Ifo Institute – Leibniz Institute for Economic Research at the University of Munich

ifo Working Papers

Estimating the effects of Kyoto on bilateral trade flows using matching econometrics

Rahel Aichele
Gabriel J. Felbermayr

Ifo Working Paper No. 119

December 2011

Estimating the effects of Kyoto on bilateral trade flows using matching econometrics*

Abstract

Many Kyoto countries fear a loss of competitiveness due to unilateral climate policy efforts; policymakers therefore call for carbon-related border tax adjustments. With this paper we attempt to estimate the treatment effect of Kyoto commitment on bilateral export flows using regression-adjusted differences-in-differences matching techniques. The gravity and international environmental agreement formation literatures provide guidelines for the choice of matching variables. We find that Kyoto countries' exports are reduced by 13–14% due to Kyoto commitment. Trade effects are largest in energy-intensive, homogeneous industries such as iron and steel, non-ferrous metals, organic and inorganic chemicals but also in machinery and equipment.

JEL Code: F18, Q54, Q56.
Keywords: Competitiveness, Kyoto Protocol, matching econometrics, treatment effects.

Gabriel J. Felbermayr
University of Munich,
Ifo Institute – Leibniz Institute for Economic Research
at the University of Munich,
GEP Nottingham, CESifo
Poschingerstr. 5
81679 Munich, Germany
Phone: +49(0)89/9224-1428
felbermayr@ifo.de

Rahel Aichele**
University of Munich,
Ifo Institute – Leibniz Institute for Economic Research
at the University of Munich
Poschingerstr. 5
81679 Munich, Germany
Phone: +49(0)89/9224-1275
aichele@ifo.de

* We are grateful to seminar participants at the GEP Postgraduate and ETSG conferences 2011 for comments. Special thanks to Tilmann Rave for helpful suggestions. The authors acknowledge financial support from DFG grant no. 583467.
** Corresponding author.

1 Introduction

The Kyoto Protocol – signed in 1997, entered into force in 2005 – assigns emission ceilings to industrial countries relative to their 1990 emission levels in the period 2008-12. Yet, it covers less than half of anthropogenic greenhouse gas (GHG) emissions because developing countries including major polluters like China and India are exempt *en bloc* and the U.S. did not ratify the treaty. As a result Kyoto countries' politicians fear for the competitiveness of their (energy-intensive) industries. They argue that increased costs of GHG emissions due to Kyoto would put Kyoto countries' industries at a comparative disadvantage. This was indeed the reasoning given by the U.S. for not ratifying the Kyoto Protocol. And it is the reason why Canada recently pulled out of the treaty. Classical trade theory suggests that, in a globalized world, (GHG-intensive) industries should increasingly produce in non-Kyoto countries and export their products to emission-constrained Kyoto countries.[1] So the question arises whether the Kyoto Protocol actually had an impact on trade patterns. We will address the issue by investigating bilateral export flows.

The analysis of competitiveness issues seems crucial for the design of future climate agreements. At the moment it seems politically infeasible to reach a global deal. Potential Kyoto follow-ups would only apply to a sub-group of countries. If it turns out that trade flows react to differentials in climate policy, policymakers should think of ways to address the issue. One instrument to level the playing field currently debated, and for example advocated by French president Sarkozy, is the use of carbon-related border tax adjustments (BTA).

Related literature. The *ex-ante* analysis of competitiveness effects of unilateral climate policy is typically addressed in computable general equilibrium (CGE) models. Babiker (2005) uses a model with increasing returns to scale and an Armington demand system. He finds competitiveness effects for an OECD emission cap, but the extent of

[1]This entails potentially detrimental effects for the environment. Emission savings in Kyoto countries are at least partially offset, when the possibility to trade leads to the relocation of production (and thus emissions) to non-Kyoto countries due to Kyoto commitment ("carbon leakage").

locational effects depends on the assumed market structure. Manders and Veenendaal (2008) use a different model and find only modest competitiveness effects from a policy to reduce emissions in the European Union in 2020 to 20 percent below 1990 levels when accompanied by a BTA. In contrast, Babiker and Rutherford (2005) model the Kyoto Protocol in a CGE framework and find more substantial competitiveness effects. Recent work focuses on border tax adjustments as remedies to the competitiveness and carbon leakage problem. Mattoo et al. (2009) highlight how carbon-related BTAs could harm developing economies. The most recent paper, by Elliott et al. (2010), investigates trade in carbon and finds substantial carbon leakage ranging from 15 percent at low tax rates to over 25 percent for the highest tax rate. *Ex-post* analyses of trade effects of environmental policy mostly embed a measure of environmental stringency in the gravity framework (Jaffe et al., 1995; Ederington et al., 2005; Levinson and Taylor, 2008, see, e.g.). Studies on climate policy are, however, scant. A study by the World Bank (2008) finds no significant competitiveness effects of carbon taxes on energy-intensive trade flows. Aichele and Felbermayr (2011) derive a gravity equation for the carbon content of trade. Their study suggests that Kyoto commitment on average leads to increased carbon imports in committed countries, thereby leading to leakage. Based on aggregate data and on a different way to deal with self-selection of countries into the Protocol, Aichele and Felbermayr (forthcoming) confirm these findings.

We contribute to the literature in the following ways. First, we use a different empirical methodology that combines differences-in-differences estimation with matching techniques to account for the endogeneity of Kyoto commitment. Second, beyond assessing the average effect of Kyoto commitment, we provide an estimate of the average treatment effect on the treated (ATT). From a policy perspective, this is the relevant estimate since it informs about how *Kyoto countries'* exports – and not an average country's exports – have reacted to their Kyoto commitments so far. And finally, conducting a sectoral analysis of Kyoto's effect on exports allows identifying which sectors' trade flows are affected by the Kyoto Protocol and which are not.

Our empirical approach is motivated by theoretical and empirical work on the economic fundamentals driving international environmental agreement (IEA) and particularly Kyoto membership. Since ratification of the Kyoto Protocol is a political process, it is certainly not random. The empirical literature typically distinguishes economic, political and environmental determinants of IEAs (see Murdoch and Sandler, 1997; Beron et al., 2003; Egger et al., 2011, for examples). GDP or GDP per capita are important variables. York (2005) stresses demographic change as predictor of Kyoto ratification. And also free-riding on other's efforts might matter (Murdoch and Sandler, 1997; Carraro and Siniscalco, 1998). Egger et al. (2011) show that a country's trade openness affects its probability to sign IEAs. Finally, the Kyoto status of important trade partners might matter, as in the U.S.-China case. This is the basis for our empirical model to estimate the likelihood of self-selection into Kyoto. The same fundamentals that determine selection into the Kyoto Protocol also drive trade patterns (see Bergstrand, 1989; Eaton and Kortum, 2002; Anderson and van Wincoop, 2003, for seminal contributions in the gravity literature). In this case, matching techniques are well suited to get an unbiased estimate of the ATT. Although matching is typically used to study effects of, for example, job training programs on labor market outcomes, several studies apply matching in the gravity context (see Persson, 2001; Chintrakarn, 2008; Egger et al., 2008; Baier and Bergstrand, 2009b, for examples).[2] Fewer studies use matching techniques to estimate the effect of environmental policies. List et al. (2003) employ a differences-in-differences matching estimator to analyze the effects of environmental air quality regulation on plant birth within New York state counties. Millimet and List (2004) extend the study by analyzing heterogeneity in the ATTs for county characteristics.

For a sample of 117 exporters, of which 34 have Kyoto commitments, our estimates suggest that bilateral exports to non-Kyoto countries are reduced by 15-20% due to Kyoto commitment. The average treatment effect for a *Kyoto* country was 13-14% only. So our results highlight that not accounting for self-selection overstates the negative effect of Kyoto commitment. We report heterogeneity of Kyoto's treatment effects across

[2]Matching is a promising strategy in the gravity context, because it allows matching on relative measures. The sheer number of country pair observations makes it likely to find an appropriate clone (in terms of joint GDP and distance etc.) for a country pair. This is certainly easier and more credible than performing matching for countries. Arguably, it is impossible to find a clone, say, for the U.S.

sectors. Some sectors, e.g. iron and steel, organic and inorganic chemicals, plastics and also machinery and equipment exhibit substantial negative competitiveness effects; while Kyoto countries even expanded exports in some sectors, e.g. travel goods and handbags or footwear. For about half of the products (27 out of 51 SITC product classes) we cannot identify significant effects, however. Consistent with theory, energy-intensive industries and sectors producing homogeneous goods are more strongly affected by negative competitiveness effects.

The rest of the paper proceeds as follows. Section 2 discusses our empirical strategy and data. Section 3 presents our results and robustness checks. Section 4 contains an analysis of competitiveness effects on the sectoral level. Section 5 concludes.

2 Empirical strategy and data

We are interested in how Kyoto commitment – i.e. the commitment to an emission cap under the Kyoto Protocol – affects the exports of Kyoto countries. The unit of analysis is a country pair, i.e. an exporter-importer dyad (possibly at the industry level), indexed by $i = 1, \ldots, N$. Let $D_{it} \in \{0, 1\}$ be a treatment dummy that takes on the value of one if country pair i's exporter has a Kyoto commitment in period t and zero else. Working with a Kyoto dummy is certainly a crude assumption because the intensity of Kyoto commitment might differ across countries. Nevertheless, this approach is common in the treatment evaluation literature, see e.g. the literature on treatment effects of free trade agreements (FTAs) (Baier and Bergstrand, 2007), currency unions (Baldwin and Taglioni, 2007) or other international environmental agreements (Ringquist and Kostadinova, 2005; Aakvik and Tjøtta, 2011). We assume treatment starts with ratification of Kyoto commitment in national parliaments. The notion is that once ratification takes place, governments adjust their policies and economic subjects adjust there expectations. This assumption is also common in the evaluation of other international environmental agreements such as the Helsinki Protocol regulating sulfur dioxide emissions (Ringquist and Kostadinova, 2005). In a robustness check, we use the Kyoto Protocol's entry into force in 2005 as alternative treatment date.

Let Y_{it} denote the outcome variable of interest: country pair i's value of bilateral exports in period t (default sample). In a reduced sample, we restrict attention to exports to non-Kyoto countries. This amounts to evaluating the effect of *differential status* in trade partners' Kyoto commitments. Y_{it} is determined by Kyoto status and a vector of standard gravity covariates $\mathbf{X}_{it}$ including GDPs, bilateral trade costs proxied by joint FTA, WTO and EU membership, and multilateral resistance terms. Bilateral export flows could also be affected by unobservable influences. These might include differences in endowments, geographic location or climatic conditions, culture and also preferences. Let u_i be country-pair specific, time-invariant determinants of exports. The log gravity equation can then be written as

$$\ln Y_{it} = \gamma D_{it} + \mathbf{X}_{it}{}'\beta + u_i + \alpha_t + \epsilon_{it} \tag{1}$$

where α_t is a common time trend and ϵ_{it} is an i.i.d. error term. The coefficient of interest is Kyoto's treatment effect γ.

2.1 Self-selection into Kyoto commitments: problems and cures

A complication arising in the estimation of γ is self-selection into treatment. Kyoto membership is the outcome of a political process and therefore not random. When selection is on time-invariant unobservables like differences in climatic conditions or endowments in fossil fuels, differences-in-differences (DID) estimation eliminates u_i from equation (1) and recovers Kyoto's treatment effect.[3] Yet, the likelihood of Kyoto commitment is influenced by economic fundamentals also affecting bilateral trade flows. Economic size and economic growth are important determinants, as well as GDP per capita. York (2005) stresses the importance of demographic factors for Kyoto ratification. Rose and Spiegel (2009) document that signing bilateral environmental agreements positively influences bilateral cross asset holding. The reasoning is that commitment under an environmental treaty reveals a country's time preference. So commitment in the environmental arena signals trustworthiness and furthers cooperation in other international forums. And Eg-

[3] See a similar discussion for self-selection into FTAs in Baier and Bergstrand (2007).

ger et al. (2011) show that trade openness positively affects the number of international environmental agreements a country signs. These arguments suggest that treated and untreated country pairs may differ with respect to their economic fundamentals and thus might differ in their willingness to commit to Kyoto and be differently affected by Kyoto commitment. It implies that the treatment effect for an average country differs from the average treatment effect on the treated (ATT). As argued above, the ATT is the relevant indicator of how Kyoto commitment has affected Kyoto countries' exports.

Selection on observable covariates suggests the use of matching econometrics.[4] The basic idea of the matching method is to find untreated units that are similar to treated units in terms of their covariates (also called matching variables) except for treatment status, and thus establish experimental conditions. For a survey, see e.g. Blundell and Dias (2009) or Imbens and Wooldridge (2009). In the matching language, each unit has two potential outcomes $Y_i(D_i)$ depending on treatment status. The average treatment effect (ATE) is the average difference between treated and untreated outcome, and the ATT is the average difference between treated and untreated outcome conditional on treatment

$$\begin{aligned} ATE &= \mathbb{E}\left[Y_i(1) - Y_i(0)\right], \\ ATT &= \mathbb{E}\left[Y_i(1) - Y_i(0) \mid D_i = 1\right], \end{aligned} \tag{2}$$

where $\mathbb{E}$ is the expectation operator. In actual data however, we can only observe one of the potential outcomes. Either a unit is treated or it receives no treatment. Matching econometrics infers the missing counterfactual by the outcome of country pairs j in the properly constructed control group. The critical assumptions are that for every treated observation with $X_i = x$ there has to be at least one untreated observation with $X_j = x$ (*overlap assumption*) and once we control for covariates X treatment is randomly assigned (*ignorability assumption* or *selection on observables*). A simple estimator of the ATT in

[4] Several studies use cross-section matching techniques in a gravity context. Baier and Bergstrand (2009b) find that matching econometrics helps to get economically plausible and more stable estimates of FTAs' effects on trade flows. In a similar vein, Persson (2001) and Chintrakarn (2008) use propensity-score matching to estimate the trade effects of currency unions.

a very general form is

$$\hat{ATT} = \frac{1}{N_T} \sum_{i \in D_i=1} \left[Y_i - \sum_{j \in D_j=0} w_{ij} Y_j \right], \tag{3}$$

where w_{ij} is the weight assigned to country pair j in the control group being matched with country pair i and N_T is the number of treated country pairs.[5]

One way to construct the control group and respective weights is based on the *Mahalanobis metric* (one-to-one matching, k nearest neighbors). The Mahalanobis metric exploits the euclidean distance in matching variables between i and j, $\|X_i - X_j\|$. With one-to-one matching the untreated country pair j for which the Mahalanobis metric is smallest (i's nearest "neighbor") is chosen as control and receives a weight of one; for all other untreated pairs the weight is zero. Accordingly, in the case of k-nearest neighbor matching, the k closest neighbors are chosen as control group with $w_{ij} = 1/k$.[6] An alternative matching approach dates back to Rosenbaum and Rubin (1983) and matches on the *propensity score* (one-to-one, k nearest neighbor, kernel, radius matching). Treatment selection is modeled with a probit or logit model. We use a probit specification as default. Country pairs are matched according to their probability of exporter's Kyoto commitment. Nearest neighbor matching again uses the k nearest neighbors, but now in terms of the propensity score. With kernel density matching, the control group comprises all untreated pairs with propensity scores in the neighborhood of i (defined by the bandwidth), where j receives a higher weight, the closer its propensity score is to i's. Finally, radius matching uses all untreated pairs with propensity score differences smaller than the specified radius.

The simple matching estimator is confounded in the presence of unobserved heterogeneity. However, the framework is easily extended to a DID setup with time-invariant

[5]The same logic applies to retrieve an estimate for ATE. The summation then is over all country pairs $i = 1, \ldots, N$ and the counterfactual outcome is recovered by matching. In the following, our representation focuses on ATTs but the respective ATEs can be estimated in a similar fashion.

[6]With continuous matching variables, the ATT will have a conditional bias depending on sample size and number of covariates. Abadie and Imbens (2006) provide a bias-adjusted version that renders the estimator $N^{1/2}$-consistent and asymptotically normal.

unobservables (see e.g. Heckman et al., 1997; Blundell and Dias, 2009). In its simplest version, there are two time periods: a pre-treatment period ($t = 0$) and a post-treatment period ($t = 1$). For a country pair receiving treatment, matches in the untreated group are found on the basis of pre-treatment period covariates X_i.[7] The ATT compares the differences between treated and control country pairs in the difference between post- and pre-treatment outcomes. So the DID matching estimator is

$$\hat{ATT}^{MDID} = \frac{1}{N_T} \sum_{i \in D_i=1} \left[(Y_{i1} - Y_{i0}) - \sum_{j \in D_j=0} w_{ij}(Y_{j1} - Y_{j0}) \right]. \quad (4)$$

For example, Egger et al. (2008) apply the DID matching estimator to estimate the effect of regional trade agreements on trade structure and volume.

The DID matching estimator assumes that changes in the covariates $\mathbf{X}_i$ follow a common time trend. This assumption is not likely to hold in our context, thus creating a bias due to discrepancies in covariates. For example, non-Kyoto countries are predominantly developing countries experiencing higher growth rates in GDP and GDP per capita than Kyoto countries. *Regression-adjusted matching estimators* deal with this bias by correcting for changes in covariates, see Robins and Ritov (1997), Heckman et al. (1998), Imbens (2004) or Imbens and Wooldridge (2009) and Heckman et al. (1997) for a DID version. The correction typically is linear in covariates. In equation (4), $(Y_{i1} - Y_{i0})$ is replaced by $((Y_{i1} - X_{i1}{}'\beta) - (Y_{i0} - X_{i0}{}'\beta))$ and $(Y_{j1} - Y_{j0})$ is replaced by $((Y_{j1} - X_{j1}{}'\beta) - (Y_{j0} - X_{j0}{}'\beta))$ (Heckman et al., 1997), where β stems from a regression of Y on X for the untreated in the post-treatment period. This is equivalent to performing a DID estimation on equation (1) with weighted least squares. The weights stem from propensity score or Mahalanobis matching on pre-treatment covariates as described above. To our knowledge, the present paper is the first application of a regression-adjusted matching estimator in the gravity context. The combination of matching and DID estimation has the advantage of generating a quasi-experimental data set and will take us a long way in reducing selection bias.

[7]Note that the basic DID matching estimator only allows for a common time trend in X_i changes, such that the pre- and post-treatment distribution of covariates remain unchanged.

A last issue meriting attention is that countries' ratification of the Kyoto Protocol took place in different years. The first committed countries to ratify the Protocol were the Czech Republic and Romania in 2001. The bulk of Kyoto countries followed in 2002 and 2003 and late ratifiers include Australia and Croatia in 2007. We deal with this by analyzing averages of a pre- and post-treatment period.[8] Define a treatment period from 2001 to 2003 in which most countries ratified Kyoto. Pre- and post-treatment period are chosen to be symmetric 4-year windows around the treatment period, i.e. 1997-2000 and 2004-2007 respectively. Note that using differences in average outcomes before and after treatment has the additional advantage of overcoming problems of autocorrelation in the data (see Bertrand et al., 2004).

2.2 The choice of matching variables

Matching relies on the *ignorability assumption*. This assumption ensures that once we control for covariates treatment is random. Put differently, it reestablishes a dataset as if from an experimental setup. So successful matching crucially hinges on the choice of matching variables. The appropriate matching variables are those that influence both the decision to select into treatment and the outcome of interest. However, there exists no test equivalent to a goodness-of-fit test for model selection in the matching context. Thus, we use theoretical insights from the public economics and gravity literature to guide our choice. We bilateralize all covariates. That is, we search for clones that are similar, e.g., in their joint GDP.

Bilateral exports are determined by market size of exporter and importer, carbon taxes, bilateral trade costs, price indices and production technology (see Anderson and van Wincoop, 2003; Aichele and Felbermayr, 2011). Market size is measured by joint GDP and joint population size. GDP and population growth are also typical determinants of IEA membership (see e.g. Murdoch and Sandler, 1997; Beron et al., 2003; York, 2005). We capture technological differences in a country pair by the product of real GDP per capita (the growth literature shows that GDP per capita and technology are closely

[8]This is also the approach taken in Egger et al. (2008).

related) and emission intensity differences in a pair. These variables also matter for Kyoto selection. Advanced countries with a high GDP per capita might care more for environmental problems. Emission intensity on the other hand represents reliance on fossil fuels which reduces the likelihood for Kyoto commitment. Also trade openness matters for IEA membership (Egger et al., 2011). Multilateral resistance (MR) is related to openness and captures how close a country pair is to all other trade partners in terms of distance and other trade cost measures such as joint WTO membership. So MR terms bear information on how easy it is to find other trade partners which is linked to competitiveness effects. Therefore, we include MR terms for FTA, joint EU and WTO membership and bilateral distance, contiguity and common language. We compute multilateral resistance terms as linear approximations to price indices as suggested by Baier and Bergstrand (2009a). They take the form $MR^V_{mx} = \sum_{k=1}^{K} \theta_k V_{mk} + \sum_{l=1}^{K} \theta_l V_{lx} - \sum_{l=1}^{K} \sum_{k=1}^{K} \theta_k \theta_l V_{kl}$ where m, x index the importer and exporter respectively, k and l are country indices, and θ_k is country k's share in world GDP. V comprises the log of bilateral distance and dummies for common language, contiguity, joint FTA, WTO and EU membership. In a robustness check, we will also add political controls to the matching variables (see subsection 3.2 for details). A country's political institutions might influence how easy it is to ratify an international treaty in national parliament. And the political orientation might influence trade patterns.

There is no direct test whether the ignorability assumption holds. However, a *balancing test* proposed by Rosenbaum and Rubin (1985) is used to ensure that the distribution of covariates is the same for treated and control pairs. The test checks whether the differences in the mean of each covariate between treated and matched control country pairs is too large. The STATA routine also provides a measure of bias reduction (based on the differences in the mean of covariates between treated and untreated pairs). An additional prerequisite in matching is the *overlap assumption*. Since we have about 12.000 country pairs the overlap assumption is most likely fulfilled. Additionally, with propensity score matching, we drop observations outside the common support – i.e. treated country pairs with a propensity score higher than the maximum or lower than the minimal propensity score of untreated pairs.

Summarizing, our matching variables are log of joint GDP, log of joint population, log of joint real GDP per capita, the exporter's energy intensity minus the importer's energy intensity, and the six multilateral resistance terms. The list of covariates captures a broad spectrum of determinants of bilateral trade flows which are related to IEA membership. We hope this ensures that no variable is omitted that could confound the estimates.

Figure 1 shows that treated and untreated country pairs differ with respect to our matching variables. In Panel (a), the kernel density function of the log of the product of GDPs in a treated country pair (black solid line) is to the right of the untreated country pairs' kernel (gray dashed line). This indicates that treated country pairs jointly have larger markets. Panel (b) shows that treated country pairs are jointly smaller in population size than untreated ones, although the difference is not very distinctive. In Panel (c) the log of joint real GDP per capita is to the right of the one of untreated pairs. So treated pairs are jointly more advanced countries. The distribution of energy intensity differences does not differ (Panel (d)). Treated country pairs also differ with respect to how close they are to other WTO countries (Panel (e)) and they also tend to be geographically closer to other trade partners (Panel (f)).

2.3 Data description

Bilateral export flows for the years 1990-2009 stem from the UN Comtrade database. We use total as well as sectoral export data. Sectoral bilateral exports comprise the 52 non-agricultural 2-digits SITC Rev. 3 commodities.[9] Nominal GDP, population and emission intensities are obtained from the World Development Indicator (WDI) 2010 database. Real GDP per capita is taken from the Penn World Tables (PWT) 7.0. Geographical variables and bilateral distance measures are taken from CEPII. Joint FTA membership comes from the WTO. The EU and WTO dummy are constructed from the homepage of the EU and WTO, respectively. Information on the Kyoto status of countries stems from the UNFCCC. A country is coded as Kyoto country when it has ratified the Kyoto Protocol and is listed in the Annex B to the Kyoto Protocol. So only countries that

[9] See Table 4 for a list with sector descriptions.

committed to an emission ceiling under the Protocol are Kyoto countries.

Our benchmark period is 1997-2007.[10] The dataset comprises 117 exporters and 128 importers, 34 of which are Kyoto countries.[11] This gives a total of 12,139 country pairs or roughly 24,000 observations. 4,210 country pairs, i.e. about 35%, have a Kyoto exporter. In the reduced sample, we focus on exports into non-Kyoto countries. Here, we have roughly 17,000 observations. Of the 8,573 country pairs again around 36% of the exporters have Kyoto obligations. Table 1 provides summary statistics for the default sample.

Figure 2 shows sectoral differences between post- and pre-treatment period averages in the log of treated pair's real exports minus the log of untreated pair's real exports, i.e. the difference in the average real trade growth trend in treated versus untreated country pairs between these periods. Export flows are deflated with the exporter's GDP deflator taken from WDI 2010.[12] The dashed line indicates the overall trend. Kyoto countries' real exports on average grew by 44% between the pre- and post-treatment period. The respective growth for non-Kyoto countries was 35%. Hence, Kyoto countries' exports grew by roughly 9 percentage points more. Albeit the positive overall trend difference, 15 out of the 51 goods categories experienced less export growth if the exporter was a Kyoto country. The variation in sectoral trends is quite substantial. Iron and steel (goods category 67) displays the largest negative growth difference. Here, exports grew by 30 percentage points less for Kyoto exporters. Other energy-intensive goods categories (black bars) are also amongst the sectors affected most negatively by the exporter's Kyoto commitment.[13] For example, plastics in primary form (goods category 57) with -12 percentage points or chemical materials and products (goods category 59) with -11 percentage points less

[10] We also run a robustness check on 1995-2009 data, but caution that the financial crisis starting in 2008 could bias the results if Kyoto and non-Kyoto countries were hit differently.

[11] Liechtenstein is not in our data set due to data availability. Australia and Croatia are coded as non-Kyoto countries because they ratified Kyoto at the end of our benchmark period, in late 2007.

[12] Using nominal instead of real export flows does not change the ordering of the goods categories.

[13] We follow the EU Commission and the U.S. Department of Energy (`http://www1.eere.energy.gov/industry/industries_technologies/index.html`) in classifying goods as energy-intensive.

growth. Most of the energy-intensive goods categories experienced a below average growth trend. Other goods categories like cork and wood (goods category 24), travel goods, handbags and similar containers (goods category 83) or pulp and waste paper (goods category 25) had substantially more growth if the exporter committed to Kyoto. So Figure 2 suggests quite substantial effects of Kyoto commitment on a sectoral level, where energy-intensive goods categories are affected negatively. In Section 4 we will look into sectoral effects in more detail, but first we analyze overall trends in the following section.

3 Estimates of Kyoto's effect on exports

Before turning to our results, we will revisit the distribution of covariates. After matching, tests for differences in means are rejected for all our matching variables. The achieved bias reductions are large. The kernel densities for treated country pairs (black solid line) and the control group (gray dashed line) confirm this as well (see Figure 3). Although not perfectly identical, the distributions are a lot more similar for the two groups. In light of the ignorability assumption this is reassuring.

3.1 Baseline results

We apply the variants of the regression-adjusted DID matching estimator outlined in section 2 (Mahalanobis matching and propensity score matching with nearest neighbors, kernel or radius) to estimate the ATT of Kyoto commitment on bilateral exports. The baseline results for the default sample including all country pairs are reported in Table 2. Column (1) shows estimates obtained by a differences-in-differences gravity estimation as benchmark. The gravity controls other than Kyoto commitment are log GDP of the importer and exporter, log real GDP per capita of the importer and exporter, dummies for FTA as well as joint WTO and EU membership, multilateral resistance terms for FTA, joint EU and joint WTO membership, the energy intensity difference, a period dummy and a constant. The adjusted R^2 is 0.293. So around one fourth of the within variation in the log of bilateral exports can be explained with our model. The coefficient on the log of the importer's GDP is 0.740 and statistically significant at the 1% level. This implies that a one percent increase in the importer's GDP increases bilateral exports by about 0.74%. The effect of an increase in exporter's GDP is not statistically different from zero. The coefficient on the log of the exporter's real GDP per capita is 0.605 and highly statistically significant. This suggests that more economically advanced exporters trade more. The effect of the importer's real GDP per capita on the other hand is insignificant. Joint WTO membership reduces exports by roughly 30%. Probably, this is because in our sample period new WTO members typically are less developed countries. FTA and joint EU membership increase bilateral exports by 17% and 30% respectively. Energy intensity differences are not significant. Finally, the average treatment effect of the exporter's Kyoto commitment is -0.082 and statistically significant at the 10% level. This implies that exports are reduced by about 8% due to the exporter's Kyoto commitment.

The next three columns show results on ATEs from regression-adjusted DID matching. Column (2) applies 5 neareast-neigbor propensity score matching, column (3) uses kernel propensity score matching and column (4) applies matching on the Mahalanobis metric with 5 nearest neighbors. Compared with column (1), the magnitude and significance of covariates vary only a bit. Most notably, the exporter's market size now matters for export volumes and the exporter's real GDP per capita turns insignificant. The models in columns (2)-(4) can explain roughly 40% of the within variation of bilateral exports. Note also that the number of observations reports country pairs used in the regression but does not take into account the weighting procedure. 5 nearest-neighbor propensity score matching (column 2) gives an estimate of Kyoto's ATE of -0.164, statistically significant at the 5% level. This suggests that bilateral exports are by 16.4% lower if the exporter has a Kyoto commitment. The estimate is larger than under the standard gravity benchmark. Kernel propensity score matching confirms this result. The estimated coefficient is -0.197, statistically significant at the 1% level. With Mahalanobis matching with 5 nearest neighbors, Kyoto's ATE is -0.152, significant at the 5% level. Summarizing, our results suggest an average country's exports are lowered by 15-20% due to the exporter's Kyoto commitment. And Kyoto's ATE is larger in the quasi-experimental data set obtained from matching.

Columns (5)-(7) show Kyoto's ATT from regression-adjusted DID matching using the same matching variants as in columns (2)-(4). The estimated effects lie in the range of -0.13 to -0.14. So, our results suggest a *Kyoto* country's exports are lowered by 13-14% due to the Kyoto commitment. Also, the ATTs are smaller in absolute terms than the respective ATEs.

Our findings can be summarized as follows. The estimates suggest that bilateral exports to non-Kyoto countries are reduced by 15-20% when the exporter has a Kyoto commitment. Our results also highlight that not accounting for self-selection on observables overstates the negative effect of Kyoto commitment: the ATEs are larger in absolute terms than the ATTs. Kyoto countries' competitiveness is less affected by Kyoto commitment than an average country's competitiveness. The ATT is around 13%. It follows, that comparing treated country pairs with a properly constructed control group alters results. In our context, it proofs important to use matching techniques to get closer to an experimental dataset.

3.2 Robustness checks

In this subsection, we report robustness checks pertaining to the selection model used, the assumption about when treatment occurs, the sample composition, the investigated time horizon and the choice of matching variables. Table 3 summarizes the obtained ATTs of Kyoto commitment from regression-adjusted DID matching. Column (1) replicates the benchmark ATTs from various propensity score and Mahalanobis metric matching variants to simplify comparison.

Logit selection model. Using a logit instead of a probit selection model for propensity score matching does not affect the obtained ATTs, see column (2). The estimated coefficients again suggest a 13-14% drop in bilateral exports due to the exporter's Kyoto commitment.

Treatment period. The choice of the treatment period from 2001-03 might influence our results. As a robustness check, we vary the definition of the time window of treatment. First, we include 2004 in the treatment period. Russia and the Ukraine ratified the Kyoto Protocol in 2004. So by including 2004 in the treatment window, all ratifications except the one of Belarus (in 2005) and Australia and Croatia (both in 2007, they are therefore assigned to the untreated group) fall into the treatment period. Pre- and post-treatment period are again chosen to be symmetric periods around the treatment window: 1998-2000 and 2005-2007. Column (3) shows that the ATTs from propensity score matching are a bit smaller but still significant using this alternative broader treatment period. The results for matching on the Mahalanobis metric are weaker. Overall, the results are robust to this alternative assumption on the treatment window.

Another question is whether treatment occurs with ratification in national parliament or with entry into force of the Protocol in 2005. We use entry into force as treatment date in a second robustness check. Then, the relevant pre- and post-treatment periods are 1997-2004 and 2005-2007, respectively. Interestingly, the ATTs are again statistically significant in most propensity score models but now lie in the range of -5 to -9%, see column (4). So the ATT from ratification is larger than the one from entry into force. Since both models have basically the same post-treatment period, it seems that only part of the observed negative competitiveness effects originates from entry into force.

Sample composition. So far, we have analyzed Kyoto countries' exports to all other countries irrespective of their Kyoto status. In a next step, we limit attention to exports into non-Kyoto countries. Column (5) reports results. Comparing the obtained ATTs in column (1) and (5), the ATTs approximately lie in the same range but the effects are less significant. Turning back to the default sample, the estimated effects might be due to special trends in China or economies in transition (EIT). Columns (6) and (7) show that results are not sensitive to excluding China or EITs from Central and Eastern Europe and the Baltics from the sample.

Time horizon. In a further robustness check, we extend the time horizon to cover 2009 – the latest year with data on all variables. Pre- and post-treatment period are again chosen as symmetric windows around the default treatment period, i.e. 1995-2000 and 2004-09. Results are reported in column (8) of Table 3. We find highly significant ATTs of around 20% in most specifications. These effects are larger than in the baseline suggesting that either effects are larger when taking into account the Kyoto phase 2008-09 or Kyoto countries were hit more by the financial crisis.

Political variables. So far, we have omitted country's political conditions. Whether a country is e.g. politically stable or the government is left- or right-wing will influence its probability to self-select into Kyoto. The trade literature also discusses whether political conditions influence bilateral trade flows (see e.g. Mansfield et al., 2000). We check whether results are sensitive to including the durability index for political stability from the Polity IV Project and political variables from the World Bank Database on Political Institutions (DPI). The latter variables are FRAC: a country's fractionalization, SYSTEM: the political system, CHECKS: checks and balances which measures the number of veto players, YRSOFF: the years the government has been in office and GOV1RLC: an index of the government's political orientation, right-left-center. To bilateralize these variables, we take the maximum and minimum values in a country pair (see also Egger et al., 2011). The only exception being SYSTEM where we use the similarity in systems by taking differences and GOV1RLC where we create four dummy variables for whether one or both governments in a country pair are left or right wing. Column (9) shows the results. Results are robust to including political variables in the matching process, although the Mahalanobis matching seems less successful in finding a treatment effect. Given that the number of matching variables is increased quite a bit, this might be related to the curse of dimensionality.

4 Industry-level heterogeneity

Goods categories differ in terms of their average energy intensity, the degree of product differentiation and tradeability, and also in terms of the degree of regulation they are subjected to. This can lead to heterogeneity in trade reactions to Kyoto commitment. This is also reflected in the political debate which focuses especially on effects on energy-intensive sectors. So, studying aggregate bilateral exports might lead to aggregation bias. This leads us to a sector-by-sector analysis.

4.1 Results on sectoral ATTs

We estimate the ATT for each of the 51 non-agricultural 2-digits SITC goods categories separately. The matching weight is also obtained separately. We choose regression-adjusted DID kernel propensity score matching as default. Table 4 presents our results. 17 categories display partly substantial negative effects in the range of 13-58%. Most of these sectors fall into the category chemicals, non-metallic mineral and metal products and machinery and equipment. For example, Kyoto commitment led to a reduction of iron and steel (category 67) exports of roughly 51%. With an ATT of -28% non-ferrous metals (category 68) are also substantially affected. And both non-metallic mineral manufactures (66) and manufactures of metal exports (69) are reduced due to Kyoto commitment by little below 20%. In the chemicals category, the affected sectors are organic chemicals (category 51, ATT of -24%), inorganic chemicals (category 52, ATT of -18%) and plastics in primary forms (category 57, ATT of -19%). In the machinery and equipment category the negative ATTs lie in the range of 20-58%. The categories with the largest effects in absolute terms are power-generating machinery and equipment (category 71) and telecommunications equipment (category 76). Interestingly, we find a total of seven positive and significant estimates. Examples are pulp and waste paper (category 25), travel goods, handbags and similar containers (category 83) and footwear (category 85).

We perform several robustness checks on the sectoral ATTs. Table 5 reports the results for all sectors with significant effects in the baseline. Column (1) provides the baseline for easier comparison. Column (2) uses a logit selection model. Column (3) drops China from the sample. And column (4) adds a host of policy variables to the matching variables. The robustness checks confirm the estimates on sectoral ATTs both in terms of magnitude and significance. In the appendix, we also provide results on sectoral ATTs in the reduced sample (Tables A-1 and A-2). Here, we find less sectors with significant effects. Yet, the results are consistent for the categories chemicals, non-metallic mineral and metal products and partly also machinery and equipment.

4.2 Interpretation

Our estimates suggest large heterogeneity of the Kyoto Protocol's effects on sectoral trade. To understand these differences, one has to turn to a more structural interpretation of the underlying gravity equation. Aichele and Felbermayr (2011) use a well-specified theoretical model to derive such an equation. A decomposition of the overall ATT is beyond the scope of the present paper, but the analysis in Aichele and Felbermayr (2011) shows that the ATT confounds four elements: sectoral energy intensity, the elasticity of trade flows with respect to cross-country cost differences (essentially the elasticity of substitution in a CES demand system), the effect of Kyoto commitment on production costs, and industry-level transportation costs. Industries differ strongly along these dimensions. The absolute value of the size of the estimated ATT is increased by the cost effect of Kyoto (which is larger the more energy-intensive an industry is) or by the elasticity of substitution (which measures the strength at which exports react to cost differences). It is decreased by the importance of iceberg trade costs in the sector.

We draw the following broad conclusions. First, for some industries we find that the ATT is statistically identical to zero. Then, Kyoto cannot have had any effect on the cost structure. In industries where we find negative ATTs, i.e. negative export elasticities of Kyoto commitment, Kyoto affected sectoral costs. Second, among the goods categories with negative ATTs, many are indeed deemed to be energy-intensive. Examples are iron and steel, non-ferrous metals (like aluminium), non-metallic mineral manufactures (like cement or clay) and manufactures of metal, organic and inorganic chemicals and plastics in primary forms. Third, Figure 4 plots the sectoral ATTs against the average sectoral elasticity of substitution taken from Broda and Weinstein (2006). There seems to be a positive relationship. This finding suggests that sectoral trade flows react stronger to Kyoto commitment, the larger the elasticity of substitution. For example, iron and steel (67) is a rather homogeneous goods category with a high elasticity of substitution of about 10. And we also observe a high ATT of roughly 50%. Similarly, non-ferrous metals (68) has an elasticity of substitution of about 4 and an ATT of about 30%. However, there are two outliers – goods categories 71 (power-generating machinery) and 76 (telecommunications equipment). And the effects are also large in other machinery and equipment categories, which are differentiated goods according to the Rauch classification. However, these may be goods categories with relatively low *ad valorem* transportation costs.

Moreover, there is substantial heterogeneity in how Kyoto may have affected sectoral costs. Some sectors are exempt from regulation (this is for example the case under the EU Emisisons Trading Scheme), some are more generously covered by subsidies. Many sectors might not be affected directly, but rather indirectly because they use energy-intensive intermediate products. Despite these complications, our results are broadly in line with theoretical arguments.

5 Conclusions

The international policy community is still on the search for a solution to the threat of global warming. Greenhouse gas emissions have detrimental effects on climate change irrespective of where they take place. If not all countries subject themselves to a world-wide climate deal, unilateral climate policy entails competitiveness effects leading to carbon leakage. This may undermine individual countries' efforts to curb emissions. Relocation effects may even result in an increase of the global level of emissions. The economics literature contributes to this debate by (1) discussing whether international environmental agreements are successful in achieving their goals and (2) by determining the effects of environmental regulation on trade patterns. This paper contributes to the second thread.

The present paper sheds light on the effects of Kyoto commitment on trade patterns. We use regression-adjusted DID matching to account for the possible endogeneity of commitment to the Kyoto Protocol. Our estimates suggest that an average country faces a reduction of exports of around 15-20% due to Kyoto commitment. The average treatment effect for a Kyoto country is smaller and in the range of 10-13%. So our results highlight that not accounting for self-selection overstates Kyoto's negative effect on exports. However, the effect is still large. Moreover, there is large sectoral heterogeneity of Kyoto's ATT. We identify sectors that are affected by competitiveness issues. These are typically energy-intensive industries like iron and steel, non-ferrous metals and chemicals but also machinery and equipment goods. So our message is: Kyoto has had an impact, at least on some sector's trade patterns.

This implies that unilateral climate policy like the Kyoto Protocol in and off itself might not be able to bring down GHG emissions. Some emissions might relocate to other countries. Thus, unilateral climate policy should be accompanied, for example, by carbon-related border tax adjustments. These adjustments should be designed such that they do not lead to green protectionism but that they help in restoring the effectiveness of unilateral climate policy. An industry-by-industry approach may be sensible, as our sector-level results suggest. Targeting the most energy-intensive and easily tradeable goods by BTA may suffice to restore the overall effectiveness of unilateral climate policy.

References

Aakvik, Arild and Sigve Tjøtta, "Do collective actions clear common air? The effect of international environmental protocols on sulphur emissions," *European Journal of Political Economy*, 2011, *27* (2), 343–351.

Abadie, Alberto and Guido W. Imbens, "Large Sample Properties of Matching Estimators for Average Treatment Effects," *Econometrica*, January 2006, *74* (1), 235–267.

Aichele, Rahel and Gabriel Felbermayr, "Kyoto and Carbon Leakage: An Empirical Analysis of the Carbon Content of Bilateral Trade," CESifo Working Paper No. 3661, CESifo 2011.

_ and _ , "Kyoto and the Carbon Footprint of Nations," *Journal of Environmental Economics and Management*, forthcoming.

Anderson, James E. and Eric van Wincoop, "Gravity with Gravitas: A Solution to the Border Puzzle," *American Economic Review*, 2003, *93* (1), 170–192.

Babiker, Mustafa H., "Climate change policy, market structure, and carbon leakage," *Journal of International Economics*, 2005, *65* (2), 421 – 445.

_ and Thomas F. Rutherford, "The Economic Effects of Border Measures in Subglobal Climate Agreements," *The Energy Journal*, 2005, *26* (4), 99–126.

Baier, Scott L. and Jeffrey H. Bergstrand, "Do free trade agreements actually increase members' international trade?," *Journal of International Economics*, 2007, *71* (1), 72–95.

_ and _ , "Bonus vetus OLS: A simple method for approximating international trade-cost effects using the gravity equation," *Journal of International Economics*, February 2009, *77* (1), 77–85.

_ and _ , "Estimating the effects of free trade agreements on international trade flows using matching econometrics," *Journal of International Economics*, 2009, *77* (1), 63 – 76.

Baldwin, Richard and Daria Taglioni, "Trade Effects of the Euro: a Comparison of Estimators," *Journal of Economic Integration*, December 2007, *22* (4), 780–818.

Bergstrand, Jeffrey H., "The Generalized Gravity Equation, Monopolistic Competition, and the Factor-Proportions Theory in International Trade," *The Review of Economics and Statistics*, 1989, *71* (1), 143–153.

Beron, Kurt J., James C. Murdoch, and Wim P. M. Vijverberg, "Why Cooperate? Public Goods, Economic Power, and the Montreal Protocol," *The Review of Economics and Statistics*, May 2003, *85* (2), 286–297.

Bertrand, Marianne, Esther Duflo, and Sendhil Mullainathan, "How Much Should We Trust Differences-in-Differences Estimates?," *The Quarterly Journal of Economics*, February 2004, *119* (1), 249–275.

Blundell, Richard and Monica Costa Dias, "Alternative Approaches to Evaluation in Empirical Microeconomics," *Journal of Human Resources*, Summer 2009, *44* (3), 565–640.

Broda, Christian and David E. Weinstein, "Globalization and the Gains from Variety," *The Quarterly Journal of Economics*, May 2006, *121* (2), 541–585.

Carraro, Carlo and Domenico Siniscalco, "International Institutions and Environmental Policy: International environmental agreements: Incentives and political economy," *European Economic Review*, 1998, *42* (3-5), 561–572.

Chintrakarn, Pandej, "Estimating the Euro Effects on Trade with Propensity Score Matching," *Review of International Economics*, 02 2008, *16* (1), 186–198.

Eaton, Jonathan and Samuel Kortum, "Technology, Geography, and Trade," *Econometrica*, September 2002, *70* (5), 1741–1779.

Ederington, Josh, Arik Levinson, and Jenny Minier, "Footloose and Pollution-Free," *Review of Economics and Statistics*, February 2005, *87* (1), 92–99.

Egger, Hartmut, Peter Egger, and David Greenaway, "The trade structure effects of endogenous regional trade agreements," *Journal of International Economics*, 2008, *74* (2), 278 – 298.

Egger, Peter, Christoph Jeßberger, and Mario Larch, "Trade and investment liberalization as determinants of multilateral environmental agreement membership," *International Tax and Public Finance*, December 2011, *18* (6), 605–633. 10.1007/s10797-011-9169-9.

Elliott, Joshua, Ian Foster, Samuel Kortum, Todd Munson, Fernando Pérez Cervantes, and David Weisbach, "Trade and Carbon Taxes," *American Economic Review: Papers & Proceedings*, 2010, *100* (2), 465–69.

Heckman, James, Hidehiko Ichimura, Jeffrey Smith, and Petra Todd, "Characterizing Selection Bias Using Experimental Data," *Econometrica*, September 1998, *66* (5), 1017–1098.

Heckman, James J., Hidehiko Ichimura, and Petra E. Todd, "Matching as an Econometric Evaluation Estimator: Evidence from Evaluating a Job Training Programme," *The Review of Economic Studies*, October 1997, *64* (4), pp. 605–654.

Imbens, Guido W., "Nonparametric Estimation of Average Treatment Effects under Exogeneity: A Review," *The Review of Economics and Statistics*, February 2004, *86* (1), 4–29.

_ and Jeffrey M. Wooldridge, "Recent Developments in the Econometrics of Program Evaluation," *Journal of Economic Literature*, 2009, *47* (1), 5–86.

Jaffe, Adam B., Steven R. Peterson, Paul R. Portney, and Robert N. Stavins, "Environmental Regulation and the Competitiveness of U.S. Manufacturing: What Does the Evidence Tell Us?," *Journal of Economic Literature*, March 1995, *33* (1), 132–163.

Levinson, Arik and M. Scott Taylor, "Unmasking The Pollution Haven Effect," *International Economic Review*, February 2008, *49* (1), 223–254.

List, John A., Daniel L. Millimet, Per G. Fredriksson, and W. Warren McHone, "Effects of Environmental Regulations on Manufacturing Plant Births: Evidence from a Propensity

Score Matching Estimator," *The Review of Economics and Statistics*, 2003, *85* (4), 944–952.

Manders, Ton and Paul Veenendaal, "Border tax adjustment and the EU-ETS, a quantitative assessment," CPB Document 171, CPB Netherlands Bureau for Economic Policy Analysis October 2008.

Mansfield, Edward D., Helen V. Milner, and B. Peter Rosendorff, "Free to Trade: Democracies, Autocracies, and International Trade," *The American Political Science Review*, June 2000, *94* (2), 305–321.

Mattoo, Aaditya, Arvind Subramanian, Dominique van der Mensbrugghe, and Jianwu He, "Reconciling Climate Change and Trade Policy," Peterson Institute for International Economics Working Paper No. 09-15, Peterson Institute for International Economics 2009.

Millimet, Daniel and John List, "The Case of the Missing Pollution Haven Hypothesis," *Journal of Regulatory Economics*, August 2004, *26* (3), 239–262.

Murdoch, James C. and Todd Sandler, "The Voluntary Provision of a Pure Public Good: The Case of Reduced CFC Emissions and the Montreal Protocol," *Journal of Public Economics*, 1997, *63* (3), 331–349.

Persson, Torsten, "Currency unions and trade: how large is the treatment effect?," *Economic Policy*, October 2001, *16* (33), 433–462.

Ringquist, Evan J. and Tatiana Kostadinova, "Assessing the Effectiveness of International Environmental Agreements: The Case of the 1985 Helsinki Protocol," *American Journal of Political Science*, January 2005, *49* (1), 86–102.

Robins, James M. and Ya'acov Ritov, "Toward a curse of dimensionality appropriate (coda) asymptotic theory for semi-parametric models," *Statistics in Medicine*, February 1997, *16* (3), 285–319.

Rose, Andrew K. and Mark M. Spiegel, "Noneconomic Engagement and International Exchange: The Case of Environmental Treaties," *Journal of Money, Credit and Banking*, March-April 2009, *41* (2-3), 337–363.

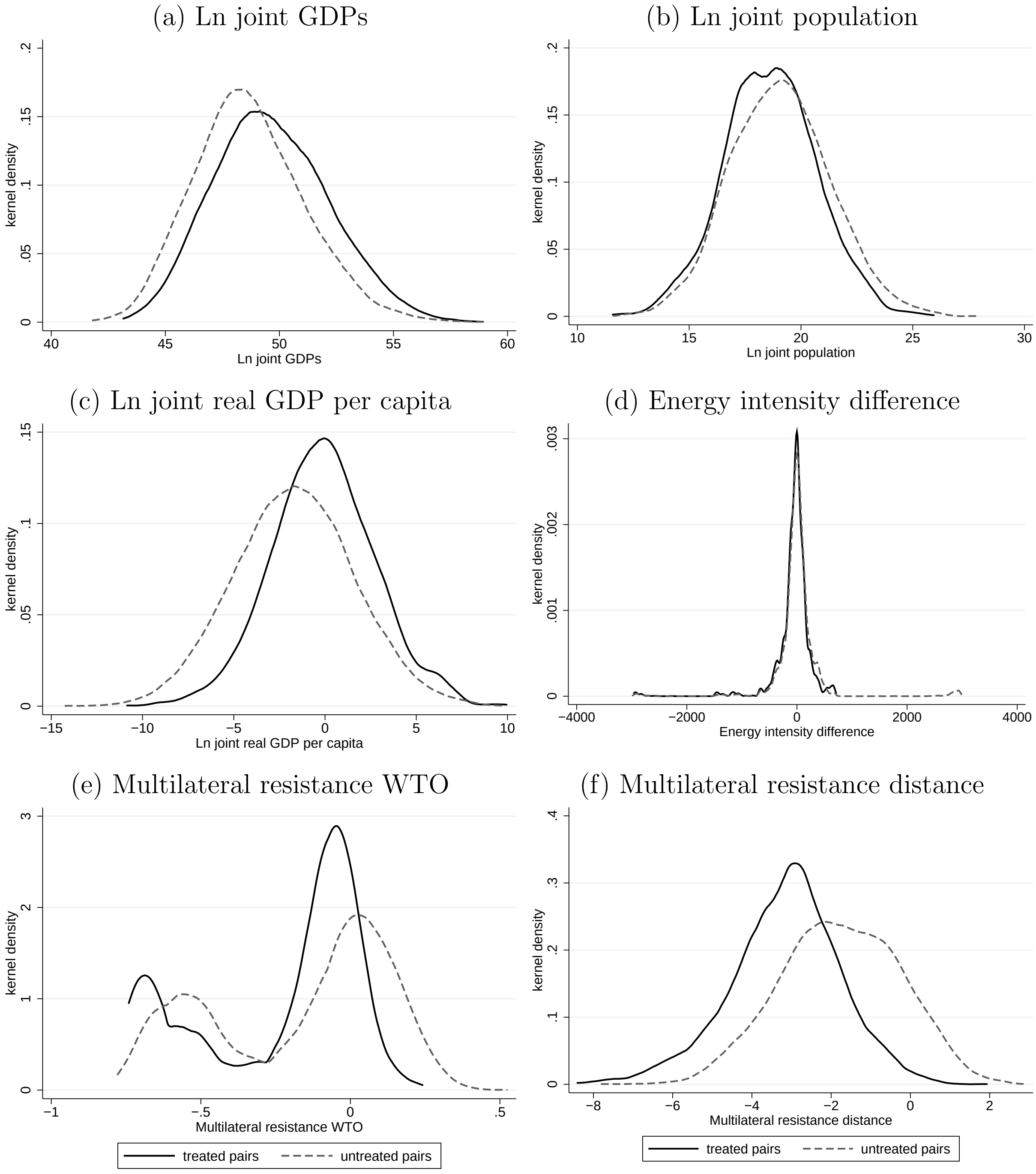
Rosenbaum, Paul R. and Donald B. Rubin, "The Central Role of the Propensity Score in Observational Studies for Causal Effects," *Biometrika*, 1983, *70* (1), 41–55.

_ and _ , "Constructing a Control Group Using Multivariate Matched Sampling Methods That Incorporate the Propensity Score," *The American Statistician*, 1985, *39* (1), 33–38.

World Bank, *International Trade and Climate Change - Economic, Legal, and Institutional Perspectives*, Washington: IBRD/The World Bank, 2008.

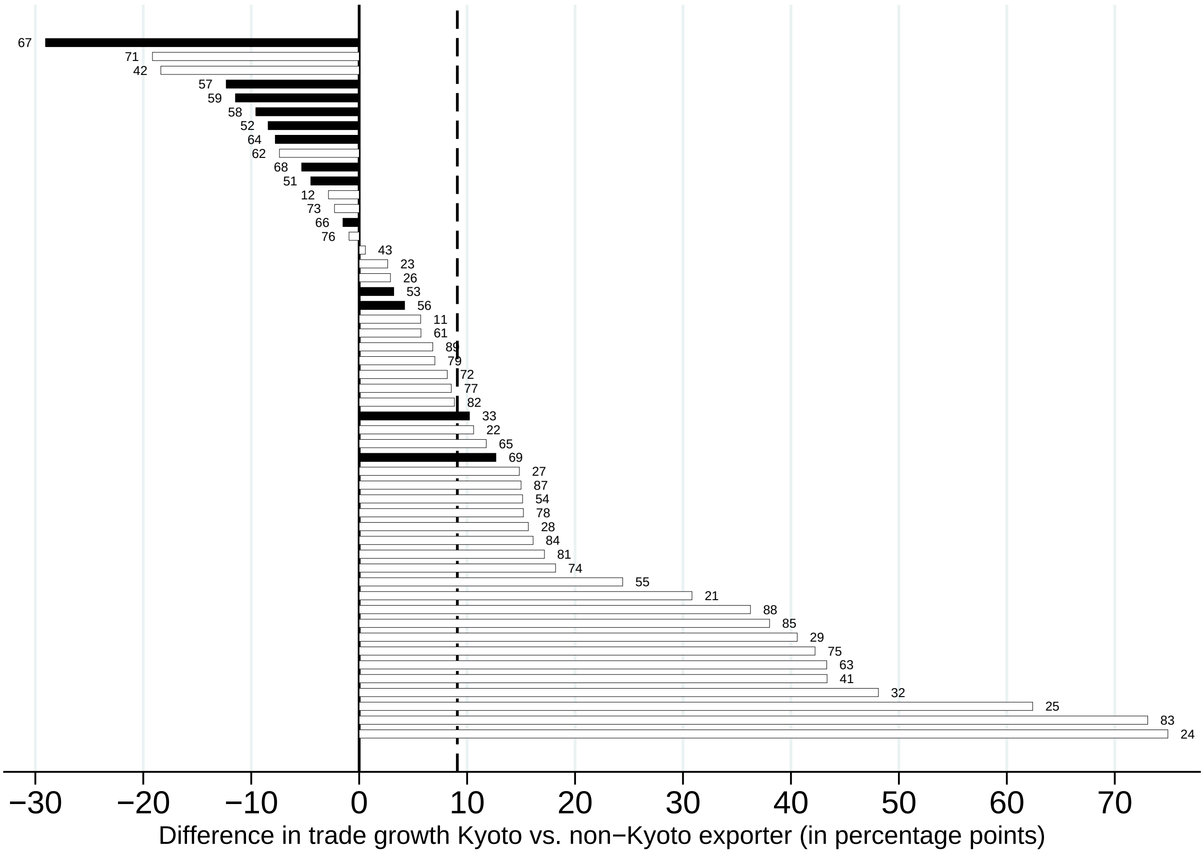
York, Richard, "Kyoto Protocol Participation: A Demographic Explanation," *Population Research and Policy Review*, October 2005, *24* (5), 513–526.

Figure 1: Kernel densities before matching (pre-treatment period)



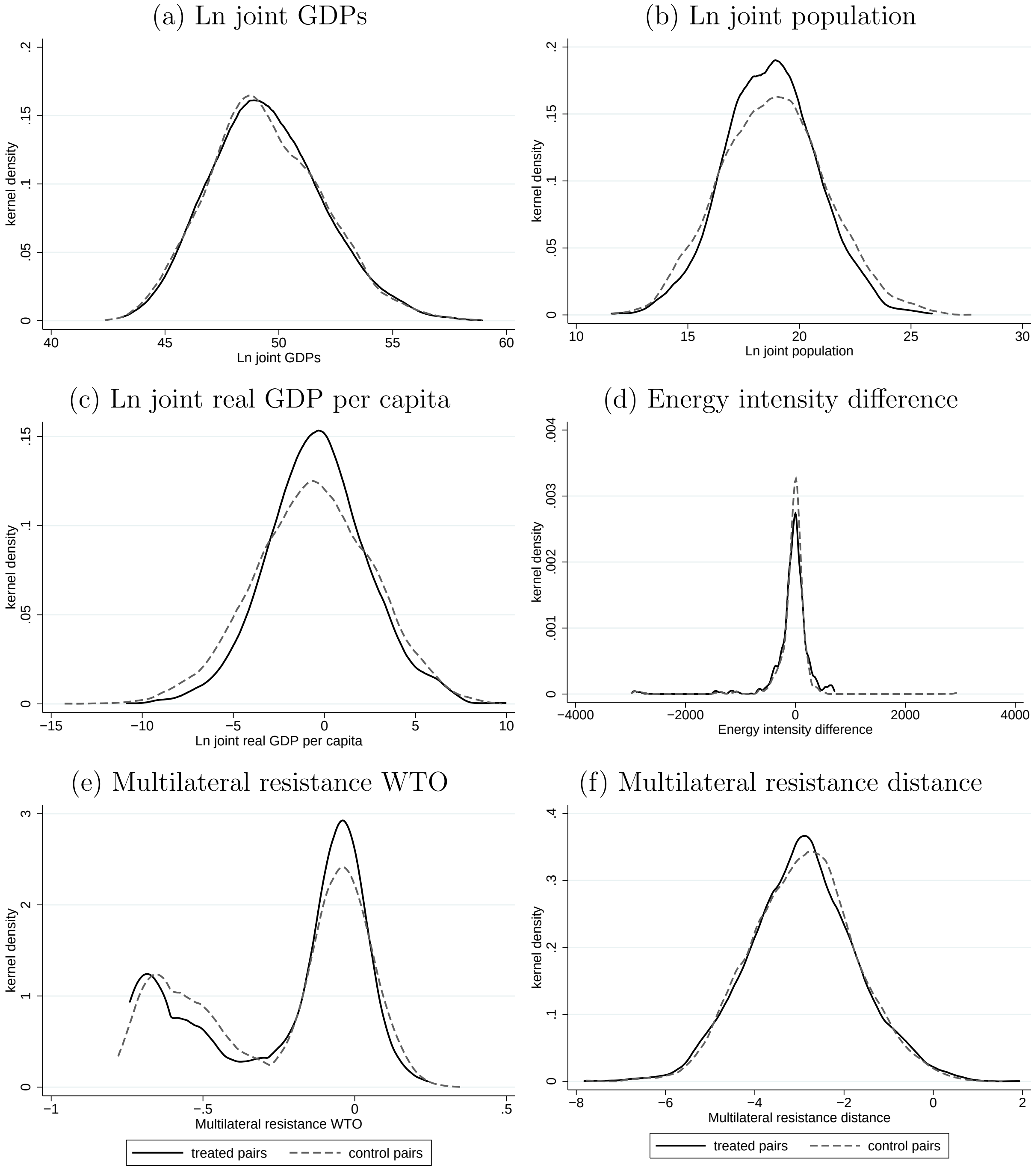
Note: The graph shows Epanechnikov kernel density functions of the matching variables for treated country pairs (i.e. the exporter is a Kyoto country in the post-treatment period) and untreated country pairs (i.e. the exporter is no Kyoto country in the post-treatment period) for the pre-treatment period 1997-2000.

Figure 2: Differences in pre- to post-treatment period sectoral real trade growth



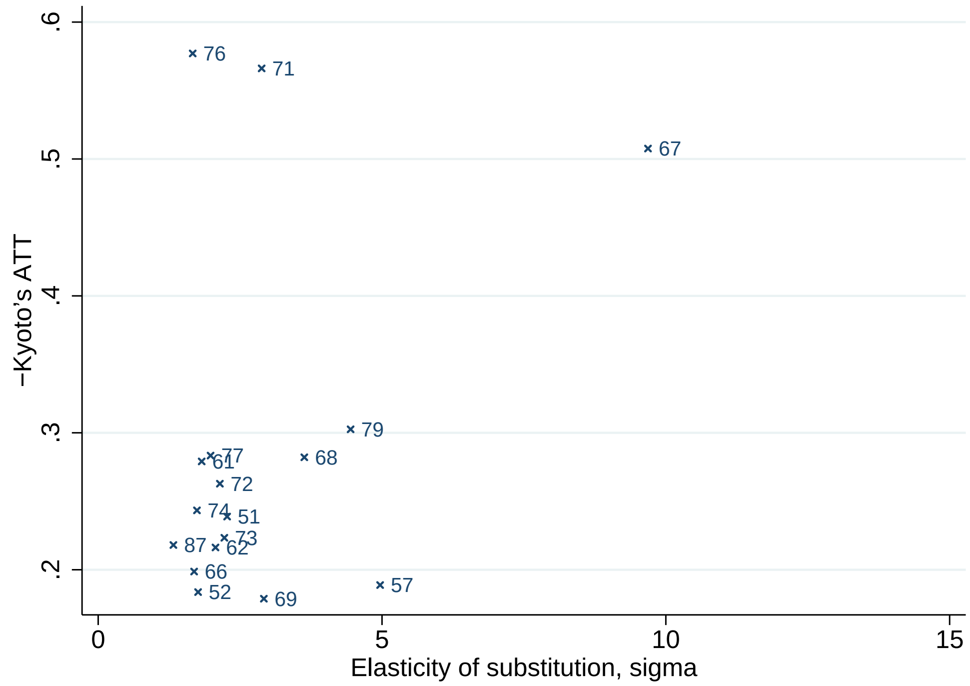
Note: The graph shows the difference in average pre- to post-treatment real trade growth between country pairs with and without Kyoto exporter for all non-agricultural 2 digit SITC Rev. 3 goods categories. Black bars indicate energy-intensive goods. The dashed line at 9.09 denotes the average aggregate difference in trade growth, i.e. Kyoto exporters experienced about 9 percentage points more real trade growth than non-Kyoto exporters.

Figure 3: Kernel densities after matching (pre-treatment period)



Note: The graph shows Epanechnikov kernel density functions of the matching variables for treated country pairs (i.e. the exporter is a Kyoto country in the post-treatment period) and control country pairs (i.e. the exporter is no Kyoto country in the post-treatment period) for the pre-treatment period 1997-2000. Matches are based on 5 nearest neighbor propensity score matching.

Figure 4: Sectoral ATTs and elasticity of substitution



Note: The graph shows a scatter plot of sectoral ATTs and average sectoral elasticity of substitution taken from Broda and Weinstein (2006). The graph only displays sectors with a negative and significant effect from regression-adjusted DID propensity score matching.

Table 1: Summary statistics

Period:		Pre-treatment		Post-treatment	
Variable	Obs.	Mean	Std. Dev.	Mean	Std. Dev.
Ln exports	12,139	15.53	3.40	16.39	3.42
Kyoto (0,1)	12,139	0.00	0.00	0.35	0.48
Gravity variables					
Ln GDP exporter	12,139	24.62	1.87	25.24	1.82
Ln GDP importer	12,139	24.38	1.94	25.01	1.87
Ln real GDP per capita exporter	12,139	-0.49	2.28	-0.35	2.29
Ln real GDP per capita exporter	12,139	-0.64	2.30	-0.52	2.30
FTA (0,1)	12,139	0.23	0.42	0.29	0.45
WTO (0,1)	12,139	0.63	0.47	0.77	0.41
EU (0,1)	12,139	0.02	0.13	0.05	0.21
MR FTA	12,139	-0.27	0.09	-0.35	0.11
MR WTO	12,139	-0.82	0.24	-1.08	0.24
MR EU	12,139	-0.02	0.03	-0.06	0.06
Emission intensity difference	12,139	-10.42	424.05	-30.22	541.08
Matching variables					
Ln joint GDP	12,139	49.00	2.51	50.25	2.43
Ln joint population	12,139	18.93	2.21	19.09	2.21
Ln joint real GDP per capita	12,139	-1.13	3.24	-0.87	3.24

Note: The table shows summary statistics for averages of the dependent, treatment, gravity control and matching variables for the periods before (1997-2000) and after (2004-2007) treatment in the default sample.

Table 2: Treatment effects on export flows – Baseline results

Dep. var.: Ln bilateral exports	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Method:	ATE: DID	ATE: reg.-adj. DID matching			ATT: regression-adjusted DID matching		
	FE-OLS	PS 5 N-N	PS kernel	Maha 5 N-N	PS 5 N-N	PS kernel	Maha 5 N-N
Kyoto (0,1)	-0.082*	-0.164**	-0.197***	-0.152**	-0.142***	-0.139***	-0.133***
	(0.042)	(0.068)	(0.065)	(0.076)	(0.043)	(0.039)	(0.049)
Ln GDP exporter	0.131	0.334**	0.329**	0.522***	0.483***	0.458***	0.569***
	(0.090)	(0.168)	(0.152)	(0.139)	(0.095)	(0.082)	(0.111)
Ln GDP importer	0.740***	0.607***	0.644***	0.888***	0.830***	0.817***	0.842***
	(0.075)	(0.153)	(0.151)	(0.157)	(0.071)	(0.066)	(0.083)
Ln real GDP per capita exporter	0.605***	0.207	0.189	-0.100	0.347**	0.390***	0.016
	(0.145)	(0.350)	(0.319)	(0.281)	(0.157)	(0.140)	(0.186)
Ln real GDP per capita importer	0.084	0.375	0.446	0.294	0.124	0.111	0.147
	(0.120)	(0.294)	(0.297)	(0.235)	(0.116)	(0.107)	(0.130)
FTA (0,1)	0.173**	0.074	0.107	0.187	0.067	0.105	0.178*
	(0.086)	(0.149)	(0.119)	(0.142)	(0.093)	(0.087)	(0.105)
Joint WTO (0,1)	-0.329***	-0.114	0.118	-0.130	-0.127	-0.152	-0.380**
	(0.123)	(0.343)	(0.281)	(0.247)	(0.130)	(0.122)	(0.150)
Joint EU (0,1)	0.305***	0.212	0.134	-0.063	0.173*	0.190**	0.105
	(0.089)	(0.172)	(0.155)	(0.170)	(0.102)	(0.096)	(0.106)
Energy intensity difference	-0.000	-0.001**	-0.001*	-0.001	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Multilateral resistance terms[a]	YES	YES	YES	YES	YES	YES	YES
Period fixed-effects	YES	YES	YES	YES	YES	YES	YES
Observations	24,278	16,846	21,790	13,578	17,094	23,374	15,352
Adj. R^2	0.293	0.401	0.382	0.428	0.438	0.437	0.457

Note: Country-pair fixed-effects estimation on pre- and post-treatment averages, i.e. 1997-2000 and 2004-2007, respectively. Period fixed-effects and constant not shown. Heteroskedasticity-robust standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01. PS: Propensity score matching. Maha: Matching on Mahalanobis metric. N-N: nearest-neighbor matching. [a] Construction of multilateral resistance terms for FTA, joint WTO and joint EU membership, see Baier and Bergstrand (2009a).

Table 3: Sensitivity analysis on Kyoto's ATT

	(1) Baseline	(2) Logit	(3) Broad	(4) Entry force	(5) Reduced	(6) w/o China	(7) w/o EIT[a]	(8) 1995-2009	(9) Policy
ATT, propensity score matching									
One-to-one	-0.135***	-0.143***	-0.147***	-0.088**	-0.149	-0.204***	-0.151***	-0.208***	-0.166**
	(0.050)	(0.052)	(0.054)	(0.041)	(0.097)	(0.061)	(0.055)	(0.054)	(0.070)
3 nearest-neighbor	-0.157***	-0.130***	-0.100**	-0.054	-0.123	-0.167***	-0.123***	-0.207***	-0.150**
	(0.047)	(0.046)	(0.046)	(0.039)	(0.084)	(0.050)	(0.047)	(0.048)	(0.074)
5 nearest-neighbor	-0.142***	-0.144***	-0.096**	-0.066*	-0.142*	-0.153***	-0.122***	-0.217***	-0.162**
	(0.043)	(0.045)	(0.045)	(0.036)	(0.076)	(0.045)	(0.044)	(0.045)	(0.072)
Kernel	-0.139***	-0.138***	-0.102**	-0.072**	-0.117*	-0.136***	-0.125***	-0.219***	-0.154**
	(0.039)	(0.039)	(0.041)	(0.033)	(0.067)	(0.040)	(0.041)	(0.040)	(0.069)
Radius (radius=0.1)	-0.143***	-0.141***	-0.110***	-0.074**	-0.116*	-0.138***	-0.131***	-0.222***	-0.150**
	(0.039)	(0.039)	(0.041)	(0.033)	(0.067)	(0.039)	(0.040)	(0.040)	(0.068)
ATT, Mahalanobis metric									
One-to-one	-0.120**		-0.090*	-0.004	-0.156	-0.119**	-0.149**	-0.174***	-0.105
	(0.053)		(0.054)	(0.057)	(0.097)	(0.056)	(0.062)	(0.059)	(0.075)
3 nearest-neighbor	-0.125**		-0.084	-0.022	-0.179*	-0.115**	-0.111*	-0.175***	-0.107
	(0.054)		(0.055)	(0.047)	(0.093)	(0.055)	(0.059)	(0.056)	(0.072)
5 nearest-neighbor	-0.133***		-0.092*	-0.038	-0.186**	-0.124**	-0.119**	-0.201***	-0.113*
	(0.049)		(0.051)	(0.042)	(0.084)	(0.050)	(0.055)	(0.053)	(0.066)

Note: Dependent variable is the log of bilateral export flows. Treatment: exporter ratifies Kyoto commitment. ATTs from regression-adjusted DID matching estimation on pre- and post-treatment averages, the default is 1997-2000 and 2004-2007, respectively. Broad: 1998-2000 and 2005-2007. Entry force: 1997-2004 and 2005-2007. Covariates as in Table 2 (not shown). Logit uses a logit selection model. The reduced sample (8,573 country pairs) contains only exports to non-Kyoto importers. [a] Economies in transition (EIT) from Central and Eastern Europe and the Baltics (i.e. ALB, BGR, CZE, HUN, HRV, MKD, POL, ROU, SVK, SVK, and EST, LVA, LTU) excluded from sample. Policy also includes political variables. Heteroskedasticity-robust standard errors in parantheses. Significance at 1%, 5% and 10% indicated by ***, ** and * respectively.

Table 4: Sectoral ATTs of Kyoto commitment

SITC	Sector label	ATT	SITC	Sector label	ATT
11	Beverages	0.077	61	Leather, leather manufactures, n.e.s.,	-0.279*
		(0.110)		and dressed furskins	(0.167)
12	Tobacco and tobacco manufactures	-0.562	62	Rubber manufactures, n.e.s.	-0.216**
		(0.506)			(0.096)
21	Hides, skins and furskins, raw	-0.055	63	Cork and wood manufactures	0.097
		(0.317)			(0.105)
22	Oil-seeds and oleaginous fruits	-0.471	64[a]	Paper, paperboard and articles of	-0.125
		(0.442)		paper pulp, of paper or of paperboard	(0.094)
23	Crude rubber	-0.143	65	Textile yarn, fabrics, made-up	0.135*
		(0.182)		articles, n.e.s., and related products	(0.075)
24	Cork and wood	0.217	66[a]	Non-metallic mineral manufactures,	-0.199**
		(0.236)		n.e.s.	(0.079)
25	Pulp and waste paper	0.700***	67[a]	Iron and steel	-0.508***
		(0.257)			(0.115)
26	Textile fibres and their wastes	-0.008	68[a]	Non-ferrous metals	-0.282**
		(0.123)			(0.113)
27	Crude fertilizers, and crude minerals	0.018	69[a]	Manufactures of metals, n.e.s.	-0.179**
		(0.136)			(0.071)
28	Metalliferous ores and metal scrap	-0.155	71	Power-generating machinery	-0.566***
		(0.184)		and equipment	(0.094)
29	Crude animal and vegetable	0.225**	72	Machinery specialized for	-0.263***
	materials, n.e.s.	(0.094)		particular industries	(0.075)
32	Coal, coke and briquettes	0.658	73	Metalworking machinery	-0.223**
		(0.547)			(0.103)
33[a]	Petroleum, petroleum products	0.023	74	General industrial machinery,	-0.243***
	and related materials	(0.248)		n.e.s., machine parts, n.e.s.	(0.077)
41	Animal oils and fats	0.437*	75	Office machines and automatic	0.162*
		(0.257)		data-processing machines	(0.087)
42	Fixed vegetable fats and oils, crude,	-0.243	76	Telecommunications and sound-	-0.577***
	refined or fractionated	(0.201)		recording and reproducing equip.	(0.091)
43	Animal or vegetable fats and oils,	-0.221	77	Electrical machinery, apparatus	-0.283***
	processed; waxes	(0.189)		and appliances, n.e.s.	(0.073)
51[a]	Organic chemicals	-0.239**	78	Road vehicles (including	-0.078
		(0.104)		air-cushion vehicles)	(0.094)
52[a]	Inorganic chemicals	-0.184*	79	Other transport equipment	-0.303**
		(0.110)			(0.147)
53[a]	Dyeing, tanning and coloring	-0.021	81	Prefabricated buildings; sanitary,	-0.149
	materials	(0.094)		plumbing, heating, lighting fixtures	(0.111)
54	Medicinal and pharmaceutical	-0.144	82	Furniture, and parts thereof	-0.009
	products materials, n.e.s.	(0.087)			(0.087)
55	Essential oils, resinoids, perfume ma-	-0.089	83	Travel goods, handbags	0.426***
	terials; toilet, cleansing preparations	(0.087)		and similar containers	(0.107)
56[a]	Fertilizers	0.101	84	Articles of apparel and	-0.070
		(0.249)		clothing accessories	(0.085)
57[a]	Plastics in primary forms	-0.189*	85	Footwear	0.250**
		(0.103)			(0.117)
58[a]	Plastics in non-primary forms	-0.075	87	Professional, scientific and controlling	-0.218***
		(0.107)		instruments and apparatus, n.e.s.	(0.077)
59[a]	Chemical materials and	-0.065	88	Photographic apparatus, optical	0.175*
	products, n.e.s.	(0.087)		goods, n.e.s.; watches and clocks	(0.098)
			89	Miscellaneous manufactured	-0.072
				articles, n.e.s	(0.065)

Note: The table displays ATTs from sector-by-sector regression-adjusted DID kernel propensity score matching estimation. Dependent variable is log of bilateral exports. Controls not shown. Heteroskedasticity-robust standard errors in parantheses. Significance at 1%, 5% and 10% indicated by ***, ** and * respectively. [a] Goods category considered to be energy-intensive.

Table 5: Robustness checks sectoral ATTs

SITC	Sector label	(1) Baseline	(2) Logit	(3) w/o China	(4) Policy
51[a]	Organic chemicals	-0.239**	-0.237**	-0.230*	-0.415*
		(0.104)	(0.104)	(0.118)	(0.234)
52[a]	Inorganic chemicals	-0.184*	-0.178	-0.183	-0.231
		(0.110)	(0.110)	(0.118)	(0.203)
57[a]	Plastics (in primary form)	-0.189*	-0.194*	-0.103	-0.601***
		(0.103)	(0.103)	(0.114)	(0.200)
61	Leather, leather manufactures, n.e.s., and dressed furskins	-0.279*	-0.283*	-0.337*	-0.519**
		(0.167)	(0.168)	(0.178)	(0.259)
62	Rubber manufactures, n.e.s.	-0.216**	-0.216**	-0.229**	-0.629***
		(0.096)	(0.096)	(0.098)	(0.181)
66[a]	Non-metallic mineral manufactures	-0.199**	-0.195**	-0.183**	-0.136
		(0.079)	(0.080)	(0.087)	(0.164)
67[a]	Iron and steel	-0.508***	-0.505***	-0.397***	-0.813***
		(0.115)	(0.116)	(0.122)	(0.309)
68[a]	Non-ferrous metals	-0.282**	-0.282**	-0.212*	-0.483***
		(0.113)	(0.114)	(0.122)	(0.186)
69[a]	Manufactures of metals, n.e.s.	-0.179**	-0.178**	-0.192**	-0.426***
		(0.071)	(0.071)	(0.076)	(0.135)
71	Power-generating machinery and equipment	-0.566***	-0.564***	-0.501***	-0.449
		(0.094)	(0.094)	(0.104)	(0.307)
72	Machinery specialized for particular industries	-0.263***	-0.261***	-0.238***	-0.356***
		(0.075)	(0.074)	(0.079)	(0.136)
73	Metalworking machinery	-0.223**	-0.224**	-0.232**	-0.645***
		(0.103)	(0.104)	(0.112)	(0.182)
74	General industrial machinery, n.e.s., machine parts, n.e.s.	-0.243***	-0.240***	-0.228***	-0.261
		(0.077)	(0.077)	(0.081)	(0.163)
76	Telecommunications equipment	-0.577***	-0.576***	-0.579***	-0.623***
		(0.091)	(0.091)	(0.101)	(0.191)
77	Electrical machinery, apparatus and appliances, n.e.s.	-0.283***	-0.282***	-0.274***	-0.491***
		(0.073)	(0.073)	(0.079)	(0.125)
79	Other transport equipment	-0.303**	-0.296**	-0.416***	-0.012
		(0.147)	(0.147)	(0.155)	(0.377)
87	Professional, scientific and controlling instruments and	-0.218***	-0.219***	-0.206**	-0.029
	apparatus, n.e.s.	(0.077)	(0.078)	(0.089)	(0.132)
25	Pulp and waste paper	0.700***	0.743***	0.656**	1.673***
		(0.257)	(0.254)	(0.280)	(0.555)
29	Crude animal and vegetable materials, n.e.s.	0.225**	0.225**	0.232**	0.141
		(0.094)	(0.095)	(0.097)	(0.180)
41	Animal oils and fats	0.437*	0.439*	0.521*	0.313
		(0.257)	(0.255)	(0.297)	(0.325)
65	Textile yarn, fabrics, made-up articles, n.e.s.,	0.135*	0.138*	0.105	0.067
	and related products	(0.075)	(0.075)	(0.082)	(0.140)
75	Office machines and automatic data-processing machines	0.162*	0.165*	0.172*	0.301
		(0.087)	(0.087)	(0.098)	(0.183)
83	Travel goods, handbags	0.426***	0.420***	0.397***	0.324
		(0.107)	(0.107)	(0.120)	(0.236)
85	Footwear	0.250**	0.245**	0.288**	0.327
		(0.117)	(0.117)	(0.132)	(0.313)
89	Miscellaneous manufactured articles, n.e.s.	0.175*	0.178*	0.104	0.178
		(0.098)	(0.099)	(0.107)	(0.174)

Note: The table displays ATTs from regression-adjusted DID kernel matching estimation in the default sample. Weights are obtained sector-by-sector. Dependent variable is log of bilateral sectoral exports. Heteroskedasticity-robust standard errors in parantheses. Significance at 1%, 5% and 10% indicated by ***, ** and * respectively. Results only shown for sectors with significant effects in Table 4. Logit uses a logit selection model. Policy includes political variables. [a] Goods category considered to be energy-intensive.

A Appendix

Table A-1: Sectoral ATTs of Kyoto commitment - reduced sample

SITC	Sector label	ATT	SITC	Sector label	ATT
11	Beverages	-0.166 (0.174)	61	Leather, leather manufactures, n.e.s., and dressed furskins	-0.264 (0.244)
12	Tobacco and tobacco manufactures	-0.339 (0.689)	62	Rubber manufactures, n.e.s.	0.013 (0.142)
21	Hides, skins and furskins, raw	0.262 (0.436)	63	Cork and wood manufactures	0.042 (0.165)
22	Oil-seeds and oleaginous fruits	0.202 (0.545)	64[a]	Paper, paperboard and articles of paper pulp, of paper or of paperboard	-0.186 (0.147)
23	Crude rubber	-1.102*** (0.296)	65	Textile yarn, fabrics, made-up articles, n.e.s., and related products	-0.022 (0.117)
24	Cork and wood	0.170 (0.480)	66[a]	Non-metallic mineral manufactures, n.e.s.	-0.229* (0.128)
25	Pulp and waste paper	0.102 (0.333)	67[a]	Iron and steel	-0.419** (0.174)
26	Textile fibres and their wastes	-0.159 (0.194)	68[a]	Non-ferrous metals	-0.787*** (0.192)
27	Crude fertilizers, and crude minerals	0.195 (0.224)	69[a]	Manufactures of metals, n.e.s.	-0.200* (0.110)
28	Metalliferous ores and metal scrap	0.287 (0.343)	71	Power-generating machinery and equipment	-0.429*** (0.146)
29	Crude animal and vegetable materials, n.e.s.	0.045 (0.151)	72	Machinery specialized for particular industries	-0.276** (0.123)
32	Coal, coke and briquettes	-0.182 (0.779)	73	Metalworking machinery	-0.119 (0.164)
33[a]	Petroleum, petroleum products and related materials	-0.445 (0.344)	74	General industrial machinery, n.e.s., machine parts, n.e.s.	-0.062 (0.113)
41	Animal oils and fats	0.408 (0.326)	75	Office machines and automatic data-processing machines	0.024 (0.130)
42	Fixed vegetable fats and oils, crude, refined or fractionated	0.078 (0.383)	76	Telecommunications and sound-recording and reproducing equip.	-0.449*** (0.136)
43	Animal or vegetable fats and oils, processed; waxes	-0.679* (0.384)	77	Electrical machinery, apparatus and appliances, n.e.s.	-0.203* (0.114)
51[a]	Organic chemicals	-0.213 (0.161)	78	Road vehicles (including air-cushion vehicles)	-0.070 (0.138)
52[a]	Inorganic chemicals	-0.330** (0.158)	79	Other transport equipment	-0.264 (0.265)
53[a]	Dyeing, tanning and coloring materials	-0.419*** (0.138)	81	Prefabricated buildings; sanitary, plumbing, heating, lighting fixtures	-0.306** (0.154)
54	Medicinal and pharmaceutical products materials, n.e.s.	-0.166 (0.128)	82	Furniture, and parts thereof	-0.013 (0.128)
55	Essential oils, resinoids, perfume materials; toilet, cleansing preparations	-0.112 (0.146)	83	Travel goods, handbags and similar containers	0.391** (0.161)
56[a]	Fertilizers	-0.189 (0.306)	84	Articles of apparel and clothing accessories	-0.226 (0.147)
57[a]	Plastics in primary forms	-0.537*** (0.168)	85	Footwear	-0.053 (0.195)
58[a]	Plastics in non-primary forms	-0.252 (0.164)	87	Professional, scientific and controlling instruments and apparatus, n.e.s.	-0.027 (0.125)
59[a]	Chemical materials and products, n.e.s.	-0.160 (0.134)	88	Photographic apparatus, optical goods, n.e.s.; watches and clocks	0.176 (0.140)
			89	Miscellaneous manufactured articles, n.e.s	-0.285*** (0.105)

Note: The table displays ATTs from sector-by-sector regression-adjusted DID kernel propensity score matching estimation in reduced sample. Dependent variable is log of bilateral exports. Controls not shown. Heteroskedasticity-robust standard errors in parantheses. Significance at 1%, 5% and 10% indicated by ***, ** and * respectively. [a] Goods category considered to be energy-intensive.

Table A-2: Robustness checks sectoral ATTs - reduced sample

SITC	Sector label	(1) Baseline	(2) Logit	(3) w/o China	(4) Policy
23	Crude rubber	-1.102***	-1.105***	-1.203***	-0.722
		(0.296)	(0.302)	(0.351)	(0.441)
43	Animal or vegetable fats	-0.679*	-0.700*	-0.666	-0.476
	and oils	(0.384)	(0.389)	(0.425)	(0.499)
52	Inorganic chemicals	-0.330**	-0.298*	-0.344*	-0.457**
		(0.158)	(0.165)	(0.176)	(0.205)
53	Dyeing, tanning and coloring	-0.419***	-0.450***	-0.423***	-0.493**
	materials	(0.138)	(0.139)	(0.146)	(0.225)
57	Plastics (in primary form)	-0.537***	-0.617***	-0.472**	-0.846***
		(0.168)	(0.173)	(0.201)	(0.277)
66	Non-metallic mineral	-0.229*	-0.110	-0.095	-0.218
	manufactures	(0.128)	(0.136)	(0.149)	(0.211)
67	Iron and steel	-0.419**	-0.461**	-0.337	-0.516**
		(0.174)	(0.192)	(0.205)	(0.256)
68	Non-ferrous metals	-0.787***	-0.701***	-0.665***	-0.619**
		(0.192)	(0.201)	(0.222)	(0.296)
69	Manufactures of metals, n.e.s.	-0.200*	-0.165	-0.182	-0.417**
		(0.110)	(0.119)	(0.140)	(0.181)
71	Power-generating machinery	-0.429***	-0.339**	-0.256	0.701
	and equipment	(0.146)	(0.159)	(0.162)	(0.666)
72	Machinery specialized for	-0.276**	-0.336***	-0.332**	-0.414**
	particular industries	(0.123)	(0.127)	(0.142)	(0.201)
76	Telecommunications equipment	-0.449***	-0.503***	-0.468***	-0.466**
		(0.136)	(0.141)	(0.149)	(0.217)
77	Electrical machinery, apparatus	-0.203*	-0.268**	-0.243*	-0.373**
	and appliances, n.e.s.	(0.114)	(0.118)	(0.129)	(0.177)
81	Prefabricated buildings	-0.306**	-0.299*	-0.183	-0.332
		(0.154)	(0.160)	(0.173)	(0.236)
89	Miscellaneous manufactured	-0.285***	-0.256**	-0.229*	-0.390***
	articles	(0.105)	(0.112)	(0.133)	(0.140)
83	Travel goods, handbags	0.391**	0.376**	0.432**	0.352
		(0.161)	(0.172)	(0.189)	(0.336)

Note: The table displays ATTs from regression-adjusted DID kernel matching estimation in reduced sample. Weights are obtained sector-by-sector. Dependent variable is log of bilateral sectoral exports. Heteroskedasticity-robust standard errors in parantheses. Significance at 1%, 5% and 10% indicated by ***, ** and * respectively. Results only shown for sectors with significant effects in Table A-1. Logit uses a logit selection model. Policy includes political variables.

Ifo Working Papers

No. 118 Heid, B., J. Langer and M. Larch, Income and Democracy: Evidence from System GMM Estimates, December 2011.

No. 117 Felbermayr, G.J. and J. Gröschl, Within US Trade and Long Shadow of the American Secession, December 2011.

No. 116 Felbermayr, G.J. and E. Yalcin, Export Credit Guarantees and Export Performance: An Empirical Analysis for Germany, December 2011.

No. 115 Heid, B. and M. Larch, Migration, Trade and Unemployment, November 2011.

No. 114 Hornung, E., Immigration and the Diffusion of Technology: The Huguenot Diaspora in Prussia, November 2011.

No. 113 Riener, G. and S. Wiederhold, Costs of Control in Groups, November 2011.

No. 112 Schlotter, M., Age at Preschool Entrance and Noncognitive Skills before School – An Instrumental Variable Approach, November 2011.

No. 111 Grimme, C., S. Henzel and E. Wieland, Inflation Uncertainty Revisited: Do Different Measures Disagree?, October 2011.

No. 110 Friedrich, S., Policy Persistence and Rent Extraction, October 2011.

No. 109 Kipar, S., The Effect of Restrictive Bank Lending on Innovation: Evidence from a Financial Crisis, August 2011.

No. 108 Felbermayr, G.J., M. Larch and W. Lechthaler, Endogenous Labor Market Institutions in an Open Economy, August 2011.

No. 107 Piopiunik, M., Intergenerational Transmission of Education and Mediating Channels: Evidence from Compulsory Schooling Reforms in Germany, August 2011.

No. 106 Schlotter, M., The Effect of Preschool Attendance on Secondary School Track Choice in Germany, July 2011.

No. 105 Sinn, H.-W. und T. Wollmershäuser, Target-Kredite, Leistungsbilanzsalden und Kapitalverkehr: Der Rettungsschirm der EZB, Juni 2011.

No. 104 Czernich, N., Broadband Internet and Political Participation: Evidence for Germany, June 2011.

No. 103 Aichele, R. and G.J. Felbermayr, Kyoto and the Carbon Footprint of Nations, June 2011.

No. 102 Aichele, R. and G.J. Felbermayr, What a Difference Kyoto Made: Evidence from Instrumental Variables Estimation, June 2011.

No. 101 Arent, S. and W. Nagl, Unemployment Benefit and Wages: The Impact of the Labor Market Reform in Germany on (Reservation) Wages, June 2011.

No. 100 Arent, S. and W. Nagl, The Price of Security: On the Causality and Impact of Lay-off Risks on Wages, May 2011.

No. 99 Rave, T. and F. Goetzke, Climate-friendly Technologies in the Mobile Air-conditioning Sector: A Patent Citation Analysis, April 2011.

No. 98 Jeßberger, C., Multilateral Environmental Agreements up to 2050: Are They Sustainable Enough?, February 2011.

No. 97 Rave, T., F. Goetzke and M. Larch, The Determinants of Environmental Innovations and Patenting: Germany Reconsidered, February 2011.

No. 96 Seiler, C. and K. Wohlrabe, Ranking Economists and Economic Institutions Using RePEc: Some Remarks, January 2011.

No. 95 Itkonen, J.V.A., Internal Validity of Estimating the Carbon Kuznets Curve by Controlling for Energy Use, December 2010.

No. 94 Jeßberger, C., M. Sindram and M. Zimmer, Global Warming Induced Water-Cycle Changes and Industrial Production – A Scenario Analysis for the Upper Danube River Basin, November 2010.

No. 93 Seiler, C., Dynamic Modelling of Nonresponse in Business Surveys, November 2010.