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The Effects of Preferential Rules of Origin on Trade Flows

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This paper estimates the effects of preferential rules of origin (PROOs) on trade flows, using a "treatment" effect model. Exporters meet the content rules for the benefit of trade preferences, which is similar to "self-selection" into treatment. The IV estimation of the treatment effect using OECD data shows that PROOs negatively affect the trade in intermediate inputs and final goods. Estimation results confirm that PROOs are the protectionist instrument, inducing hidden protection through an "effect of tariffs" on imported intermediate inputs, and causing an indirect protective effect on final goods. Since preferential treatments of FTAs are conditional on compliance with PROOs, the effects of FTAs and PROOs move in the opposite direction. The net change in intermediate inputs trade will be smaller than what it would have been without PROOs. Given an inverse relationship between PROOs and intermediate inputs trade, the presence of PROOs will adversely affect final goods trade because a decrease in intermediate inputs trade distorts final goods trade.

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I. Introduction

Member-country producers have to comply with preferential rules of origin (PROOs) to be eligible for the benefit of tariff preferences allowed to FTA partners. Yet compliance with PROOs often leads to the diversion of intermediate input sources from a low-cost non-member country to a high-cost member country (Arndt, 2004). Consequent decrease in parts and components trade with non-members prevents FTA partners from fully enjoying cost savings resulting from using cheaper outsourced inputs.

Compliance with PROOs brings about efficiency costs arising from decrease in

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intermediate inputs trade and ensuing increase in production costs. It would eventually weaken the cost competitiveness of final goods, because more of protected inputs have to be used as required by the content rules. Moreover, compliance with PROOs generates additional costs associated with meeting the rules for determining origin and implementing requirements. Administrative costs increase with the number of FTAs entered into and with the complexity of necessary procedures. Such efficiency and administrative losses generate the "compliance costs" of PROOs.

Compliance costs can be large enough to exceed the benefit of tariff preferences. In this case, member-country producers may well be reluctant to comply with PROOs or even give up compliance and preferential treatment. With the gains from preferential market access for final goods fallen short of the compliance costs of PROOs, it could be more profitable *not* to seek preferential treatments. Compliance costs effectively put firms under "participation-constraint," which prevents member-country producers from taking full advantage of the benefits of FTAs.[1] Member-country firms may choose MFN rates instead of preferential rates, as they seek alternative destinations with MFN rates. As far as compliance costs constrain participation in FTAs, PROOs work as an effective substitute for tariffs as an instrument of intra-bloc protection (Anson et al., 2005, 507). Compliance costs erode the benefits of tariff-preferences and deny "easier" market access even to member-country producers (Anson et al., 2005; Manchin and Pelksmans-Baloing, 2007).[2]

The goal of this paper is to investigate how PROOs as "hidden" barriers affect trade flows within a framework of "treatment" effect. Compliance with PROOs is analogous to receiving treatment (i.e. eligibility for preferential tariffs), for which the prospective exporters should make efforts to satisfy the content conditions and/or prove the conformity with the rules. It is like "self-selection" into treatment, since exporters meet the requirements of PROOs in anticipation of preferential tariffs. Yet the willingness to undertake treatment is inversely related to the severity of PROOs. Restrictive PROOs will discourage member-country producers from meeting the requirements (and receiving treatment) if the expected gain from receiving preferential treatment with compliance costs falls short of the expected gain from giving up compliance and exporting to the other destinations. The high

[1] For a given tariff preference margin, the more restrictive PROOs are, the lower is the utilization of tariff preferences. Alternatively, for a given restrictiveness of PROOs, the higher the tariff preference margin is, the higher is the utilization rate of tariff preferences (Cadot and de Melo, 2007, 7).

[2] Anson et al. (2005) found that, in the case of NAFTA, average compliance costs are around 6 percent *in ad valorem* equivalent, which undoes the tariff preference (4 percent on average) for a large number of tariff lines. They also found that administrative costs amount to 47 percent of the preference margin. Compliance costs are particularly burdensome to many developing countries where vertically integrated production structures do not exist or function well.

compliance costs of restrictive PROOs will induce the prospective exporters to reduce intra-bloc outsourcing efforts, which in turn will affect final goods trade. The treatment effect model is useful to investigating such inverse relationship between compliance costs and intra-bloc outsourcing efforts. In particular, the treatment effect model is appropriate for addressing how PROOs affect intermediate inputs trade and final goods trade.

One of the most popular methods for estimating the average treatment effect (ATE) is to use the coefficient on the dummy variable representing treatment. For example, Baier and Bergstrand (2007) provide a useful tool for estimating ATEs as the partial effect of a binary variable (such as FTAs or PROOs) on a continuous endogenous variable (such as trade flows). However, as Baier and Bergstrand (2009) and Gosh and Yamarik (2004) have shown, the dummy variable method is "fragile and unstable."

An alternative method is nonparametric matching estimation. For example, Baier and Bergstrand (2009) estimates the long-run treatment effect of FTAs on the bilateral international trade flows using matching methods. They show that nonparametric estimates of *ex post* long-run treatment effects provide much more economically plausible values than OLS estimates using typical gravity equations. Egger et al. (2008) also uses matching techniques to examine the effect of FTAs on the intra-industry trade structure, and finds that FTAs augment gains from trade mainly through scale economies and product differentiation that would show up in a growing share of intra-industry trade.

Matching methods need the "ignorability of treatment" assumption for identification of treatment effects. This assumption ensures that treatment assignment is random. The ignorability assumption requires a control group for each treated country pair, which is matched closely to the treated pair in terms of all relevant covariates influencing trade (Baier and Bergstrand, 2009). However, this assumption does not hold more often than not. For example, the FTA member-country producers may "self-select" into treatment or comply with PROOs for the benefit of tariff preferences. In other words, compliance with PROOs or accepting "treatment" is endogenously determined. Thus, the error term in the estimation equation may represent the unobserved influence on the bilateral trade, which is not explained by right-hand side independent variables but is correlated with the decision to comply with PROOs. As Baier and Bergstrand (2007) point out, such endogeneity causes a bias in estimation. Unless the endogeneity of compliance with PROOs is accounted for, estimates of ATEs cannot be consistent and reliable.

In this paper, IV regression is adopted to address endogeneity associated with self-selection into treatment (endogenous treatment). Estimation of ATEs is carried out using a generated instrument representing the tendency to comply with PROOs. Firm's compliance with PROOs is not generally observable. In such a case, compliance costs can instead be used to infer the "inverse" tendency to comply with

PROOs since there exists a negative relationship between compliance costs and self-selection. The problem with this strategy is that compliance costs are not directly observable either. Nevertheless, an indirect way based on Herin's (1986) revealed preference approach is available for estimating compliance costs. If exporters are indifferent between shipping under preferential treatment with compliance costs and under MFN status without compliance costs, their utilization of tariff preferences will be incomplete. Incomplete utilization indicates that the compliance costs of PROOs are revealed equal to the average preferential margin.[3]

With the estimates of compliance costs given, the "treatment" probability of complying with PROOs can be constructed from a function that depends on the preferential margin (i.e. compliance costs) and the opportunity cost of exporting to other destinations under MFN rates. The treatment probability is "probit-fitted" in two steps. First, the treatment "binary" variable is set to equal one (i.e. receiving treatment), if the MFN rate on a product imported by an FTA member country is "below" the average MFN rate on the same product category imported by all the other destinations, and it equals zero otherwise. Second, an instrument for this treatment binary variable is estimated using a function that depends on another indicator variable representing entry into FTAs and features of PROO regimes among others. The generated instrument for the treatment binary variable predicts compliance (i.e. treatment). The treatment binary variable is endogenous and correlated with the probability of complying with PROOs, but it is not correlated with trade flows. Instrumentation using such a binary variable makes possible the consistent and reliable estimation of the ATEs.

Empirical findings in this paper confirm the notion that, while the elimination of tariffs under FTAs will increase intermediate inputs trade between member countries, the origin requirements for tariff preferences (i.e. compliance with PROOs) at least partly offset the effect of tariff elimination. Since the effects of FTAs and PROOs move in the opposite direction, the net change in intermediate inputs trade due to FTAs will be smaller than what it would have been without PROOs. Compliance with PROOs impedes exporters' efforts to reduce costs through outsourcing, and results in reduced trade in intermediate inputs. PROOs impede trade in intermediate inputs.

The estimation results of final goods trade do not contradict theoretical conjectures either. While PROOs are indispensable to FTAs, restrictive PROOs tend to cancel out the effect of FTAs on final goods trade. The effects of PROOs and FTAs move in the opposite direction. Moreover, the influence of PROOs working through intermediate inputs trade also adversely affects the final goods trade. With an inverse relationship between the severity of PROOs and intermediate inputs trade, restrictive PROOs may have a negative effect on final goods trade

[3] Anson et al. (2005, 509).

because a decrease in intermediate inputs trade may also cause depression in final goods trade.

The rest of the paper is organized as follows. Section II introduces empirical models for analysis. Section III describes empirical implementation procedures and presents estimation results. Section VI concludes.

II. Empirical Model

Suppose that the treatment indicator w takes on one for compliance with PROOs and zero otherwise. Let y_1 denote the outcome with treatment and y_0 the outcome without treatment. For example, the outcome variable could be the extent of outsourcing or final goods trade. Since individual firms cannot be in both states, it is not possible to observe y_1 and y_0 simultaneously. The observed outcome is $y = y_0 + w(y_1 - y_0)$.

Suppose that x denotes the set of observed covariates. Then the average treatment effect (ATE) is conditional on x. The appropriateness of the methods for estimating ATE depends on the randomness of treatment. If treatment is randomly given, the "ignorability of treatment" assumption holds and the OLS estimation method is appropriate. If treatment is not random, OLS estimation is not consistent because it does not address the endogeneity problem.

2.1. Conditional Independence: Ignorability of Treatment

When treatment is randomized, treatment status and potential outcomes are conditionally independent. The same result is obtainable under the "ignorability of treatment" assumption.[4] This assumption implies that, if x provides enough information that determines treatment, (y_1, y_0) is mean independent of w conditional on x: the possible correlation between (y_1, y_0) and w disappears once x is controlled for.[5] Given this "ignorability of treatment," the identification of treatment effects is possible because, conditional on the covariates, treatment is independent of the outcomes. For example, if compliance with PROOs is a deterministic function of the covariates, the treatment effect of PROOs on outsourcing or trade flows is obtained as conditional expectations that depend entirely on the observables.

Wooldridge (2002) suggests a parametric representation for estimating ATE.[6] If y_i can be decomposed into the means $\mu_i = E(y_i)$ and the error term v_i, where

[4] This conditional independence assumption is alternatively called "selection on observables."

[5] Wooldridge (2002, 607).

[6] Wooldridge (2002, 608-621).

$E(v_i)=0$ for $i=0,1$. Then the observed outcome can be rearranged as $y=\mu_0+(\mu_1-\mu_0)w+v_0+w(v_1-v_0)$.

Furthermore, if $E(v_i\,|\,x)=0$ where the error term contains a control function $E(v_i\,|\,x)=\eta_i+x\beta_i$ and $E(\eta_i\,|\,x)=0$ for $i=0,1$, the regression equation is given by

$$y=\gamma_0+\alpha w+x\beta_0+w(x-\overline{x})\delta+w(\eta_1-\eta_0) \qquad (1)$$

where $\gamma_0=\mu_0+\eta_0$.[7] Then the average treatment effect is estimated as the coefficient on w.[8]

2.2. Instrumental Variables Estimation

Yet the "ignorablity of treatment" assumption may not hold. A decision to comply with PROOs may not be random. Instead, individual firms may determine whether they would receive treatment based on the benefits of treatment, (y_1-y_0). In that case, OLS estimation is not consistent. IV estimation is preferable to OLS, if an instrument that predicts treatment is found for such endogenous explanatory variable.[9] Let this instrumental variable z be a binary variable, where treatment statuses $(w=1)$ and $(w=0)$ correspond to $(z=1)$ and $(z=0)$ respectively. For example, z denotes whether an exporter intends to comply with PROOs, while w represents actual self-selection into complying with PROOs. Actual participation is correlated with the benefits of compliance.

Consistent IV estimation requires no correlation between the "treatment" and the error term. However, $w(v_1-v_0)$ in the estimation equation $y=\mu_0+(\mu_1-\mu_0)w+v_0+w(v_1-v_0)$ causes trouble, since it represents correlation between the treatment term and the error term. Unless the error terms, v_1 and v_0, are conditional mean independent of w given x, IV estimates are not consistent. For consistent IV estimation, it is necessary to have restrictions on the covariance term $w(v_1-v_0)$. Wooldridge (2002, 621-633) provides procedures for consistent IV estimation, in which either distributional assumptions are made about the error terms to secure conditions for consistency or control functions with distributional assumptions are used to account for the endogeneity of the covariance term directly. The procedures suggested by Wooldridge (2002) are adopted in the following. Which one of these procedures is most appropriate depends on which restriction on the error covariance term or its distributions is most plausible. Four possible cases are considered in the following.

[7] The function $x\beta_0$ controls for possible self-selection bias (Wooldridge, 2002, 612).

[8] Wooldridge (2002, 613).

[9] Wooldridge (2002, 621-633).

Restrictions on the Covariance for Consistent IV Estimation

(1) Distributional assumptions about the error terms

(1-A) Assume that the stochastic parts of the potential outcomes are the same ($v_1 = v_0$), so that the interaction term $w(v_1 - v_0)$ may disappear. Then standard IV methods proceed in two-steps. The first step is to estimate the binary response model

$$P(w = 1 | x, z) = G(x, z; \gamma)$$

by maximum likelihood where γ needs to be estimated. The second step involves estimating

$$y = \gamma_0 + \alpha w + x\beta_0 + v_0 \quad (2)$$

by IV methods using instruments 1, $\hat{G}_i$, and x.

(1-B) If the stochastic parts of the potential outcomes are different ($v_1 \neq v_0$), the interaction term $w(v_1 - v_0)$ does not disappear. In this case, consider the error term parametrically related to explanatory variables. For example, suppose the error term can be expressed as $v_i = \eta_i + x\beta_i + \varepsilon_i$ where $E(\varepsilon_i | x, z) = 0$ for $i = 0,1$. Then the observed outcome is rearranged as

$$y = \gamma_0 + \alpha w + x\beta_0 + [w(x_i - \overline{x})]\delta + \varepsilon_0 + w(\varepsilon_1 - \varepsilon_0),$$

where $\varepsilon_0 + w(\varepsilon_1 - \varepsilon_0)$ is the composite error term. The first error component is associated with omitted variables bias, and the second with selection bias.

Assume that the omitted variables bias of the potential outcomes is the same ($\varepsilon_1 = \varepsilon_0$). Then the interaction term $w(\varepsilon_1 - \varepsilon_0)$ disappears.[10] Consistent IV estimation of ATE is possible since $w(\varepsilon_1 - \varepsilon_0)$ disappears. The error term ε_0 has zero mean, and the composite error term also has zero mean given (x, z).[11] IV estimation proceeds in two steps. The first step estimates the binary response model

$$P(w = 1 | x, z) = G(x, z; \gamma)$$

by maximum likelihood where γ needs to be estimated. The second step involves estimating

[10] Wooldridge (2002, 621-633) suggests that the assumption of $\varepsilon_1 = \varepsilon_0$ can be relaxed to $E(w(\varepsilon_1 - \varepsilon_0) | x, z) = E(w(\varepsilon_1 - \varepsilon_0))$ or if the covariance conditional on (x, z) is constant.

[11] Wooldridge (2002, 626).

$$y = \gamma + \alpha w + x\beta_0 + [w(x_i - \overline{x})]\delta + \varepsilon \tag{3}$$

by IV methods using instruments 1, $\hat{G}$ (or z), x and $\hat{G}(x-\overline{x})$ (or $z(x-\overline{x})$).[12]

(2) Accounting for the endogeneity of treatment using control functions

(2-A) Assume normality for the error difference term independent of (x,z): $\varepsilon_1 - \varepsilon_0 \sim N(0,\omega^2)$. IV estimation proceeds in two steps. The first step estimates coefficients from a probit of w on $(1,x,z)$ to derive a "correction" function, which depends on the exogenous variables (x,z). Calculate probabilities, $P(w = 1 | x,z) = \Phi_i(\theta_0 + x\theta_1 + z\theta_2)$, and densities, $\phi_i = \phi(\theta_0 + x\theta_1 + z\theta_2)$, for $i = 1,\cdots,N$. Let a denote the latent error underlying the probit equation with a standard normal distribution, $a \sim N(0,1)$. Then the covariance term $w(\varepsilon_1 - \varepsilon_0)$ has a bivariate normal distribution. The second step estimates

$$y = \gamma + \alpha w + x\beta_0 + [w(x_i - \overline{x})]\delta + \xi\phi + \varepsilon \tag{4}$$

by IV methods using instruments 1, $\hat{\Phi}_i$, x, $\hat{\Phi}_i(x_i - \overline{x})$, and $\hat{\phi}_i$.

(2-B) Assume that the treatment is the binary switching variable. The treatment is written as $w = 1$ if $\Phi_i(\theta_0 + x\theta_1 + z\theta_2 + a \geq 0 | x,z)$, where $(a,\varepsilon_1,\varepsilon_2)$ is independent of (x,z) with a trivariate normal distribution and a has a standard normal distribution, $a \sim N(0,1)$. Estimation proceeds in two steps. The first step estimates coefficients from a probit of w on $(1,x,z)$ to derive a control function that depends on the exogenous variables (w,x,z). Calculate probabilities, $P(w = 1 | x,z) = \Phi_i(\theta_0 + x\theta_1 + z\theta_2)$, and densities, $\phi_i = \phi(\theta_0 + x_i\theta_1 + z_i\theta_2)$, for $i = 1,\cdots,N$. The second step estimates

$$y = \gamma + \alpha w + x\beta_0 + [w(x_i - \overline{x})]\delta + \rho_1 w\frac{\phi}{\Phi} + \rho_2(1-w)\frac{\phi}{1-\Phi} + \varepsilon \tag{5}$$

by the OLS regression of y on 1, w, x, $w(x_i - \overline{x})$, $w\frac{\hat{\phi}}{\hat{\Phi}}$ and $(1-w)\frac{\hat{\phi}}{1-\hat{\Phi}}$.

[12] This assumption can be relaxed to $E[w(\varepsilon_1 - \varepsilon_0) | x,z] = E[w(\varepsilon_1 - \varepsilon_0)]$ (or the covariance of selection bias conditional on (x,z) is constant). Then the composite error term has zero mean conditional on (x,z). Under this condition, any function of (x,z) can be used as instruments for equation (3) (Wooldridge, 2002, 627).

III. Empirical Implementation

3.1. Data

FTAs

The treatment effects of PROOs on intermediate inputs trade and final goods trade are estimated for those FTAs entered into force among OECD members after the end of 2000 and before the beginning of 2005. Information on the FTAs concluded and notified to the GATT/WTO under GATT Articles XXIV is from the WTO. Table 1 contains the list of FTAs concluded during the 2000-2005 period.

[Table 1] Free trade agreements concluded between 2000 and 2005 (goods, services)

EC-Chile (February 2003, March 2005)
EC-Israel (June 2000, None)
EC-Mexico (July 2000, October 2000)
EC-EFTA (due to EC enlargement from 15 countries to 25) (May 2004, May 2004)
EFTA-Chile (December 2004, December 2004)
EFTA-Mexico (July 2001, July 2001)
Israel-Mexico (July 2000, None)
Japan-Mexico (April 2005, April 2005)
Korea-Chile (April 2004, April 2004)
USA-Australia (January 2005, January 2005)
USA-Chile (January 2004, January 2004)

Source: WTO (For EC-Israel, EC-Mexico, Israel-Mexico, and Japan-Mexico FTAs, the dates of entry into force do not exactly lie within the period between the end of 2000 and the beginning of 2005).

Dependent Variables

The imports of intermediate input p from country j by the "using" industry k in country i in year t are denoted as IM_{ijpkt}. Its dimension is five: importer i, exporter j, industry of origin (intermediate input) p, using industry k and year t. A change in the imports of intermediate inputs due to PROOs is a response to treatment. Imported intermediate inputs include those both under compliance and under non-compliance. The change in imported intermediate inputs represents the "average" response of all the firms subject to PROOs.

Data on bilateral trade in intermediate inputs are from the OECD STAN indicators ed. 2005 for the years 2000 and 2005.[13] Since the two sets of data are five

13 The imports of intermediate input p is indeed the product of the share of imported input p by using industry k in overall imported input p of country i, $SHARE_{ipkt}$, and the imports of input p of country i from country j, $VALUE_{ijpt}$. This relationship is expressed formally as $IM_{ijpkt} = SHARE_{ipkt} \times VALUE_{ijpt}$

Input-output tables provide information on the extent of vertical specialization. The measures of years apart, the empirical model in effect deals with treatments that had occurred sometime between 2000 and 2005.

The exports of final good from country i to country j in year t are denoted as FX_{ijpt}. Its dimension is four: exporter i, importer j, industry p and year t. The exports of final goods are affected by PROOs through the effect on intermediate inputs trade among others. Data on final goods trade are from the UN COMTRADE.

The dependent variables data originally classified into the eighteen categories of the two-digit level of the International Standard Industrial Classification (ISIC rev.3) are regrouped into six manufacturing sectors. Table 2 lists the categories matched with their two-digit constituent parts.

[Table 2] Data description

Product classification	ISIC rev.3
Food products	15 Manufacture of food products and beverages
	16 Manufacture of tobacco products
Textiles and apparel	17 Manufacture of textiles
	18 Manufacture of wearing apparel
	19 Tanning and dressing of leather
Paper and printing	20 Manufacture of wood and of products of wood and cork, except furniture
	21 Manufacture of paper and paper products
	22 Publishing, printing and reproduction of recorded media
Chemicals	23 Manufacture of coke, refined petroleum products and nuclear fuel
	24 Manufacture of chemicals and chemical products
	25 Manufacture of rubber and plastics products
Metal products	27 Manufacture of basic metals
	28 Manufacture of fabricated metal products, except machinery and equipment

vertical specialization in turn can be used to infer industry-level variations due to the application of PROOs. Changes in these measures reflect how industries are influenced by PROOs and how one industry differs from one another on both the export and the imported input sides.

The share of imported inputs, $SHARE_{ipkt}$, is taken from the I-O tables, and the value of imports of intermediates inputs is from trade statistics, based on the Broad Economic Categories (BEC) classification. See OECD STAN indicators Metadata for details.

Eighteen OECD members (Austria, Chile, Czech, Denmark, Estonia, Finland, Greece, Hungary, Iceland, Israel, Luxembourg, New Zealand, Poland, Portugal, Slovak, Slovenia, Sweden, and Turkey) have imports data, but do not have exports data. Fourteen OECD members (Australia, Belgium, Canada, France, Germany, Ireland, Italy, Japan, Korea, Mexico, Netherlands, Norway, Spain, Switzerland, United Kingdom, and United States) have both imports and exports data available.

Machinery	29 Manufacture of machinery and equipment n.e.c. 30 Manufacture of office, accounting and computing machinery 32 Radio, TV, communication equipment 33 Manufacture of medical, precision and optical instruments, watches and clocks 34 Manufacture of motor vehicles, trailers and semi-trailers 35 Manufacture of other transport equipment

Source: OECD Stan indicators.

Selecting Covariates

A key explanatory variable is w, the tendency to self-select into "treatment." An ideal measure for representing w is the utilization rate of tariff preferences (Herin, 1986). The disaggregated utilization rate reveals the tendency of exporters to comply with PROOs. However, information on which firms comply with PROOs is not generally available. One way to get around this problem is to use an aggregate measure of compliance costs to replace the utilization rate as an alternative representation of the tendency to self-selection, since compliance costs negatively affect the utilization rate of tariff preferences.

Yet compliance costs are not observable either. In such a case, a "revealed preference" approach is useful to estimating compliance costs. Firms can choose between preferential tariffs with compliance costs and MFN tariffs with no compliance costs, and they will not want to bear compliance costs that exceed the bounds set by tariff preferences. If compliance costs were greater than the benefits conferred by preferential tariffs (or the difference between the MFN rates and the preferential rates), PROOs would not be binding because member-country producers would not bother to comply with PROOs for no gain at all. Thus, compliance costs can be inferred from tariff preferences approximated by the tariff-preference margin.[14]

Under the assumption that compliance costs would be revealed equal to tariff preferences, the average "treatment probability" of complying with PROOs, w, is instrumented by a binary variable z conditioned on the tariff-preference margin, $TPM = \frac{t-\tau_A}{1+\tau_A}$, where t is the MFN rate and τ_A the preferential rate. The binary variable z equals one, if the tariff-preference margin on a product exported to a member country is "equal to or below" the opportunity cost of exporting that product to other destinations, $OD = \frac{\overline{t}_A-\tau_A}{1+\tau_A}$, where $\overline{t_A}$ is the average MFN rate on the same product category of all destination countries, and it equals zero otherwise : $z=1$ for $TPM-OD \leq 0$, and $z=0$ for $TPM-OD>0$. Alternatively, it can be assumed that z equals one for t that is equal to or below $\overline{t}_A$, and it equals zero otherwise: that is, $z=1$ for $t-\overline{t}_A \leq 0$, and $z=0$ for $t-\overline{t}_A>0$, since

[14] For all those tariff headings with incomplete utilization, the rate of tariff preferences gives an approximate value of combined costs. Anson et al. (2005, 509).

$TPM - OD = (\frac{t-\tau_A}{1+\tau_A} - \frac{\bar{t}_A-\tau_A}{1+\tau_A})$.

Member-country producers will comply with PROOs only if they have no other destinations with lower MFN rates than the MFN rate of the country for which their exports are originally destined. The presumption here is that the likelihood of compliance with PROOs depends on the increase in the expected gain from receiving preferential treatment rather than paying MFN tariffs, and that the relative gain is the opportunity cost of paying MFN rates in all possible destination countries. The higher is the MFN rate, the greater will be the expected gain from complying with PROOs. Thus, given tariff preferences, compliance with PROOs will be beneficial, only if compliance costs are less than the opportunity costs of exporting to other destinations.

The instrumental variable z itself is an endogenous binary variable to be estimated from a function $z = g(q, x; \omega)$ where q is a vector of indicator functions, a set of binary variables reflecting the features of PROO regimes, x is a vector of explanatory variables, and ω a vector of parameters need to be estimated.[15] Member-country producers may comply with PROOs with different eagerness for various reasons unobservable but possibly correlated with the restrictiveness of PROOs. For example, the structure of PROO regimes (such as PANEURO, NAFTA and so forth) affects the inclination of member-country producers for complying with PROOs. Under these assumptions, the fitted value of z on q and x, $\hat{z} = g\left(q, x; \hat{\omega}\right)$, can be used as the generated instrument for w that predicts compliance or "treatment."

Consistent IV estimation requires no correlation between w and the error term. Thus, it is desirable to reduce further the degree of possible correlation between the instrument and the error term by controlling for variables that may affect intermediate inputs trade through outsourcing or final goods trade between country pairs.

For intermediate inputs trade, three variables are added to the list of controls. The first candidate is tariff barriers, from which FTA partners are exempted. The tariff barriers variable enters the equation in the form of an interaction term, the product of tariffs and a dummy for common FTA membership. Tariffs between FTA members are different from those between non-members or between a member and a non-member. Since preferential tariffs are allowed to FTA partners only, this interaction term makes a good indicator of tariff changes induced by FTAs.

The second candidate is the extent of services trade liberalization. Outsourcing requires additional coordination activities that cause some extra costs of the needed

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[15] Wooldrige (2002, 117). FTA membership, PANEURO, NAFTA, EFTA, and ETC(others) dummies have been used as explanatory variables for q.

services.[16] If these extra costs are larger than a reduction in production costs, the benefits of outsourcing will not follow.[17] High services costs suppress the demand for outsourcing (Debaere et al., 2009), and reduce the size of savings on production costs. On the contrary, services liberalization facilitates greater fragmentation of production processes across countries. With services liberalization, communication and transport services have become available at lower costs, and vertical specialization and outsourcing have globally expanded.[18]

The third candidate is FDI stock, which partly reflects the extent of relocated production activities across borders. FDI flows often precede fragmentation of production processes that aims to save on factor costs, and usually facilitate vertical specialization and outsourcing. Such FDI responds sensitively to the factor-price differences across countries, enhancing intra-product specialization and intra-firm trade.[19]

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[16] Services include transportation of goods between production locations. Outsourcing or offshoring involves multitudes of intermediate production processes, so that coordination technologies are a limiting factor on determining the extent of its size and scope. Examples of such technologies include communication and transport services (Jones and Kierzkowski, 2001).

[17] Fragmentation saves production costs in two ways (Deardorff, 2001). First, at given factor costs, fewer production factors are required in producing final good in fragmented production than in integrated production. In this case, fragmentation is equivalent to technical progress. Second, if factor-prices (or factor-intensities) are different across countries, fragmentation will reduce costs as at least one fragment can be produced more cheaply in another country. The larger the factor-price or factor-intensity differentials are in the two segments, the more fragmentation will be profitable. If factor-intensity or factor-price differentials are sufficiently large, the fragmented technology may still reduce overall production costs even with coordination expenses. However, as integrated production remains feasible, international fragmentation makes sense only if it does not increase overall production costs.

[18] International transaction is not possible without transportation services, insurance, or financial services. Services trade liberalization has contributed to the expansion of merchandise trade and foreign direct investment by reducing international transaction costs. Technological progress in services also has changed the nature of merchandise trade and foreign direct investment.

[19] An anonymous referee raised an issue that FDI stock might not correctly represent the extent of fragmented production across borders. Given limited factor-intensity or factor-price differentials across rich countries, horizontal FDI rather than vertical FDI is more likely to prevail between OECD members. This horizontal FDI has less to do with intermediate inputs trade. Vertical FDI better represents the effect of fragmented production on intermediate inputs trade than does horizontal FDI. The problem is that vertical FDI data are not accessible. OECD STAN Indicators do not provide a breakdown of relevant FDI data. Relying on FDI stock data (inclusive of both horizontal and vertical FDI) in place of vertical FDI may generate the omitted variables problem or the errors-in-variables problem. However, using FDI stock data may be justified on condition that the omitted variables bias or measurement error problem is properly handled with.

Omitted variables bias can be avoided if FDI stock data can work as a proxy variable for unobserved vertical FDI. There are two requirements of a proxy: ignorability of the proxy, and the correlation between the proxy and the unobserved variable (Wooldridge, 2002, 63). Outward FDI stock satisfies the proxy variable requirements: first, if vertical FDI were known, FDI stock would be redundant or could be ignored, and, second, FDI stock is closely related to vertical FDI.

On the other hand, measurement error is a more serious problem. Yet if FDI stock is uncorrelated with covariates except vertical FDI, estimators of all the covariates but FDI stock are consistent, For final goods trade, two variables are controlled for. The first candidate is a trade barrier. The trade barrier variable in final goods trade is net of the indirect effect working through intermediate inputs trade. The second candidate is the extent of outsourcing, which positively affects final goods production and trade.

Other Control Variables

Regardless of whether they belong to the same FTAs, trading countries share common economic characteristics that explain trade flows between them. For example, all conditioning characteristics of the gravity equation qualify as covariates that are common to both the treated and the non-treated.[20] Those unobserved characteristics that affect trade flows are represented by country pair fixed effects (λ_{ij}), exporter fixed effects (λ_i) and importer fixed effects (λ_j).[21] The country pair fixed effects are to control for the impact on trade of the distance between countries, a common language, pre-existing regional trade agreements, colonial status or other historical ties between the countries, and any unobserved characteristics of the country pair that are constant over time. The exporter and importer fixed effects are to control for the importer and exporter specific factors that encourage or hinder trade flows. They capture the overall influence on trade of such variables as infrastructure, factor endowments, and "multilateral resistance."[22]

The estimation equation also includes industry-specific factors because they may affect the impact of PROOs on trade flows (Gasiorek et al, 2007). For example, the "using" industry (ξ_k) and "supplying" industry (ξ_p) fixed effects are used in explaining trade flows. The "using" industry and "supplying" industry fixed effects are supposed to control for unobserved sector-specific shocks and industrial characteristics.

Tariff data are compiled from the WTO IDB database (WTO *Comprehensive Tariff Data*) using WITS, a data consultation and extraction software developed by the World Bank. Services data are compiled from *United Nations Service Trade Statistics Database* and FDI stock data are from OECD STAN Indicators ed. 2005.

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although the estimate of FDI stock tends to underestimate the coefficient of vertical FDI (Wooldridge, 2002, 75). This condition is satisfied, since FDI stock is not correlated with tariff barriers and services trade liberalization. Tariff jumping FDI may be related to tariff barrier, but FDI stock as a whole may not. Under the assumption of no-correlation between FDI stock and other covariates, the parameter of z is consistently estimated, while the parameter of vertical FDI is underestimated.

[20] Yet the relationship between the FTA determinants (selection into FTAs) and other trade-flow determinants (conditioning characteristics) could be nonlinear. For this reason, Baier and Bergstrand (2009, 64) suggests employing a matching estimator as a nonparametric benchmark for the empirical analysis of FTA treatment effects. The conditioning characteristics can make a criterion for selecting control groups.

[21] Feenstra (2004, 161).

[22] The coefficients of the importer and exporter dummies estimate the "multilateral resistance" terms, the unobserved price indexes introduced by Anderson and van Wincoop (2003).

Estimation

For models with data from two periods (2000 and 2005), first differencing eliminates the fixed effects. Two equations in first differences are estimated: one for intermediate inputs and the other for final goods. The dependent variable is a change in bilateral trade relative to the product of GDPs. Following the estimation strategy of Anderson and van Wincoop (2003), the GDP terms are moved from the right- to the left-hand side of an equation.

The estimating equation for intermediate inputs trade includes as independent variables treatment, tariff barriers, services trade growth, changes in FDI stock, and interactions of treatment with demeaned covariates. The estimating equation for final goods trade includes variables like treatment, trade barriers, outsourcing and interactions of treatment with demeaned covariates. Dummies representing fixed effects (importer, exporter, user, and supplier specificity) are eliminated in the first-differenced equation. Table 3 provides summary statistics of the dependent and explanatory variables.

[Table 3] Summary statistics

A. intermediate goods trade					
variables	observations	mean	standard deviation	minimum	maximum
$\Delta(\ln IM_{ijpk} / \ln Y_i \ln Y_j)$	2732	0.062	0.994	-7.277	6.553
z	6308	0.639	0.480	0.000	1.000
$\Delta \ln(1+t_a) \cdot w$	6308	0.010	0.042	0.000	1.417
$\Delta \ln SM$	2118	0.681	0.657	-1.894	4.524
$\Delta \ln OFDI$	2826	0.877	1.308	-4.109	9.399
$(\Delta \ln(1+t_a) - \overline{\Delta \ln(1+t_a)}) \cdot w$	6308	0.000	0.042	-0.010	1.406
$(\Delta \ln SM - \overline{\Delta \ln SM})$	2118	0.000	0.657	-2.575	3.843
$(\Delta \ln OFDI - \overline{\Delta \ln OFDI})$	2826	0.000	1.308	-4.986	8.522
B. final goods trade					
variables	observations	mean	standard deviation	minimum	maximum
$\Delta(\ln FX_{ij} / \ln Y_i \ln Y_j)$	6593	0.303	1.070	-10.780	9.173
z	6306	0.639	0.480	0.000	1.000
$\Delta \ln(1+t_b)$	5875	-0.020	0.078	-0.847	1.363
$\Delta \ln GIM$	2732	0.320	0.993	-6.877	6.774
$(\Delta \ln(1+t_b) - \overline{\Delta \ln(1+t_b)})$	6308	0.000	0.070	-0.034	1.383
$(\Delta \ln GIM - \overline{\Delta \ln GIM})$	2766	0.000	3.159	-14.812	7.299

Abbreviations: intermediate goods imports (*IM*); services imports (*SM*); outbound FDI (*OFDI*); tariff $(1+t)$; final goods exports (*FX*); outsourcing (*GIM*); and Y_i, Y_j denote GDPs.

3.2. Results

Estimation results are reported in Table 4A and 4B. IV models in Table 4A and 4B are distinguishable from one another in terms of their restrictions on the interaction between the treatment and the error terms, which in turn change the specification of the models by prescribing what to include as covariates, interaction terms, and control (correct) functions. The key factor in selecting one among various estimation models reported in Table 4A and Table 4B is to determine which one of various restrictions on the covariance of the error and treatment terms is most plausible. These restrictions are supposed to satisfy the consistency condition of the estimators: no correlation between the treatment term and the error term, which is secured if the product of the treatment term and the difference in errors disappears or if the error term has zero mean conditional on the explanatory variables.

Column (M0) in Table 4A and Table 4B provides estimates from a sample selection model (i.e. a treatment-effect model). In IV estimation with a binary endogenous regressor, a treatment indicator becomes the sample selection indicator.[23]

Explanatory variables in (M0) (Table 4A) get expected signs, and coefficient estimates are statistically significant. Outbound FDI stock growth ($\Delta \ln OFDI$) has a positive coefficient estimate that is statistically significant. Outbound FDI stock growth accompanies an increase in outsourcing and intermediate inputs trade because the latter will be higher between countries with a high degree of FDI activities. Services imports growth ($\Delta \ln SM$) has a positive coefficient estimate and is statistically significant. Services imports growth is inversely related to the cost of services abroad, which in turn adversely affects outsourcing. Services imports facilitate intermediate inputs trade.

The change in tariff rates ($\Delta \ln(1+t_a)\cdot w$) has a negative sign and is statistically significant. Obviously, an increase in tariffs adversely affects trade in intermediate inputs. The treatment indicator (z) has a negative sign and its coefficient estimate is statistically significant. An increase in compliance costs leads to a decrease in outsourcing, a negative treatment effect.

The inclusion of these two regressors, tariffs and compliance, has an interesting implication. The elimination of tariffs under FTAs will notably increase trade flows. (The coefficient estimate of tariffs is (-0.871).) FTA status provides tariff preferences to FTA members, which will increase intermediate inputs trade between them. Yet such tariff preferences are conditional on compliance with PROOs. Only firms that comply with PROOs are eligible for preferential tariffs. On the other hand, the

[23] The objectives of these two models are different from each other. The sample selection problem is to obtain the coefficient estimates of covariates. The treatment effect model aims to estimate an average treatment effect (Wooldridge, 2002, 631). For estimation of the sample selection model, see Cameron and Trevedi (2010), 192-194.

effect on intermediate inputs trade of tariff elimination is somewhat offset by the effect of compliance with PROOs (-0.543). The effects of these two variables move in the opposite direction. The net change in intermediate inputs trade due to FTAs will be smaller than what it would have been without PROOs. For example, in the case of a customs union, the effect of tariff elimination would not be offset by the compliance effect.

Estimation of models (M1) through (M4) in Table 4A uses a probit-fitted value as an instrument.[24] In other words, $\hat{\Phi}$ is plugged in as an instrument for w in a 2SLS procedure. While the invariance to covariates is desirable, the marginal effects generated by IV procedures turn out to be sensitive to the list of covariates. For example, adding correction functions has produced huge effect on the estimates, making them vary widely from (-0.267) to (-1.829). Those in (M3) are problematic: the coefficient estimate of $\hat{\phi}$ is not zero and the coefficient estimate of w looks imprecise. In that regard, Wooldridge (2002) has an important point. If the covariance term $w(\varepsilon_1 - \varepsilon_0)$ is a bivariate normal as in **(2-A)**, the coefficient estimate of $\hat{\phi}$ should be zero. Even if it is not zero, adding the correction function $\hat{\phi}$ to the equation should not have much effect on the coefficient estimate of w. Yet if the single instrument is binary, and the coefficient estimate of $\hat{\phi}$ is not zero, the coefficient of w may not be identified.[25] It might be lack of identification that has generated imprecise IV estimation (-1.829) in (M3). If the model is effectively unidentified, the estimate is less precise.

Except for (M3), the estimates from various specifications are smaller in the absolute value than the estimates from the reference model (M0) with varying degrees of statistical significance. In columns (M1) - (M4), the coefficient estimate of the outbound FDI stock variable maintains the right sign with statistical significance. The coefficient on the services imports variable has the right sign, but it is not statistically significant except in (M1). The coefficient estimate of the tariff variable has the right sign and is statistically significant except in (M3). (In (M1), its significance level is around 10.6 percent.) Analogous explanation given to the estimate of the treatment indicator in (M0) can be applied to the estimates in (M1), (M2), and (M4). In other words, with the effects on intermediate inputs trade of tariff elimination and compliance with PROOs moving in the opposite direction, the net change in intermediate inputs trade would fall short of what it would have been without PROOs. While the gap between the FTA effect (0.572) and the compliance effect (-0.551) dwindles quickly in (M4), the FTA effect invariably exceeds the compliance effect by (0.493) in (M1), (0.513) in (M2), and (0.021) in (M4) respectively.

Adding interactions between covariates and treatment to the list of explanatory

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[24] Probit estimation results are not reported for brevity.

[25] Wooldridge (2002, 630).

variables changes the negative treatment effect from (-0.267) in (M1) to (-0.308) in (M2). The change is even greater with (M4), whose coefficient estimate of the treatment effect (-0.551) approaches that of the reference model (M0) (-0.543). Wooldridge (2002) suggests that estimation of equation (5) is practically more desirable if the estimates from equation (4) are too imprecise to be useful.[26] This seems to be the case with (M4). In other words, the procedure associated with (2-B) or (M4) is more efficient than (M3).

Table 4B reports the sample selection and IV estimates from the regression models that include a compliance dummy (w), trade barriers ($\Delta\ln(1+t)$) and outsourcing ($\Delta\ln GIM$) as covariates in first-differenced forms. The estimates for a probit-fitted value ($\tilde{\Phi}$), an instrument for w, in (M0)-(M4) are positive and statistically significant. The coefficient on the instrument from (M3), (0.727), looks widely different from the estimates from the other models. In the other models, the coefficient estimates range from (0.393) to (0.427). As is the case in Table 4A, the specification of final goods trade with the correction function (M3) seems to be less efficient than the specification with the control function (M4) in Table 4B. The estimation result of the probit-fitted term indicates that compliance with PROOs helps facilitate exports. Consequently, an increase in the severity of PROOs will adversely affect final goods trade between member countries because, the severer PROOs are, the less willing are the exporters to fulfill the origin requirements.

The marginal effects generated by z have opposite signs in two groups of trade equations: the same variable has negative influence in intermediate inputs trade, but has positive influence in final goods trade. This is not surprising, since the predicted value of z picking up the likelihood of compliance with PROOs (or willingness to receive "treatment") suggests that compliance has a "cost" effect in intermediate inputs trade and a "facilitation" effect in final goods trade. The rational for including z in the intermediate inputs trade equation is to represent the "costs" of complying with restrictive rules. The expected signs of its coefficient estimate should be negative. That is, costly compliance with PROOs will depress intermediate inputs trade. On the other hand, the compliance instrument in the final goods trade equation represents the extent to which member countries meet the origin requirement. It should be positively related to final goods exports, since greater compliance means bigger trade in final goods unhindered by the origin rules.

The coefficient estimates of trade barriers ($\Delta\ln(1+t)$) and outsourcing ($\Delta\ln GIM$) in (M0)-(M4) also have right signs with relatively high degrees of statistical significance. Unlike the estimate for the probit-fitted value term, these estimates vary moderately, ranging from (-0.424) to (-0.672) for trade barriers, and from (0.033) to (0.042) for outsourcing. Since the effects of FTAs and PROOs are moving in the opposite direction, restrictive PROOs are likely to moderate the

[26] Wooldridge (2002, 632).

positive effect of FTAs on final goods trade. The addition of outsourcing (represented by intermediate inputs trade) to the final goods trade models aims to control for the indirect influence of PROOs working through intermediate inputs trade. Given an inverse relationship between severe PROOs and intermediate inputs trade, it is highly likely that restrictive PROOs may adversely affect final goods trade because a decrease in intermediate inputs trade suppresses final goods trade.

[Table 4A] Estimation results (dependent variable: $\Delta\ln(IM_{ijpk} / Y_i Y_j)$)

	intermediate goods trade				
independent variables	(M0) SS/FD	(M1) IV/FD	(M2) IV/FD	(M3) IV/FD	(M4) OLS/FD
w					-0.551** (0.227)
z [A]	-0.543*** (0.178)	-0.267*** (0.091)	-0.308*** (0.123)	-1.829*** (0.630)	
$\Delta\ln(1+t)$	-0.871* (0.497)	-0.760 (0.471)	-0.821* (0.487)	-0.873 (0.693)	-0.572* (0.348)
$\Delta\ln SM$	0.227** (0.111)	0.083 (0.074)	0.086 (0.076)	0.159 (0.116)	0.143* (0.079)
$\Delta\ln OFDI$	0.153*** (0.046)	0.109*** (0.037)	0.109*** (0.040)	0.106* (0.057)	0.127*** (0.038)
$\hat{\Phi}\cdot(\Delta\ln(1+t)-\overline{\Delta\ln(1+t)})$ [B]			2.131 (3.704)	8.245 (5.660)	-7.917 (6.259)
$\hat{\Phi}\cdot(\Delta\ln SX-\overline{\Delta\ln SX})$ [B]			0.025 (0.054)	0.077 (0.082)	0.131** (0.056)
$\hat{\Phi}\cdot(\Delta\ln OFDI-\overline{\Delta\ln OFDI})$ [B]			0.002 (0.030)	-0.007 (0.043)	-0.021 (0.031)
$\hat{\phi}$ [C]				2.293*** (0.841)	
$w\frac{\hat{\phi}}{\hat{\Phi}}$ [C]					0.451 (0.427)
$(1-w)\frac{\hat{\phi}}{1-\hat{\Phi}}$ [C]					-0.166*** (0.060)
observations	742	742	742	742	740

Abbreviations: intermediate goods imports (*IM*); services imports (*SM*); outbound FDI (*OFDI*); tariff $(1+t)$; sample selection (SS); instrumental variable (IV); and first difference (FD)
Y_i, Y_j denote GDPs, which are from the World Bank.
Country (λ_i, λ_j) and industry (ξ_k, ξ_p) fixed effects are controlled for in estimation, but their estimates are not shown for brevity.
Superscripts (*) (**) (***) indicate 10, 5, 1 percent significant levels respectively.
The heteroskedasticity-robust standard errors and test statistics are used.
[A] $\hat{\Phi}$ for z
[B] $w\times(x-\overline{x})$ instead of $\hat{\Phi}\cdot(x-\overline{x})$ for model (M4).
[C] $\hat{\phi}$, $w\frac{\hat{\phi}}{\hat{\Phi}}$, and $(1-w)\frac{\hat{\phi}}{1-\hat{\Phi}}$ are control functions.

[Table 4B] Estimation results (dependent variable: $\Delta\ln(FX_{ij} / Y_i Y_j)$)

	final goods trade				
independent variables	(M0) SS/FD	(M1) IV/FD	(M2) IV/FD	(M3) IV/FD	(M4) OLS/FD
w					0.427*** (0.117)
z A	0.410*** (0.028)	0.400*** (0.027)	0.393*** (0.027)	0.727*** (0.109)	
$\Delta\ln(1+t)$	-0.627*** (0.211)	-0.642*** (0.211)	-0.672*** (0.210)	-0.424* (0.234)	-0.605*** (0.240)
$\Delta\ln GIM$	0.033** (0.017)	0.035** (0.017)	0.042*** (0.017)	0.041** (0.018)	0.036** (0.017)
$\tilde{\Phi}\cdot(\Delta\ln(1+t)-\overline{\Delta\ln(1+t)})$ B			2.205*** (0.527)	4.610*** (0.939)	0.262 (0.490)
$\tilde{\Phi}\cdot(\Delta\ln GIM-\overline{\Delta\ln GIM})$ B			0.011 (0.009)	0.026** (0.011)	-0.001 (0.011)
$\tilde{\phi}$ C				-0.630*** (0.198)	
$w\dfrac{\tilde{\phi}}{\tilde{\Phi}}$ C					-0.117 (0.203)
$(1-w)\dfrac{\tilde{\phi}}{1-\tilde{\Phi}}$ C					0.208*** (0.018)
observations	2376	2376	2376	2376	2376

Abbreviations: final goods exports (FX); outsourcing (GIM); tariff $(1+t)$; sample selection (SS); instrumental variable (IV); and first difference (FD)
Y_i, Y_j denote GDPs, which are from the World Bank.
Country fixed effects (λ_i, λ_j) are controlled for in estimation, but their estimates are not shown for brevity.
Superscripts (*) (**) (***) indicate 10, 5, 1 percent significant levels respectively.
The heteroskedasticity-robust standard errors and test statistics are used.
[A] $\tilde{\Phi}$ for z
[B] $w\times(x-\overline{x})$ instead of $\tilde{\Phi}\cdot(x-\overline{x})$ for model (M4).
[C] $\tilde{\phi}$, $w\frac{\tilde{\phi}}{\tilde{\Phi}}$, and $(1-w)\frac{\tilde{\phi}}{1-\tilde{\Phi}}$ are control functions

3.3. Discussion

Under FTAs, the volume of intermediate inputs imported from the ROW to the FTA regions will decrease. Yet this decrease in imports from the ROW may be partly offset if restrictive PROOs cause a reduction in intra-FTA outsourcing. However, even intra-FTA outsourcing may not necessarily increase in the long-run if the prices of final goods using imported inputs rise with production costs due to limited outsourcing. Without an offsetting increase in the demand for the final good, the derived demand for intra-FTA outsourcing may not increase. On the other hand, PROOs may induce increase in investment in the FTA regions aimed to evade "effective tariffs" and undertake intermediate inputs production. Then the prices of intermediate inputs may decrease, resulting in more active intra-FTA outsourcing.

The selected sample is a subset of a larger population (i.e. all the countries in the world). This might cause the "selection bias" problem.[27] However, in some contexts, the selection bias may not be an issue. As Wooldridge (2002, 551) points out, when people propose a model for a subpopulation, what matters is to obtain a random sample from *that* subpopulation. That the selected sample is not a random sample from the *larger* population should not prevent consistent estimation of the parameters of the model for *that* subpopulation. Despite the fact that "non-random" sampling should not cause statistical problems, the estimation results in this paper are not meant to be unconditionally generalizable. Estimation based on OECD data may or may not concur with what would have been obtained for the larger data set. The results based on OECD data may or may not hold in general, but are only suggestive of what could have occurred in OECD trade.

VI. Conclusion

This paper estimates the average treatment effect (ATE) of PROOs using OECD data to show that PROOs adversely affect trade in intermediate inputs and final goods. The effect of PROOs on intermediate inputs trade among FTA members is estimated to be negative. So is the effect of PROOs on final goods trade.

Faced with PROOs, exporters have to make substantial efforts to satisfy the content conditions and/or prove conformity with the rules. In the sense that exporters bear compliance costs in anticipation of tariff preferences, compliance with PROOs can be regarded as willingness to receive "treatment." Decision to abide by PROOs depends on the benefits of compliance (i.e. preferential treatment) against compliance costs. Whether exporters comply with PROOs and accept treatment may be endogenously determined. The treatment effect model has been used to infer the ATE of PROOs on outsourcing from the coefficient estimate of PROOs on exporters' efforts to reduce costs through intermediate inputs trade. The ATE is a rough estimate of the change in bilateral outsourcing flows attributable to PROOs.

IV regression method has been used to estimate the ATEs, for the error term in the estimation equation includes an omitted variable correlated with the decision to comply with PROOs. Estimation in this paper adopts as an instrument an endogenous binary variable conditioned on the MFN rates of FTA members. This binary instrumental variable is correlated with compliance with PROOs, but is not

[27] Another anonymous referee raised this issue, which is greatly appreciated.

correlated with trade flows. Such instrumentation makes it possible to obtain consistent and reliable estimates of the ATEs. Without a good instrument for treatment, IV methods cannot be efficient. The analysis in this paper contradicts Baier and Bergstrand (2007), which concludes that standard cross-section IV methods do not provide stable estimates of the ATEs.

Estimation of PROOs' effect on outsourcing confirms the notion that PROOs are the protectionist instrument, inducing hidden protection through an "effect of tariffs" on imported intermediate inputs, and causing an indirect protective effect on final goods. For example, Kruger (1993) shows that PROOs in effect enable members of an FTA to exchange producer protection with other FTA member countries, and that PROOs extend protection to producers in other member countries, causing economic inefficiency in FTAs that is absent in customs unions. Estevadeordal (1999) shows in the study of NAFTA that PROOs did the same function as the traditional preferential tariffs as an independent commercial policy instrument. In a similar vein, Cadot et al. (2002) argues that stiff PROOs of NAFTA has induced only a relatively minor increase in Mexico's trade flows. Wonnacott (1996) even suspects that the real role of PROOs is not to prevent trade deflection, but to protect intermediate inputs producers who are the real beneficiaries of PROOs.

The elimination of tariffs under FTAs will increase trade flows. Yet tariff preferences of FTAs are conditional on compliance with PROOs. The effect on intermediate inputs trade of tariff elimination is somewhat offset by the cost of compliance. The effects of FTAs and PROOs move in the opposite direction. The net change in intermediate inputs trade will be smaller than what it would have been without PROOs.

With the effects of FTAs and PROOs moving in the opposite direction, restrictive PROOs moderate the effect of FTAs on final goods trade. Given an inverse relationship between PROOs and intermediate inputs trade, the presence of restrictive PROOs will adversely affect final goods trade because a decrease in intermediate inputs trade distorts final goods trade.

While this paper addresses the treatment effect of PROOs on outsourcing, the estimated effect found in this paper is comparable to the effect of PROOs on compliance costs found in other studies. According to Manchin and Pelksman-Baloing (2007), compliance costs estimated for selected groups of countries range from 3 percent to 8 percent of the value of the goods traded.[28] Although this paper

[28] Herin (1986) finds that one quarter of EFTA exports to the EU paying the MFN duties to avoid the costs of proving origin, and that compliance costs are equivalent to some 3 percent of the value of the goods traded. Carrère and de Melo (2006) finds that total compliance costs for Mexican traders exporting to the United States in 2001 averaged around 6 percent and 3.9 percent for products whose utilization rate is less than 100 percent. Cadot et al. (2005) estimates the trade-weighted compliance (administrative) costs for NAFTA and the Pan-European FTAs are 6.8 percent (1.9 percent) and 8

does not explicitly estimate compliance costs, the estimation results of this paper provide similarly noticeable variations in the compliance costs for the importers of outsourced intermediate inputs, the exporters of final goods.

percent (6.8 percent) respectively. Manchin (2005) finds that the costs of PROOs in the case of the Cotonou preferential scheme for non-least developed ACP countries are around 4 percent.

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