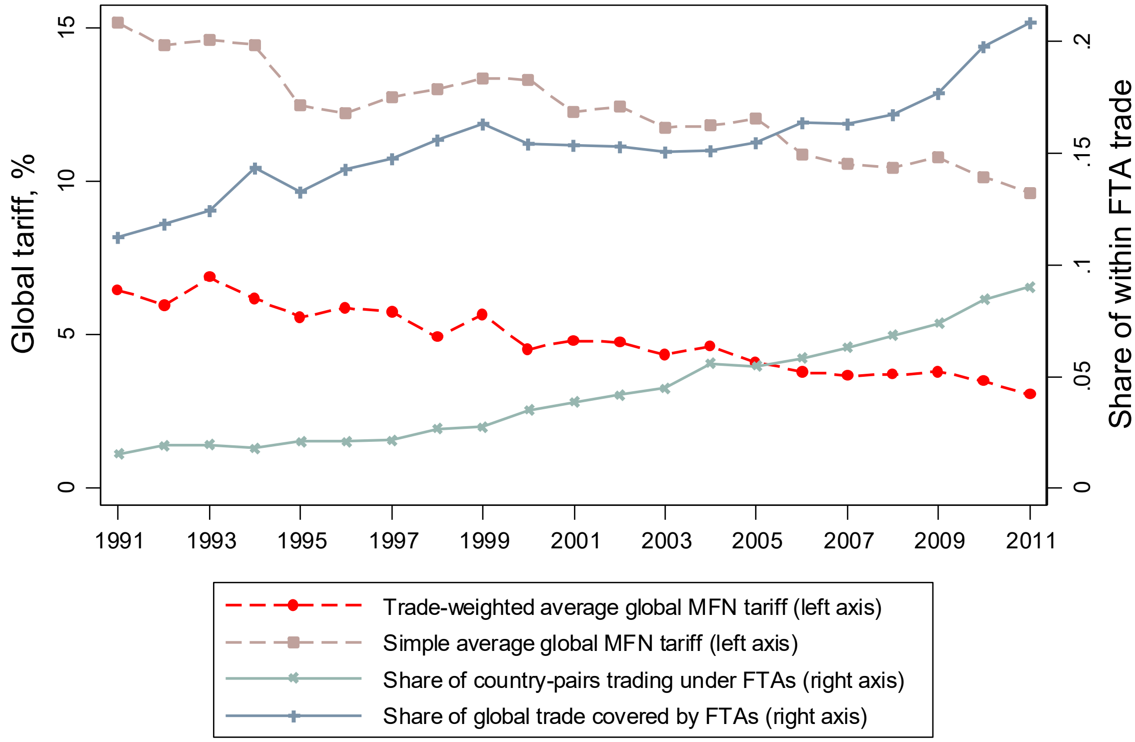


Figure 2. Kernel density for MFN tariff changes in industries with various exposures to change in preferential export share in trade partner countries

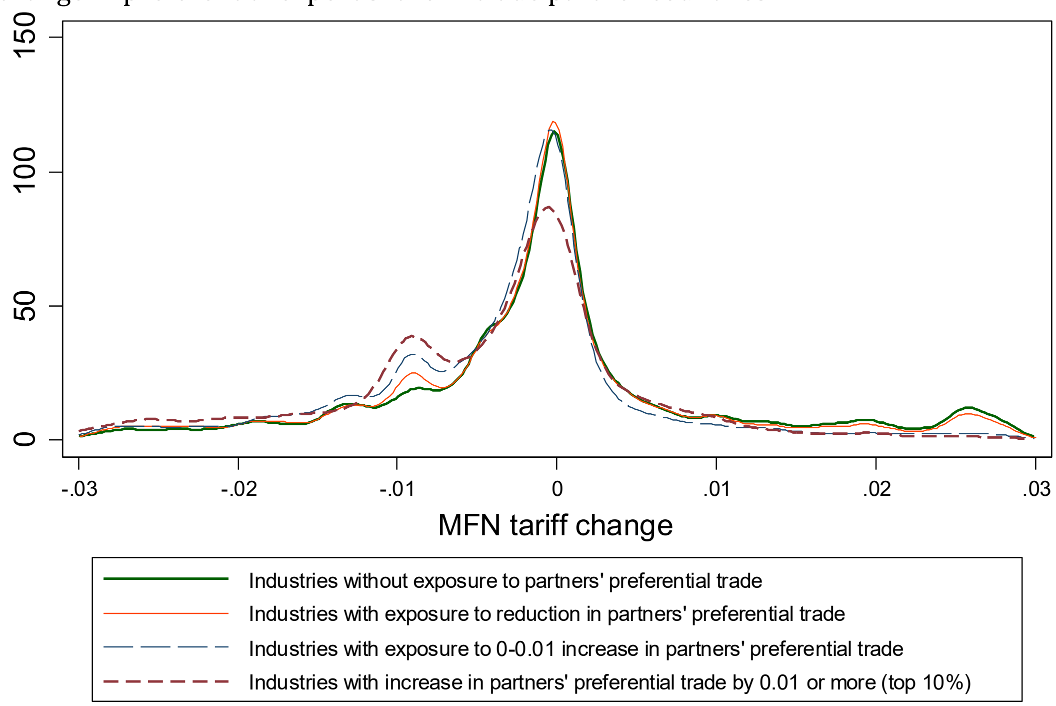


Figure 3. Relationship between FTA formation and tariffs of non-member countries.

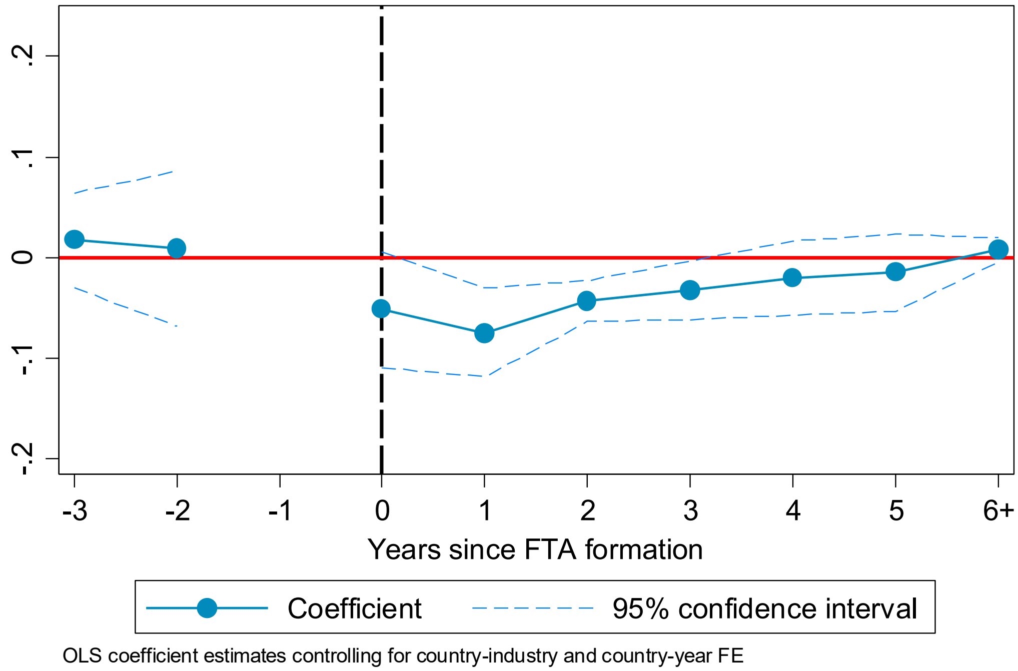
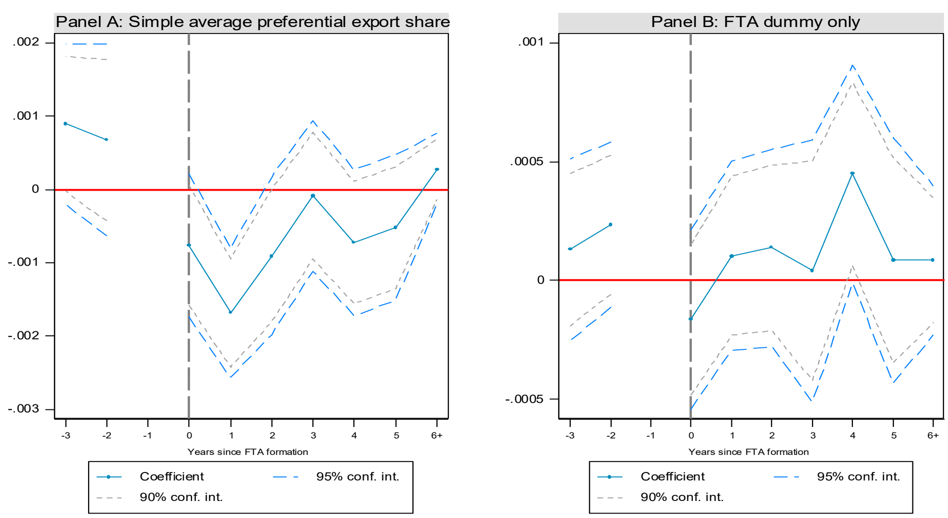


Figure 4. FTA formation and tariffs of non-member countries – the role of import shares and preferential export shares.



Notes: Explanatory variables are: simple average preferential export share of partner countries (Panel A); trade-weighted average of the number of FTA by partner countries (Panel B).

Figure 5. Relationship between FTA formation and tariffs of non-member countries – by FTAs that increase and decrease trade between members.

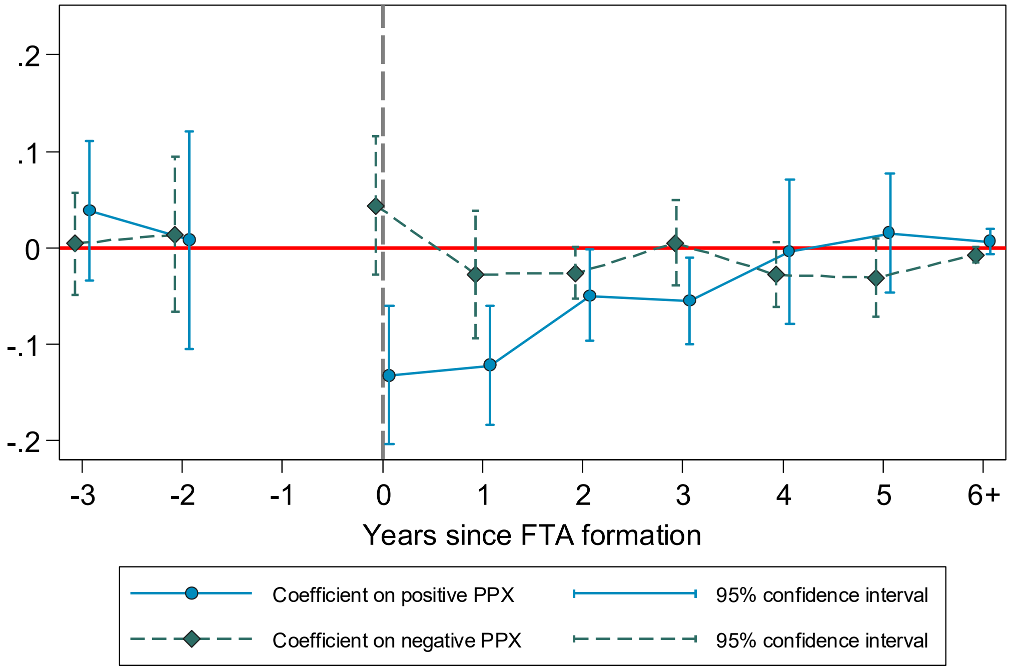
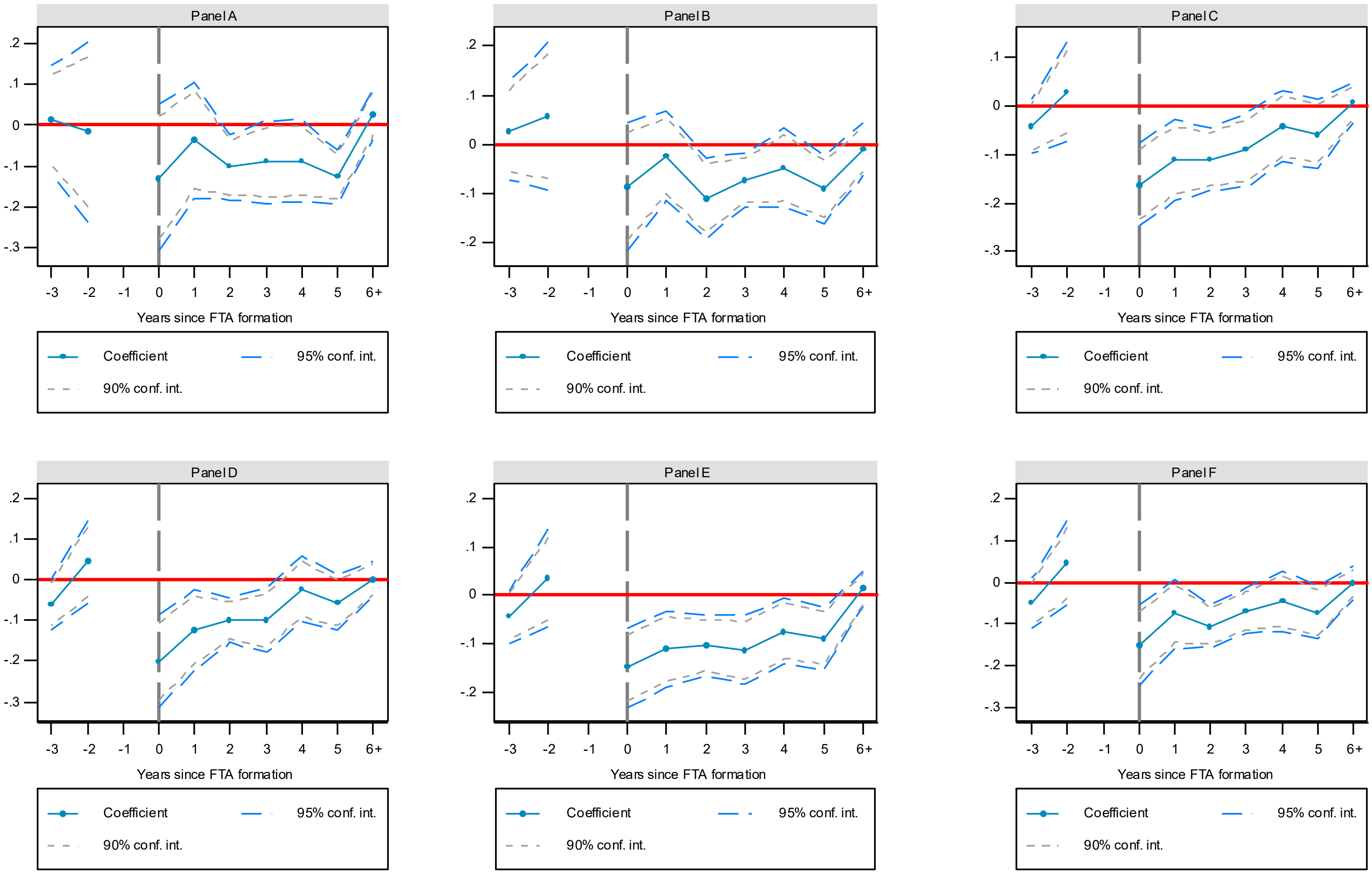
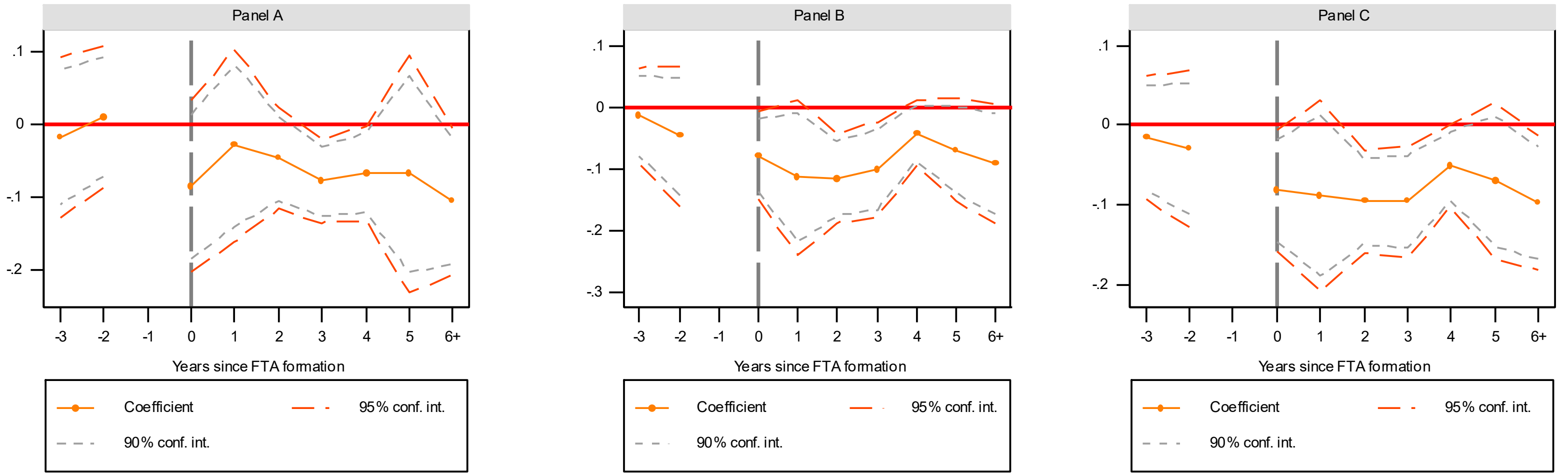


Figure 6. Baseline results with instrumented import shares.



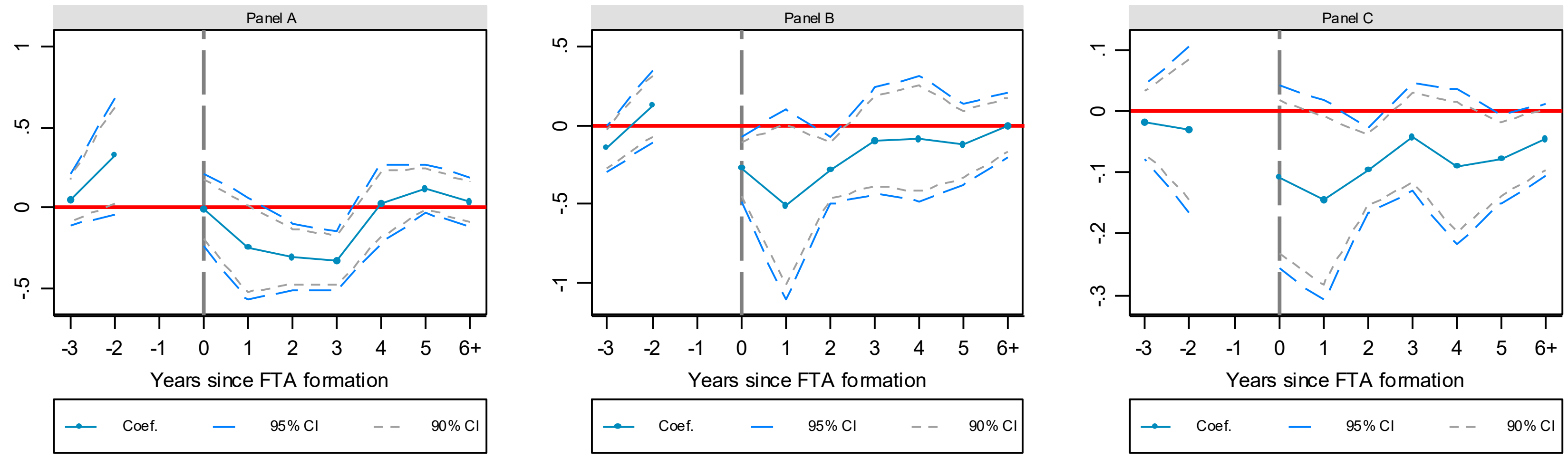
Notes: Trade shares are predicted from: OLS gravity model without fixed effects (Panel A); PPML gravity model without fixed effects (Panel B); OLS gravity model with country-industry-year fixed effects (Panel C); PPML gravity model with country-industry-year fixed effects (Panel D); OLS gravity model with and without fixed effects (Panel E); PPML gravity model with and without fixed effects (Panel F).

Figure 7. Baseline results with instrumented import shares and fixed preferential export shares.



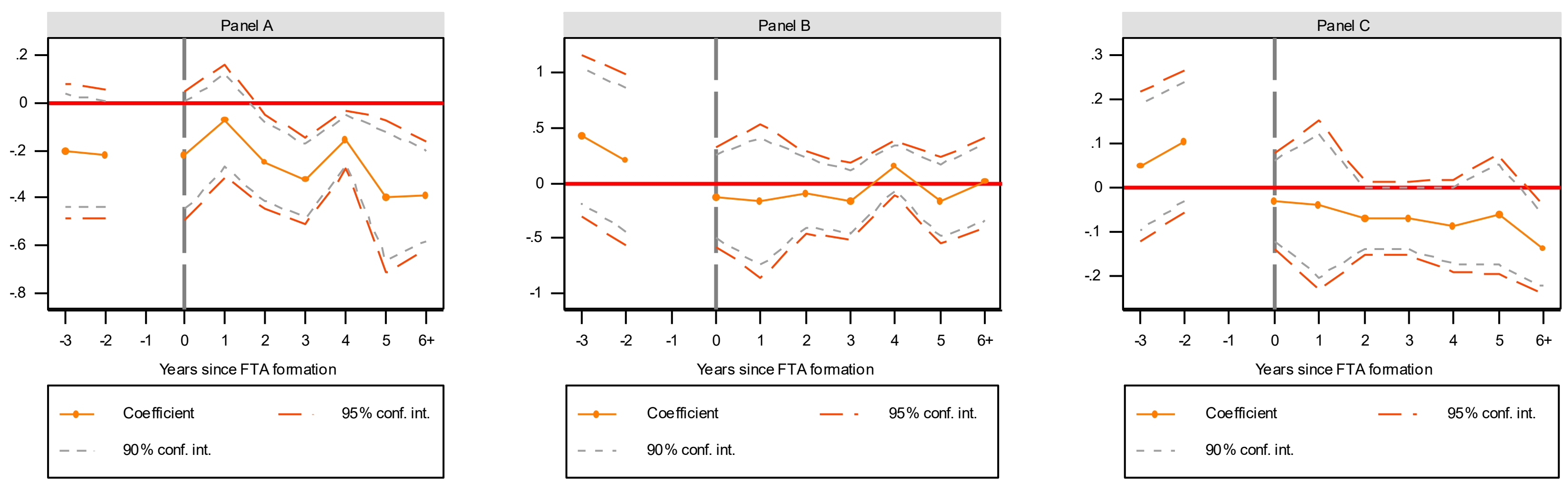
Notes: Trade shares are predicted from: PPML gravity model without fixed effects (Panel A); PPML gravity model with country-industry-year fixed effects (Panel B); PPML gravity model with and without fixed effects (Panel C).

Figure 8. Results with instrumented import shares and preferential export shares.



Preferential export shares are predicted from: OLS gravity model with geography variables (Panels A and B); PPML gravity model with geography variables (Panel C);
Import shares are predicted from: PPML gravity model without fixed effects (Panel A); PPML gravity model with fixed effects (Panels B and C).

Figure 9. Results with fixed export shares and instruments for import shares and preferential export shares.



Preferential export shares are predicted from: OLS gravity model with geography variables (Panels A and B); PPML gravity model with geography variables (Panel C);
Import shares are predicted from: PPML gravity model without fixed effects (Panel A); PPML gravity model with fixed effects (Panels B and C).

Figure 10. Results for pre- and post-Uruguay round samples.

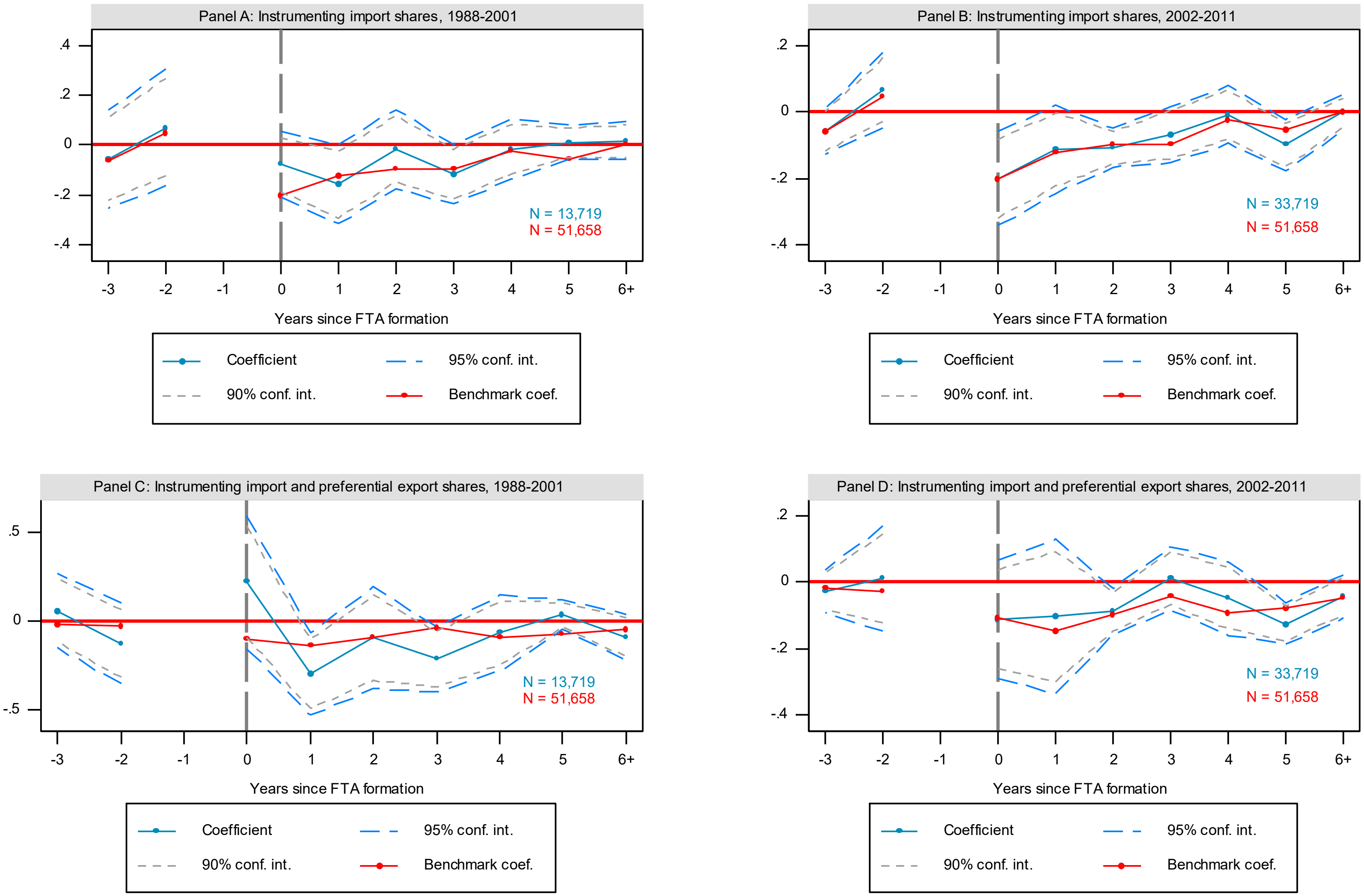
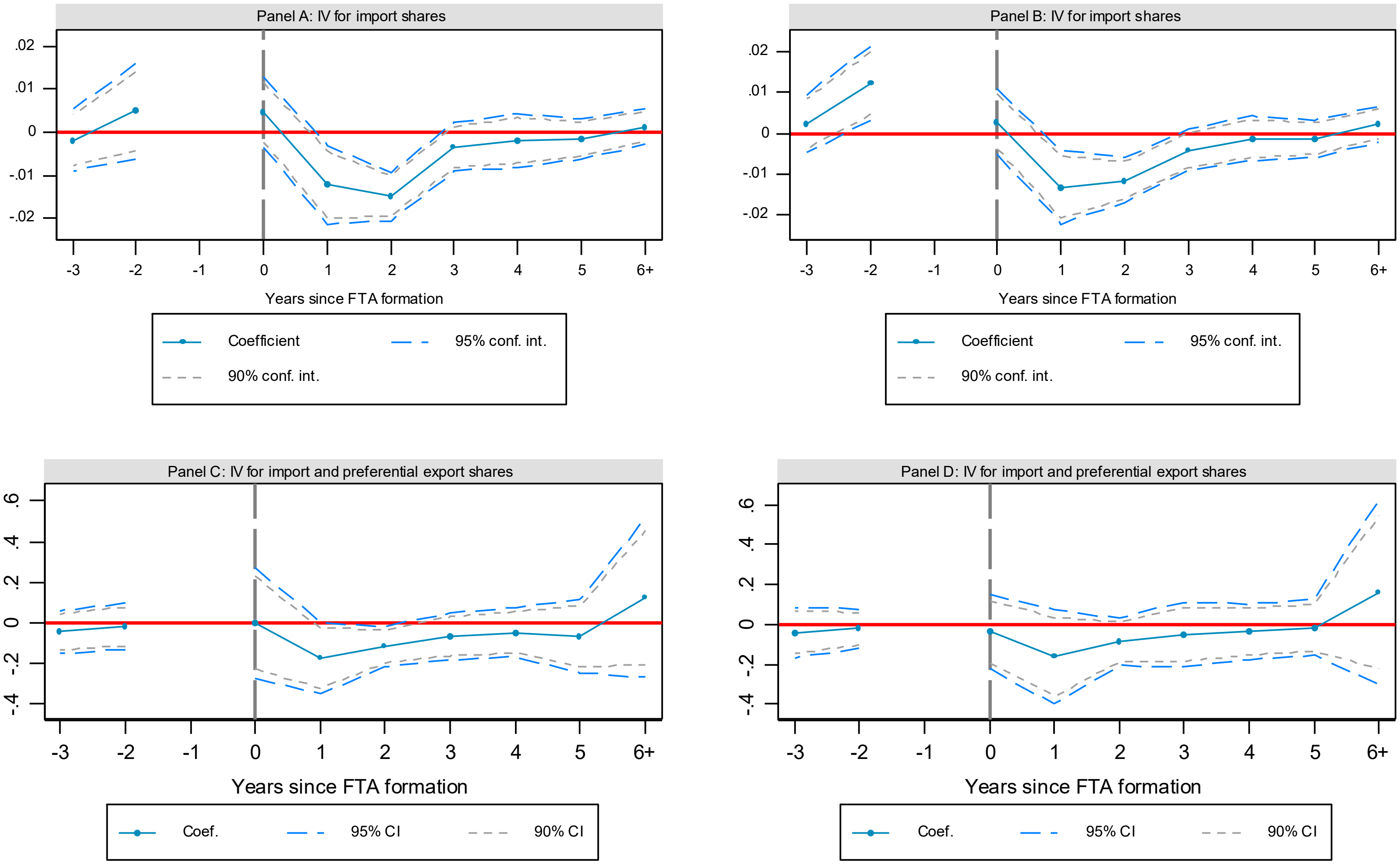


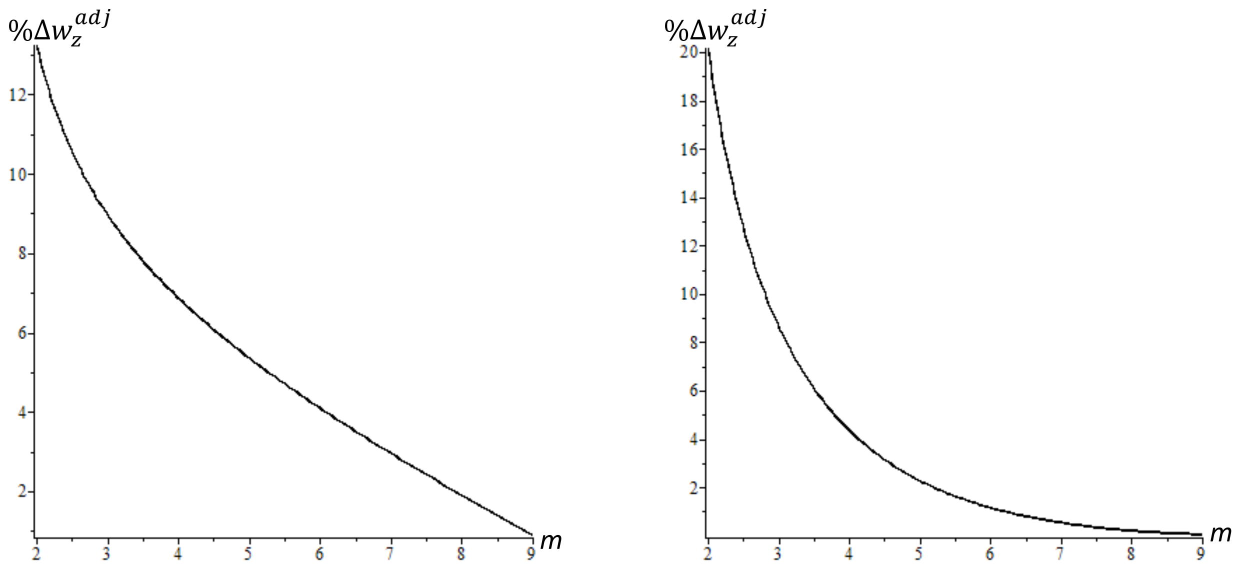
Figure 11. Results with 4-digit HS industry codes.



Notes: Trade shares are predicted from: PPML gravity model without fixed effects (Panel A); PPML gravity model with country-industry-year fixed effects (Panels B,C,D);

Preferential export shares are: oriogical (Panels A and B); predicted from the OLS gravity model with geography variables (Panel C); predicted from the PPML gravity model with geography variables (Panel D).

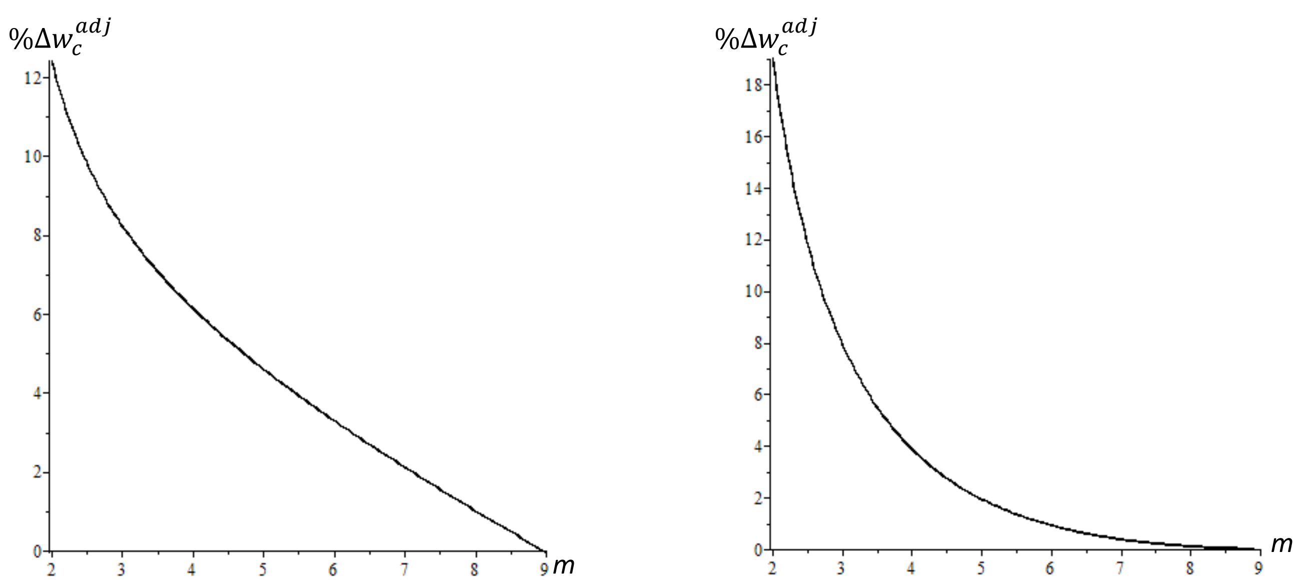
Figure 12. The effect of tariff adjustments by non-members on welfare of FTA member countries (n=10, λ=0.5)



Panel A: Theory

Panel B: Estimation results

Figure 13. The effect of tariff adjustments by FTA non-members on their welfare (n=10, λ=0.5)



Panel A: Theory

Panel B: Estimation results

Figure 14: FTA formation and log concave export supply.

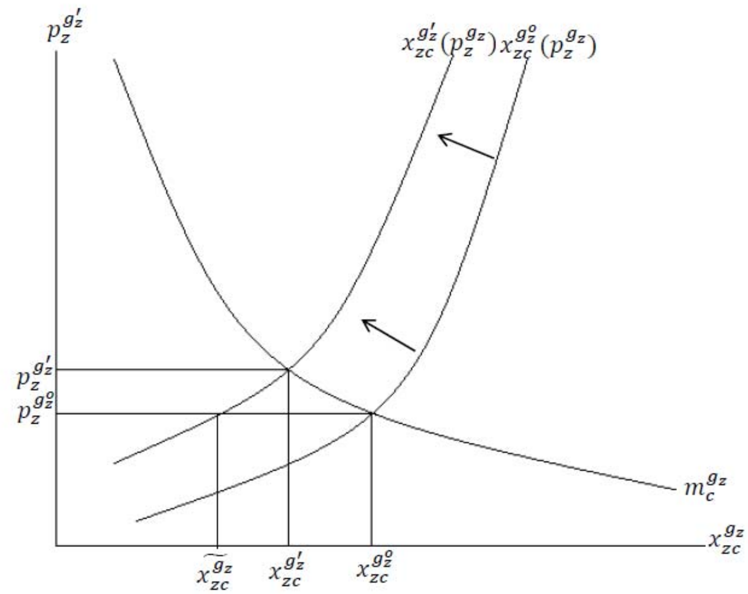


Table 1. Summary statistics

	Mean	Median	Stdev	Minimum	Maximum
MFN tariff (level)	10.35	8.35	10.68	0.00	349.5
Annual changes:					
ΔMFN	-0.20	0	3.14	-20.0	20.0
ΔPXS(T=-3)	-0.03	0	0.74	-26.8	16.1
ΔPXS(T=-2)	-0.01	0	0.61	-26.3	28.4
ΔPXS(T=0)	0.02	0	0.65	-43.0	38.6
ΔPXS(T=1)	0.03	0	0.86	-31.8	42.1
ΔPXS(T=2)	-0.01	0	0.99	-45.0	50.5
ΔPXS(T=3)	0.01	0	0.90	-31.5	59.2
ΔPXS(T=4)	-0.01	0	0.85	-36.6	36.9
ΔPXS(T=5)	-0.02	0	1.05	-55.5	44.1
ΔPXS(T¿5)	-0.24	0	2.53	-62.7	66.9

Notes: ΔPXS(T) is the change in preferential export share of a country's average trade partner due to FTAs formed T years ago.

Table 2. Estimation results.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
∆PXS(T=-3)	0.014 (0.068)	0.027 (0.050)	-0.042 (0.029)	-0.061[c] (0.031)	-0.045 (0.028)	-0.052[c] (0.031)	0.045 (0.081)	-0.148[c] (0.076)	-0.017 (0.031)
∆PXS(T=-2)	-0.016 (0.113)	0.057 (0.077)	0.029 (0.052)	0.046 (0.052)	0.036 (0.052)	0.046 (0.052)	0.322[c] (0.183)	0.121 (0.117)	-0.029 (0.069)
∆PXS(T=0)	-0.130 (0.092)	-0.086 (0.067)	-0.162[a] (0.044)	-0.201[a] (0.058)	-0.150[a] (0.042)	-0.150[a] (0.049)	-0.012 (0.113)	-0.279[a] (0.104)	-0.107 (0.076)
∆PXS(T=1)	-0.037 (0.073)	-0.023 (0.047)	-0.113[a] (0.043)	-0.123[b] (0.051)	-0.111[a] (0.040)	-0.076[c] (0.042)	-0.256 (0.163)	-0.504 (0.309)	-0.145[c] (0.084)
∆PXS(T=2)	-0.103[b] (0.041)	-0.109[a] (0.042)	-0.110[a] (0.033)	-0.099[a] (0.028)	-0.104[a] (0.032)	-0.105[a] (0.026)	-0.305[a] (0.106)	-0.290[a] (0.108)	-0.096[a] (0.035)
∆PXS(T=3)	-0.090[c] (0.052)	-0.072[a] (0.028)	-0.091[b] (0.039)	-0.100[b] (0.040)	-0.113[a] (0.036)	-0.068[b] (0.027)	-0.329[a] (0.093)	-0.101 (0.172)	-0.042 (0.045)
∆PXS(T=4)	-0.088[c] (0.052)	-0.048 (0.041)	-0.042 (0.038)	-0.022 (0.041)	-0.074[b] (0.035)	-0.045 (0.037)	0.022 (0.124)	-0.086 (0.203)	-0.091 (0.065)
∆PXS(T=5)	-0.127[a] (0.033)	-0.091[a] (0.035)	-0.058 (0.036)	-0.057[c] (0.034)	-0.089[a] (0.033)	-0.072[b] (0.033)	0.116 (0.077)	-0.121 (0.129)	-0.078[b] (0.036)
∆PXS(T>5)	0.028 (0.032)	-0.010 (0.027)	0.007 (0.021)	0.003 (0.023)	0.014 (0.019)	-0.002 (0.020)	0.032 (0.077)	0.000 (0.104)	-0.046 (0.030)
N	51,658	51,658	51,658	51,658	51,658	51,658	51,658	51,658	51,658
Instrument set:	IVS1	IVS2	IVS3	IVS4	IVS1,3	IVS2,4	IVX1	IVX1	IVX2
Gravity equation for import share instruments:									
estimator	OLS	PPML	OLS	PPML	OLS	PPML	PPML	PPML	PPML
ind-specific coef.	YES	YES	YES	YES	YES	YES	YES	YES	YES
imp/exp-ind-year FE	NO	NO	YES	YES	YES	YES	NO	YES	YES
Gravity equation for preferential export share instruments:									
estimator							OLS	OLS	PPML
dep. var.							pref. share	pref. share	log imports
Anderson-Rubin test	0.001	0.010	0.000	0.000	0.000	0.000	0.004	0.018	0.019
Hansen J-test, p-value					0.322	0.190			
F-stat:									
PXS(T=-2)	13.87	11.10	49.47	45.96	26.94	29.42	12.25	13.46	47.81
PXS(T=-1)	6.83	10.03	18.07	20.60	13.80	18.01	6.37	7.45	19.27
PXS(T=0)	10.88	6.74	17.91	5.16	23.95	10.43	10.84	16.55	3.79
PXS(T=1)	5.44	15.30	9.68	16.13	7.59	13.23	5.82	6.00	17.77
PXS(T=2)	4.55	4.76	9.79	25.00	9.20	16.14	5.50	5.57	19.56
PXS(T=3)	4.95	7.04	8.32	9.20	7.41	6.26	7.98	7.16	11.23
PXS(T=4)	11.98	15.23	22.66	37.45	22.72	24.72	9.73	3.91	31.88
PXS(T=5)	12.47	10.29	17.50	19.99	14.69	15.47	11.99	4.43	27.73
PXS(T>5)	14.54	16.50	16.29	27.07	18.58	23.90	6.07	4.62	27.58

Notes: The dependent variable is the change in the MFN tariff between years t and (t-1). ∆PXS(T) is the change in preferential export share of a country's average trade partner due to FTAs formed in year (t-T). c significant at 10%, b significant at 5%, a significant at 1%. Standard errors in parentheses are obtained using two-way clustering at country-industry and country-year levels. All specifications include country-year and country-industry fixed effects. For the Hansen test of over-identifying restrictions, the null hypothesis is that all instruments are jointly uncorrelated with the error term of the second stage regression and correctly excluded from the estimated equation. For the Anderson-Rubin test the null hypothesis is that the coefficients of the endogenous regressors in the second-stage equation are jointly equal to zero.

Table 3. Estimation results in long differences.

Dependent variable: the change in the MFN tariff over the first five years after FTA formation							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
PXS(T=5)	-0.401** (0.199)	-0.352** (0.172)	-0.235** (0.104)	-0.178* (0.093)	-0.556* (0.334)	-0.243 (0.183)	-0.273*** (0.103)
Instrument set:	IVS1	IVS2	IVS3	IVS4	IVX1	IVX1	IVX2
Anderson-Rubin Wald test	0.031	0.035	0.006	0.040	0.081	0.161	0.003
First stage F-statistic	56.6	71.4	51.9	100.0	55.3	53.8	74.0
N	32,171	32,171	32,171	32,171	32,171	32,171	32,171

Notes: * significant at 10%, ** significant at 5%, *** significant at 1%. Standard errors in parentheses are clustered by country-industry. All specifications include country-year and country-industry fixed effects. For the Anderson-Rubin test the null hypothesis is that the coefficients of the endogenous regressors in the second-stage equation are jointly equal to zero.

Table 4. Relationship between changes in the export elasticities and changes in preferential export shares

Dependent variable: Change in the average partner's preferential export share between 1988-2001 and 2002-2011 for:						
	All FTAs			FTAs formed in 2001-2002		
	(1)	(2)	(3)	(4)	(5)	(6)
Δ Inverse exp. elast.	-0.038** (0.017)	-0.037** (0.017)	-0.027** (0.012)	-0.006*** (0.002)	-0.008*** (0.002)	-0.006*** (0.002)
Industry FE	NO	YES	YES	NO	YES	YES
Country FE	NO	NO	YES	NO	NO	YES
R-squared	0.001	0.137	0.320	0.001	0.090	0.254
N	4,785	4,785	4,785	4,785	4,785	4,785

Notes: * significant at 10%, ** significant at 5%, *** significant at 1%. Standard errors are clustered by country.