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Domestic institutional quality and the effectiveness of global Greenhouse gases mitigation: evidence from Kyoto Protocol[1]

Qualidade das instituições internas e a efetividade de mitigação global de Gases de Efeito Estufa: evidência a partir do Protocolo de Quioto

Calidad de las instituciones internas y efectividad de la mitigación global de gases de efecto invernadero: evidencia del Protocolo de Kioto

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Henrique Ryosuke Tateishi[2]
Cassiano Bragagnolo[3]

Abstract

This study addressed the effectiveness of Kyoto Protocol (KP) as an international institution and the interplay of domestic institutions and KP by employing a difference-in-difference estimation. The results indicated low effectiveness, in general,

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2 Candidato ao título de Doutor pela Universidade de São Paulo Instituto de Energia e Ambiente, São Paulo, Brasil. Mestre em Economia pela Universidade Federal de São Carlos.
(hrtateishi@usp.br). **ORCID: https://orcid.org/0000-0003-4632-2024**.

3 Professor do Departamento de Economia da Universidade Federal de São Carlos, Sorocaba, São Paulo, Brasil. Doutor em Economia pela Universidade de São Paulo.
(cassiano@ufscar.com). **ORCID: https://orcid.org/0000-0002-9177-3791**.

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but not ineffectiveness. Regarding the KP, not only its formal and defined rules but also the demonstration of the intention to cooperate was bound to influence emissions' reduction. Domestic institutions were more influential than the effects of KP international institution. However, political, legal rights, and economic institutional qualities presented distinct effects over emissions' mitigation.

Keywords: Climate governance; Institutional quality; International Institutions; Kyoto Protocol; Difference-in-difference model

Resumo

Este estudo analisou a eficácia do Protocolo de Kyoto (KP) e sua relação com as instituições internas, considerando-o como uma instituição internacional utilizando uma estimação de diferenças-em-diferenças. Os resultados indicaram, no geral, baixa eficácia, mas não completa ineficácia. Concernente ao KP, não somente as regras formais definidas, mas também a demonstração de intenção em cooperar influenciaram a redução de emissões. As instituições domésticas foram mais influentes do que os efeitos do KP como instituição internacional. No entanto, os efeitos de redução de emissões decorrentes das instituições políticas, de direitos legais e das econômicas foram distintos.

Palavras-chave: Governança Climática; Qualidade Institucional; Instituições Internacionais; Protocolo de Kyoto; Modelo Diferenças em diferenças

Resumen

Este estudio analizó la efectividad del Protocolo de Kioto (KP) y su relación con las instituciones internas, considerándolo como una institución internacional utilizando un estimador de diferencias-en-diferencias. Los resultados indicaron, en general, baja eficacia, pero no completa ineficacia. Con respecto al KP, no solo las reglas formales establecidas, sino también la demostración de la intención de cooperar influenció la reducción de emisiones. Las instituciones domésticas fueron más influyentes que los efectos del KP como institución internacional. Sin embargo, los efectos de la reducción de emisiones de las instituciones políticas, de derechos legales y de las económicas fueron distintos.

Palabras Clave: Gobernanza climática; Calidad institucional; Instituciones internacionales; Protocolo de Kioto; Estimador de diferencias en diferencias

Introduction

According to the Intergovernmental Panel on Climate Change (IPCC 2014), despite the international efforts to reduce the world's Greenhouse Gases (GHG) emissions during the first decade of 2000s, total world's yearly emissions' average growth rate had increased more in the 2000-2010 period than in the prior four decades (+1.3%/yr compared to +2.2%/yr). In addition, data from the World Bank (2017) indicates that average country emissions rose by 40% in 2012 compared to 1990. On one hand, there had been skepticism against the effectiveness of international environmental regimes, which claimed that global climate risk mitigation would be too weak or too slow owing to the lack of cooperation; while, on the other hand, the learning process obtained from them demonstrated a lot of opportunities that can assist in the process of international governance of climate challenge (Stern 2016; Haas 2000; Aldy, Barrett, and Stavins 2003; Rosen 2015).

Concerning international cooperation to mitigate pollutant emissions, such as GHG, countries can attempt to free-ride instead of complying, because cooperation is not solely dependent on "human motivations" (e.g., altruism, idealism, honor), nor only explained by rational choices (e.g., benefit-cost, optimization) (Keohane 1988; Sandler and Arce 2003). Moreover, free riding is possible because the benefits are shared, while the costs are individualized (Young 2013), and sovereign parties seeking different goals and priorities are embedded in the international arena, which network implies that every party is interdependent of the other (Keohane 1984; Mitchell 2013; Dietz, Ostrom, and Stern 2003). As a consequence, one of the difficulties lies in setting the responsibilities that each country would bear, since countries' capabilities to mitigate emissions also differ (Adger et al. 2003; Paavola and Adger 2005; Jänicke 1992).

The country's strategies are influenced by domestic affairs, such as politics, socio-economic context, and technology (Martin and Simmons 1998; Keohane 1988). Furthermore, domestic institutions can influence a country's socio-economic performance (North 1990; Acemoglu et al. 2015) and assist in improving environmental governance (Paavola 2016; Ostrom 2010; Adger 2001). The countries' domestic interests to comply with international environmental policies are bound to influence the effectiveness of international environmental institutions, such as KP (Martin and Simmons 1998; Young 2013).

However, a question that remains is: had the KP and its international repercussion not existed, would emissions be higher? Since there is no counterfactual world, the answer hardly will be precise. The aims of this study are much more modest but close in meaning. We compared the performance of a group of countries (treatment) based on their average trend of emissions over time, against the trend of emissions of another group (control) over the same period. We adopted distinct treatments to assess whether distinct implemented levels of KP as an international institution were effective to alleviate the trend of emissions in certain groups more than in others, based on KP's (UNFCCC 2008) and its reference in the United Nations Framework Convention for Climate Change (UNFCCC) document (UN 1998).

Our first hypothesis considers that the distinct implemented levels of KP were important to alleviate the trend of emissions in the respective groups over the period (Keohane 1984; Young 2013). Our second hypothesis concerns that cooperation with KP goals is influenced by domestic institutions (Mitchell 2013; Martin and Simmons 1998; Cortell and Davis 1996). We employed a difference-in-difference statistical approach (Lechner 2010) to retrieve the isolated effect of KP to test the first hypothesis; and considered three indicators of domestic institutional quality, built by Kuncic (2013), in the model estimation to account for the second one.

Following this introduction, the rest of the paper is organized into four other sections: in the next section, the theoretical framework, we elaborate the consideration of KP as an international institution and its relationship with domestic institutions; the third section, the methodology, explores the difference-in-difference statistical model and we outline the treatment and control effects and the periods employed in the analysis. The fourth section displays the results and discusses them, while the fifth section presents the final remarks.

Theoretical framework

Although GHG emissions impact the entire planet through the greenhouse effect, they have a defined source, which implies that countries must shoulder the costs individually when committed to enforcing KP. Meanwhile, the benefits of reducing the detrimental risks associated with climate change are shared among all. However, the information about the tangible benefits of reducing GHG emissions (mitigation) is unknown and varies according to the society, region, or party involved (Sandler and Arce 2003; Nordhaus 2015; Paavola and Adger 2005). Since the costs are countries', domestic politics and agenda might be considered in the process of compliance or denial (Cortell and Davis 1996; Keohane 1984).

For instance, Sunstein (2007) considered that United States withdraw the ratification of KP because it would be economically worse off in case of compliance. Notwithstanding, in the case of the Montreal Protocol, the United States should be better off. According to Veiga (2013), the possibility of alternative technological innovations to address Chlorofluorocarbons' (CFCs) functionalities and pressures from the civil society regarding the ozone layer depletion made United States adopt unilateral regulations before the group of European countries in denial, which France and United Kingdom stood out. The achievement of cooperation is bound to benefit from contracts set among parties, which are formal institutions that alleviate transaction costs by attenuating uncertainty (North 1990; Paavola 2006). The more parties are involved, the higher will be the level of interdependency and complexity, which escalates the volume of transaction costs (Paavola and Adger 2005; North 1990). As a result, international markets are bound to carry both domestic transaction costs and the complexity of coordinating the international arena (North 1999).

When the source of pollution is local, pressure from civil society to adopt more environmentally sustainable measures is to be considered (Cole, Rayner, and Bates 1997; Cole 1999; Paavola 2016). However, the likelihood of succeeding is reduced if the distribution of rights and concessions is concentrated in the polluter's hands(Coase 1960; Paavola 2016; 2006). The higher is quality of domestic democratic institutions plays a role by reducing the power gap among the parties involved owing to the distribution of power and decision-making (Acemoglu and Robinson 2016; Acemoglu et al. 2015). Similarly, pressures over the national government to commit to the international environmental agenda might be more feasible if domestic actors converge into a sustainable agenda (Levy, Haas, and Keohane 1992; Lijphart 2012; Lijphart and Crepaz 1991).

Sub-national representatives that lobby for a national agenda priority can reinforce their goals by calling to multilateral international organizations, or even appeal to them because their and national interests did not converge. Regarding the latter, sub-national representatives would seek legitimation of international organizations to domestic (individual) affairs (Cortell and Davis 1996). Legitimacy bears the collective acceptance by the society that legal rights can be enforced. Regulations, policies, auditing, and legal rights are created by domestic authorities, but their legitimacy is the root of its effectiveness (Andresen and Hey 2005). The concession of property rights under legal rights institutions is what allows the actors who possess the rights to decide over the quantity of pollution is produced. The polluters, whose property rights were established by legal rights, can bargain with the civil society for acceptable pollution levels efficiently. However, in the presence of transaction costs, an efficient bargain hardly is achieved (Coase 1960). Moreover, the distribution of property rights can lead to even more pollution if the design of legal rights favors polluters or does not back up civil society (Paavola 2006).

The flexibility of institutions assists its effectiveness because it provides robustness and resilience: an institution that is able to adapt to changes in the environment without distancing itself from its initial purpose. On one hand, inflexible institutions may lack governance during changes. On the other hand, too much flexibility of a government can prove ineffective. Robustness can be measured as persistence over time, and an effective institution is likely to be also robust and transparent (Underdal and Young 1997; Young 2013). The discourse in the international arena during the 2000s was conciliatory towards seeking economic and social development rather than the global north's approach to environmental challenges, such as climate change (Andresen and Hey 2005). According to Rosen (2015), apart from the aggregate performance of Europe, the great majority of countries would have not been able to reduce its emissions according to KP goals. The KP could have created regulations that focus on the short-term mitigation pathways more than the long-term structural and institutional changes, which could have reduced its effectiveness (Aldy, Barrett, and Stavins 2003; Rosen 2015).

Interaction among institutions can support and reinforce them, be it either domestic (Sunkel 1989; North 1990) or international (Gehring and Oberthür 2009; Oberthür 2001). Moreover, not only KP can be favored by domestic actions since the reduction of GHG emissions can also be beneficial to the learning process or building capacity to address other environmental institutions (Gehring and Oberthür 2009; Young 2013). However, not all institutions' outcomes can be beneficial to the environment, society, and equity altogether, and in some cases institutions are bound to reproduce and perpetuate inequalities and inequities (Robinson and Acemoglu 2012; Acemoglu and Robinson 2016; Paavola 2016; North 1990; Mahoney 2000).

Methodology

The difference-in-difference (DD) estimator was adopted to evaluate the effectiveness of a policy intervention or policy changes (treatment) on a group by contrasting the outcomes between the treated group after the treatment and the non-exposed group (control) within the same period (Lechner 2010; Abadie 2005). DD models are panel data models involving the subtraction of two other differences: the first difference is between the period of time before and after the treatment, and the second one is between treatment and control. Using the DD procedure, one can isolate the policy's effect, which is the combination between the average treatment effect (former difference) and within the policy's active period (latter difference) (Abadie 2005).

For the time difference, this study considered the difference of the average emissions of all parties in the model corresponding to three distinct periods: (P1) the difference between the average emission's trend[4] in (1991-1997) period against the (1998-2012) period, since countries that ratified might have been preparing to reduce emissions, which might have carried over the entire period (Oberthür 2001); (P2) the difference between (1991-2004) and (2005-2012), because it is the period that KP entered into force; and (P3) the difference between (1991-1998) and (2008-2012), which is the first commitment period of KP. The overall period consisted of from 1991 to 2012, which we detail in the next sub-section.

Table 1 displays the treatment and control groups (former difference) to be considered in the DD estimations. We considered four categories of treatment to assess the distinct implemented levels of KP as an international institution (Mitchell 2013; Keohane 1988; Underdal and Young 1997), based upon the United Nations Framework Convention on Climate Change (UNFCCC) base text of the KP (UN 1998) and the Kyoto Protocol Reference Manual (UNFCCC 2008). Firstly (a), we assess the effect of the early intention to participate in the KP, based upon the signature of the Convention's text from March 1998 to March 1999 and its posterior ratification (UNFCCC 2021a). The demonstration of early intention might concern domestic public acceptance of the governor, preserving

4 One implication of the methodological choice when considering the trend of emissions, instead of base year's relative emissions (i.e., Table II-1 from UNFCCC (2008)), is that this comparison does not focus on the assessment of KP rule's effectiveness, but does consider the effectiveness based on the influence buffers created by KP institutional arrangement. In complement to this study, future ones are encouraged to assess the differences among KP rules and their respective mitigation effectiveness taking into account the base year's relative emissions.

a spot in the international arena, or the prior existence of built infrastructure or technology to mitigate emissions (Veiga 2013; Keohane 1984).

Table 1 – Treatment and control groups for the estimation of DD average group effects of distinct implemented levels of Kyoto Protocol

Treatment	Control	Difference-in-difference effect *groups*
RA	No-RA	a) Among all countries in the sample, the difference between the countries *that signed and ratified* (RA) the Convention's text and the countries that *did not sign or did not ratify it*.
RA *and* Annex B	RA *and* No-Annex B	b) Among the countries that RA the Convention's text, the difference between those which had binding emissions *targets* in KP and those which *did not have targets*.
Non-Annex I *and* RA	Non-Annex I *and* No-RA	c) Among the countries that did not have targets in KP, the difference between the countries that *RA* and the countries that *did not RA* (the Convention's text).
Annex B	Economies in Transition	d) Among the countries that had binding targets in KP, the difference between the countries with binding *targets for the first commitment period (P3)* and the countries categorized as ***Economies** in Transition.*

Source: Authors' elaboration.

We considered in the treatment (b), the effect of having binding emission reduction targets accorded in the KP (UNFCCC, 2008, 13), which corresponds to the countries of Annex B in the Convention Text (UN, 1998, 24) , among the countries that signed and ratified the protocol's text to detail treatment (a). Regarding the treatment (c), it represents the group of countries that belong to Non-Annex I parties, which targets were not defined, but signed and ratified the Convention's text (UNFCCC 2021b). The treatment (c) aimed to assess if the countries that showed intention, even though without binding targets, could have emitted less than its counterpart that did not show intention. Lastly, the treatment (d) considered the group of countries whose targets were defined by the KP, i.e. Annex B countries, but scrutinize the effect of Economies in Transition (UNFCCC, 2008, 13) on emissions' trend.

Concerning the statistical model, we consider β_{DD} as the DD estimator; Y the emissions level; $T = \{0,1\}$ the international institution effect, where $T = 1$ represents the treatment groups displayed in Table 1. Additionally, $t = \{0,1\}$ represents the time effect, where $t = 0$ stands for 1991-1997, while $t = 1$ associates P1, P2, and P3 to the models. Equation (1) represents the overall effectiveness of the KP (Abadie 2005; Lechner 2010).

$$\beta_{DD} = \{E[Y|T = 1, t = 1] - E[Y|T = 0, t = 1]\} \\ -\{E[Y|T = 1, t = 0] - E[Y|T = 0, t = 0]\} \quad (1)$$

The expected value of the DD estimator (β_{DD}) is to be at least non-positive, which would indicate that the trend of emissions after the treatments, on average, was not higher in the treatment group than the trend in the control group. In the case of a negative and statistically significant effect, it would indicate that the trend of emissions after the treatment on the treated group was lower than the trend of emissions in the control group. Conversely, if the parameter is positive, the treatment was not effective to restrain the trend of emissions within the given period relative to the control performance.

The panel model follows Equation (2).

$$Y_{it} = \alpha_0 + \gamma.T_{it} + \rho.t_{it} + \beta_{DD}.(T_{it}.t_{it}) + \alpha_C.X'_{it} + \alpha_I.Q_{it} + \varepsilon_{it} \quad (2)$$

Where Y_{it} is the emissions of carbon dioxide for each country i at a time $t_{it} = \{0,1\}$ represents the vector of control variables that can influence emissions; Q_{it} stands for the vector containing domestic institutional quality indicators; $t_{it} = \{0,1\}$ is the binary variable for treatment effect; $t_{it} = \{0,1\}$ is the binary variable for the time period; β_{DD} is the effectiveness of the KP due to interaction between both binary variables; and ε_{it} is the stochastic error in the regression.

The time effect, i.e. Υ, considers the average trend of emissions before the treatment and after the treatment for all sampled groups (treatment and control). The γ parameter captures whether all countries in the sample presented a lower (if negative) or higher (if positive) trend of emissions after the treatment. That is, for example, if all countries sampled in the model had technological enhancements over the period that reduced the level of emissions, $\gamma \leq 0$; meanwhile, suppose that $\beta_{DD} \leq 0$, this would indicate that the isolated effect of the treatment was not likely to be the responsible for the emissions' trend alleviation.

Hence, the 'effectiveness' of the KP that we considered in this study is based upon the average effect of emissions' trend alleviation in the treatment group compared to its control, after the treatment. This analysis is able to assess the isolation of global institutional effects of Table 1's treatment effects, that are: sign and posterior ratification of the Convention's text (UNFCCC's text to KP (UN 1998)); the effect of binding targets in KP (UNFCCC 2008); the effect of early intention combined with countries without targets; and the effect of a clear commitment period to reduce emissions (UNFCCC, 2008, 13).

To address the endogeneity of variables, in special economic income *per capita* (Arrow et al. 1995; List and Gallet 1999), and the endogenous relationship between domestic and international institutions (Gehring and Oberthür 2009; Martin and Simmons 1998), we employed a System Generalized Method of Moments (GMM) model specification (Arellano and Bover 1995). The System GMM uses the lag of the dependent variable and the past observations of independent variables as instrumental variables. We employed the Hausman statistical test (Hausman 1978) to verify the validity of the instruments. Moreover, we tested the autocorrelation of residuals starting from the second lag using the Arellano-Bond test (Arellano and Bond 1991).

Variables and data

The control variables are intended to control for deviations in the dependent variable (GHG emissions) owing to economic fluctuations and energy use heterogeneity across countries: we employed GDP *per capita* (constant thousand 2010 US$) and energy consumption *per capita* (kt of oil equivalent), which both were obtained from the World Bank's World Development Indicators (WDI). The dependent variable is the KP's GHG emissions *per capita* based on carbon dioxide equivalent emissions, also obtained from WDI. These data were transformed into logarithms and named *lco2eq* for carbon dioxide emissions, *lgdp* for GDP, and *le_oil* for energy consumption.

The quality of domestic institutions proxy variables was taken from (Kuncic (2013) dataset and ranges from 1990 to 2010, which we interpolated until 2012 using the moving average estimated values. One of the strengths of this dataset is its distinction among legal, political, and economic institutional quality. Another consideration is the robust estimation of institutional quality indexes, which were obtained by multivariate statistical analysis as a combination of a myriad of institutional proxies and indexes (Kuncic 2013). The Legal institutional index (*LII*) considered the degree of enforcement of property rights, the effect of laws and regulations, the impartiality of justice organizations and actors; and we employed this index as a proxy to the enforcement of legal and property rights (North 1990; Coase 1960; Paavola and Adger 2005). The Political institutional index (*PII*) was based on freedom of press, corruption, and bureaucracy, political rights; and we included in our model to address power distribution and the level of democracy (Paavola 2006; 2016; Acemoglu, Johnson, and Robinson 2005;

Acemoglu and Robinson 2016). The Economic institutional index (EII) combined indicators such as: the economic freedom; the regulatory quality of credit, labor and business; and also, foreign ownership and investment restrictions; and we used in our model to assess the economic conditions which countries operate under (Aldy, Barrett, and Stavins 2003; Williamson 1985).

The full model is presented in Equation (3), where α_0 is the constant:

$$lco2_{it} = \alpha_0 + \gamma.T_{it} + \rho.t_{it} + \beta_{DD}.(T * t) + \alpha_{I1}LII + \alpha_{I2}PII + \alpha_{I3}EII + \alpha_{C1}lgdp_{it} + \alpha_{C3}le_{it} + \varepsilon_{it} \quad (3)$$

The effectiveness of KP is assessed by β_{DD}, where the statistical significance of $\beta_{DD} \leq 0$ indicates that KP institutional effect was able to mitigate emissions by reducing the trend of emissions during the period. The significance of $\rho \leq 0$ indicates that the trend of GHG emissions in P1, P2, or P3 were lower than the trend from 1991 to 1997. Lastly, the significance of $\gamma \leq 0$ means that the emissions' trend within the treatment group was lower than the trend of the control group, despite the period (i.e. including the time prior to 1998).

Results and discussion

Results

This section shows the results for the unbalanced panel data system GMM model. The overall period analyzed ranged from 1991 to 2012 and included up to 124 countries and (2244 observations) in treatment (a), while 63 (1258 obs.), 86 (1538 obs.), and 33 countries (660 obs.) correspondent to treatments (b), (c), and (d), respectively. Twelve models were estimated in total, by considering three distinct periods (P1, P2, and P3) and four treatments (Table 1). For all twelve models, statistical validity tests were conducted individually, which showed the absence of autocorrelation was rejected but not rejected in the second lag (Arellano and Bond 1991; Arellano and Bover 1995). In addition, the validity of the instruments was not rejected at a 10% confidence level (Hausman 1978).

Table 2 displays the results for the first treatment in Table 1, a), which corresponds to the difference of KP's effect for the group of countries that signed and ratified against the group that did not. Only the time difference between 1991-1997 to 1998-2012 (P1) was statistically significant among the DD effects and the treatment effect of RA. The positive effect of the time trend (0.033) indicated that the average trend of emissions from 1998 until 2012 was higher than the average trend in the prior period. All parameters concerning domestic institutions were statistically significant, but only political institutional quality indicated lower emissions levels for countries with higher PII, on the average for all the samples. The effect of energy use (approx. 0.130) was the opposite of GDP's (-0.107). Lastly, the influence of past emissions was significant and positive up to two years, but its coefficient value in the second year $(t-2)$ presented a lower magnitude. That is, emissions from the previous year were carried over to the current period by 0.66% per 1.00% that had been emitted; and this effect is reduced in the second year prior to 0.35% per 1.00%.

Table 2 – DD effect between signed and ratified (RA) the Convention's document and did not sign or did not ratify it (No-RA) over emissions' trend, 1991-2012

Variable	Coef. 1998		S.E.	Coef. 2005		S.E.	Coef. 2008		S.E.
DD Effect	-0.030	ns	(0.02)	-0.034	ns	(0.03)	-0.047	ns	(0.03)
Treatment (a)	-0.003	ns	(0.01)	0.008	ns	(0.01)	0.004	ns	(0.01)
Time trend	0.033	**	(0.01)	0.016	ns	(0.02)	0.035	ns	(0.03)
Legal Rights Inst.	0.439	***	(0.16)	0.418	***	(0.16)	0.420	**	(0.16)
Political Inst.	-0.383	**	(0.17)	-0.401	**	(0.17)	-0.389	**	(0.17)
Economic Inst.	0.185	**	(0.08)	0.219	***	(0.08)	0.220	***	(0.08)
GDP	-0.107	***	(0.04)	-0.104	***	(0.04)	-0.110	***	(0.04)
Energy Use	0.129	***	(0.04)	0.127	***	(0.04)	0.132	***	(0.05)
Constant	-0.207	ns	(0.19)	-0.222	ns	(0.20)	-0.202	ns	(0.20)
Lag CO_2eq_{t-1}	0.664	***	(0.06)	0.660	***	(0.06)	0.658	***	(0.06)
Lag CO_2eq_{t-2}	0.355	***	(0.06)	0.364	***	(0.06)	0.361	***	(0.06)

***; **; *; ns: 1%, 5%, 10% and not statistically significant.

Source: Own elaboration.

Table 3 shows that the trend of emissions was higher in P2 for the group of countries in treatment (b), compared to the countries that did not have binding targets. On average, the countries with higher domestic legal rights and economic institutions indexes presented a higher level of emissions in comparison to countries with respective lower institutional quality. The effect of GDP and energy use was similar to Table 2. The emissions from 1 and 2 years prior were carried over to the present at, approximately, 0.59% and 0.41%, respectively.

Table 3 – DD effect between the group of countries which had binding emissions targets in KP and those which did not have targets, among countries that RA, 1991-2012

Variable	Coef. 1998		S.E.	Coef. 2005		S.E.	Coef. 2008		S.E.
DD Effect	0.007	ns	(0.02)	0.043	*	(0.02)	0.021	ns	(0.02)
Treatment (b)	0.001	ns	(0.01)	0.000	ns	(0.01)	0.004	ns	(0.01)
Time trend	-0.002	ns	(0.01)	-0.025	ns	(0.02)	-0.013	ns	(0.01)
Legal Rights Inst.	0.346	*	(0.20)	0.312	*	(0.19)	0.339	*	(0.18)
Political Inst.	-0.380	ns	(0.25)	-0.396	ns	(0.26)	-0.392	ns	(0.28)
Economic Inst.	0.137	ns	(0.10)	0.164	*	(0.09)	0.152	*	(0.09)
GDP	-0.111	***	(0.03)	-0.102	***	(0.03)	-0.103	***	(0.02)
Energy Use	0.160	***	(0.03)	0.154	***	(0.04)	0.157	***	(0.05)
Constant	-0.278	***	(0.27)	-0.281	ns	(0.23)	-0.322	ns	(0.25)
Lag CO_2eq_{t-1}	0.584	***	(0.11)	0.589	***	(0.12)	0.589	***	(0.09)
Lag CO_2eq_{t-2}	0.420	***	(0.10)	0.410	***	(0.09)	0.412	***	(0.08)

***; **; *; ns: 1%, 5%, 10% and not statistically significant.
Source: Own elaboration.

Table 4 indicated that the average trend of emissions of Non-Annex I countries that signed and ratified the Convention's text was lower than those which did not ratify, for P2. For P1, the group of countries that signed and ratified before being classified as Non-Annex I showed a lower trend of emissions than the group of countries that did not RA. However, still considering P1, the overall sample's trend of emissions had risen after 1998 in comparison to the prior period. The influence of domestic institutions, energy use and GDP, and previous emissions level were similar to Table 2's.

Table 4 – DD effect between the countries that RA and the countries that did not RA, among the group of countries that belonged to Non-Annex I, 1991-2012

Variable	Coef. 1998		S.E.	Coef. 2005		S.E.	Coef. 2008		S.E.
DD Effect	-0.011	ns	(0.03)	-0.068	*	(0.04)	-0.064	ns	(0.04)
Treatment (c)	-0.027	*	(0.02)	0.019	ns	(0.02)	0.007	ns	(0.02)
Time trend	0.042	**	(0.02)	0.018	ns	(0.02)	0.038	ns	(0.03)
Legal Rights Inst.	0.698	***	(0.24)	0.623	***	(0.20)	0.641	***	(0.22)
Political Inst.	-0.604	**	(0.24)	-0.614	***	(0.23)	-0.611	***	(0.23)
Economic Inst.	0.184	ns	(0.14)	0.272	**	(0.14)	0.261	*	(0.14)
GDP	-0.118	**	(0.05)	-0.122	**	(0.06)	-0.129	**	(0.06)
Energy Use	0.148	**	(0.06)	0.155	*	(0.08)	0.156	**	(0.08)
Constant	-0.204	***	(0.35)	-0.236	ns	(0.37)	-0.181	ns	(0.35)
Lag CO_2eq_{t-1}	0.622	***	(0.06)	0.620	***	(0.06)	0.619	***	(0.06)
Lag CO_2eq_{t-2}	0.372	***	(0.06)	0.381	***	(0.06)	0.379	***	(0.06)

***; **; *; ns: 1%, 5%, 10% and not statistically significant.
Source: Own elaboration.

In Table 5, the Annex B countries, including the EIT (whole sample), presented an increase in the emissions' trend between 2008-2012, in comparison to 1991-2007. In contrast with the previous treatments (a-c), the effect of the legal rights index was negative, while the effect of political institutions was positive, for all three periods. There was no significant difference in emissions level regarding GDP nor energy use. The emissions from the previous year were heavily carried to the subsequent year.

Table 5 – DD effect between the countries with binding targets for the first commitment period (2008-2012) and the countries categorized as Economies in Transition, among Annex B group, 1991-2012

Variable	Coef. 1998		S.E.	Coef. 2005		S.E.	Coef. 2008		S.E.
DD Effect	-0.037	ns	(0.03)	-0.007	ns	(0.02)	-0.033	ns	(0.03)
Treatment (d)	0.020	ns	(0.03)	-0.009	ns	(0.01)	-0.004	ns	(0.01)
Time trend	0.005	ns	(0.01)	0.023	ns	(0.01)	0.034	*	(0.02)
Legal Rights Inst.	-0.330	***	(0.11)	-0.262	**	(0.11)	-0.278	**	(0.12)
Political Inst.	0.336	***	(0.12)	0.337	***	(0.13)	0.348	***	(0.11)
Economic Inst.	0.058	ns	(0.10)	0.018	ns	(0.10)	0.033	ns	(0.09)
GDP	-0.029	ns	(0.05)	-0.047	ns	(0.04)	-0.055	ns	(0.04)
Energy Use	0.163	ns	(0.14)	0.193	ns	(0.14)	0.220	ns	(0.16)
Constant	-1.049	***	(0.91)	-1.148	ns	(0.90)	-1.254	ns	(0.95)
Lag CO_2eq_{t-1}[a]	0.980	***	(0.07)	0.987	***	(0.06)	0.971	***	(0.06)

***; **; *; ns: 1%, 5%, 10% and not statistically significant.

[a]The second lag was not statistically significant in the equations in all three periods.

Source: Own elaboration.

Table 6 shows the likelihood of KP effect according to the DD effect estimates (i.e. the effect of treatment group while in P1, P2, or P3, disregarding the control group and the time effect of treatment during 1991-1997, before P1). The null hypothesis of $\beta_{DD} \leq 0$ stands for the effect that KP was at least not harmful to increase emissions' trend. The p-values that are shown are the probabilities of not rejecting the given hypothesis. The treatments displayed in Table 6 correspond to the same as Table 1's, and the tests were conducted based on the models displayed in Tables 2 to 4.

Table 6 – One-sided p-value results for at least non-detrimental effect of KP, 1998-2012, 2005-2012 and 2008-2012 for treatments (a) to (d) in Table 1

Period	1998-2012 (P1)		2005-2012 (P2)		2008-2012 (P3)	
Null Hypothesis	$\beta_{DD} \leq 0$	$\beta_{DD} \leq 0$	$\beta_{DD} \leq 0$	$\beta_{DD} \leq 0$	$\beta_{DD} \leq 0$	$\beta_{DD} \leq 0$
a) Ratify (RA)	0.949	0.051	0.887	0.113	0.928	0.072
b) RA: Annex B	0.361	0.639	0.031	0.969	0.148	0.852
c) Non-Annex I	0.643	0.357	0.957	0.043	0.928	0.072
d) Annex B: EIT	0.905	0.095	0.618	0.382	0.873	0.127

Source: Own elaboration.

Based on the treatments (a)-(d) effects, the greatest likelihood of negative (or null) differences in emissions, on the average, was among the group of countries that RA the Convention's text in comparison to the group of countries that did not sign or did not ratify it. Conversely, the lowest likelihood of negative difference in emissions' trend had been among the countries that presented binding targets of mitigation in KP, in comparison to those countries that did not have targets. Noteworthy, both groups among the lowest likelihood of negative trend had RA. The DD estimation in the period from 2005-2012 in comparison to 1991-1997 presented the lowest chances of alleviating the trend of emissions, on the period average. However, regarding the average from 1998, when UNFCCC's document was opened to signature, to 2012, which was the end of the first commitment period of KP, the likelihood of at least a non-positive trend of emissions was increased.

Discussion

In general, the isolated effect of the treatments (a)-(d), regarding distinct implementation levels of KP (DD effect on Tables 2 to 5), showed no statistically significant results according to the models, which implies that there is a chance of the effects being null, except for treatment (b) and (c) in P2. Furthermore, the likelihood of these effects being at least not positive (Table 6) indicated that there was a distinction of treatment effects among the different implementation levels of KP.

On the one hand, the distinct likelihoods of $\beta_{DD} \leq 0$ showed that not only formal rules were important to endorse the goals of KP as an international institution, but also discourse and repercussion played a complementary role in supporting cooperation (Mitchell 2013; Levy, Haas, and Keohane 1992). Countries that signed in 1998 and 1999, when the UNFCCC's Convention document was open to signing, demonstrated an early intention to cooperate with the agreement, which action, aligned to the international discourse on climate responsibility, could have coped with an interest of repositioning the country in the international arena (Andresen and Hey 2005; Rosen 2015). In the time comparison P2 (2005-2012), three out of the four DD coefficients showed a decline in the likelihood of reduced emissions' trend in the treated groups (a), (b), and (d). While in the 1990s the international discourse was focused on climate responsibility, also owing to the Montreal Protocol, the following decade experienced a discourse more focused on economic and social development and growth, which may have hindered KP intentions (Andresen and Hey 2005; Veiga 2013; Sunstein 2007).

The treatment (c) in P2 (2005-2012) was a key period-treatment combination because the treatment considered the countries within the Non-Annex I group, which were expected to raise emissions owing to socioeconomic development, meanwhile P2 was the period when KP entered into force (UNFCCC 2008). Nevertheless, as the decision of RA the protocol's text had started a decade prior and included Non-Annex I countries in DD effect, KP resonance could be effective to restrict emissions (UN 1998). Despite not having targets, Tables 4 and 6 showed that the treatment (c) group presented a reduced trend of emissions and an increase in the likelihood of $\beta_{DD} \leq 0$. The results reported that for Non-Annex I countries that did RA, the chances of having the group's emissions trend lower than the group of Non-Annex I countries that did not RA were much higher in P2 than in the previous decade. The statistically significant parameter of $\beta_{DD} \leq 0$ (Table 4) and the increase in the likelihood compared to P1 (Table 6) might be because that the treatment group (c) would have emitted much more emissions without KP.

On the other hand, the effectiveness of overlapped implementation levels of KP and the Convention's document was likely to be non-linear, and not necessarily more effective, such as the opposite effects in treatments (b) and (d). While the treatment (b) indicated a reduction of the likelihood of $\beta_{DD} \leq 0$, among the countries that RA the Convention's text, the treatment (d) showed that the chances of $\beta_{DD} \leq 0$ increased for having RA and a commitment period to binding mitigation targets (Gehring and Oberthür 2009; Oberthür 2001). The not significant effects from treatment (b) and the reduction of its chances of $\beta_{DD} \leq 0$ in P2 and P3 relative to P1 (Tables 3 and 6) might indicate that actions were taken considering short-term mitigation efforts, instead of long-run transformations (Rosen 2015; Aldy, Barrett, and Stavins 2003). This corroborates the idea that the implementation level of treatment (b) and, especially in P2, KP was not very robust as an international institution, which might be associated to overextended flexibility (Aldy, Barrett, and Stavins 2003; Oberthür 2001; Underdal and Young 1997).

The period-treatment combination of P3 and treatment (d) regards the difference between Annex B countries and EIT ones, specifically to the period of commitment to Annex B targets, but not to EIT. The likelihood of $\beta_{DD} \leq 0$ was recovered in P3, compared to its fall in P2 from P1 (Table 6), meanwhile, the effect of time trend (Table 5) was statistically significant and displayed an increase in the overall group's trend of emissions in the first commitment period. These results indicate that the effect of binding targets for the first commitment period could have constrained GHG emissions, in spite of the pressure to increase emissions, as indicated by the time trend. However, although the isolated effect of KP binding targets was more likely to restrict emissions in P3, the not statistically DD coefficient in Table 5 indicated that it was not enough to reduce the trend of emissions consistently.

Tables 2 to 4 indicated that domestic institutions that improve power distribution and enhance democracy could have played an important role to support and even enable mitigation in national and international jurisdictions (Paavola 2016; Ostrom 2010). Not only more democratic institutions can provide the inclusion of environmental targets into the domestic agenda based on public appeal (Cole 1999; Paavola 2006), but also more individualized interests from local actors might contribute to mitigation policies (Cortell and Davis 1996; Broto and Bulkeley 2013). Despite the possibility of supporting environmental governance without a government scale down to regional and local actions (Young 2013), a limitation to these actions is that, in general, legal rights are sanctioned in superior scales, which comes down to the difficulty in rivaling them from localized scales (Paavola 2016).

As a consequence, legal rights bonded to pollution control can also be ineffective or inefficient (Rosen 2015; North 1990; 1999), because property rights that are given to polluter actors, whose power is likely to be greater than society's, especially in less democratic countries, are bound to perpetuate and induce defect of environmental policies at sub-national scales (Paavola 2006; Hardoy and Lankao 2011; Hardoy and Pandiella 2009). From our model, it is suggested by the positive coefficients for LII and EII, which represents that countries with higher enforcement of legal rights and higher economic freedom could have increased their trend of emissions. This corroborates that domestic and international institutions are linked (Cortell and Davis 1996), but not an improvement on any institution might be beneficial to improve international (and even domestic) environmental targets, because the institutional design is indicated to be an essential feature to achieve policy outcomes (Rosen 2015; Veiga 2013; Paavola 2016; 2006; Kuncic 2013).

However, as in Table 5 regarding the Annex B countries, once national or sub-national instruments to reduce emissions are adopted, its acceptance by the actors are conditional to already existing institutional and physical arrangements, which legal institutions are likely to reverberate in customs, traditions, and power distribution (Lijphart 2012; Paavola 2006; Jänicke 1992). While legal rights were beneficial to GHG mitigation, the same countries whose democracy quality was higher performed worse in emissions reduction (Table 5). These results suggest that legal and property rights bindings could have constrained pollution, while democratic pressure might not have legitimated these constraints. Despite being the opposite from other models, it is consistent with the debate between economic growth and environmental protection (Sunstein 2007; Cole 1999), especially during the mid-2000s in the international discourse (Andresen and Hey 2005; Rosen 2015), which have downscaled to sub-national collective acceptance to carry the costs of GHG mitigation (Cortell and Davis 1996).

Energy use was very likely to increase GHG emissions' trend, as expected, since societies are heavily dependent on fossil fuels, which is corroborated to the transmission effect of GHG lags from the two previous years to the current, except in the treatment (d) model (Aghion et al. 2014; Magazzino 2016; Bhattacharya, Awaworyi, and Paramati 2017). In addition, results reported that countries with higher levels of GDP *per capita* presented lower emissions (tables 2 and 3), which negative coefficient was consistent with Bhattacharya, Awaworyi and Paramati (2017) , whose model was also a System GMM, but with a focus on renewable and non-renewable energy effects on GDP and CO_2 emissions. Theory-wise, it might indicate that countries with higher economic capability, which are likely to be the industrialized ones, are also the most capable ones to mitigate emissions (Jänicke 1992; Lehtonen 2004). The lagged coefficients indicated that GHG emissions were "sticky", but its effect was reduced in the second year (tables 2 and 3), and there was no autocorrelation for prior years after the second.

Conclusion

This study considered a first hypothesis, which analyzed the effectiveness of distinct implemented levels of KP (four treatment effects), based upon the relative reduction in emissions' trend compared to another group of control countries (Keohane 1984; Young 2013). A second hypothesis considered that domestic institutions influence on the country's cooperation for the achievement of international institutions goals, such as KP (Mitchell 2013; Martin and Simmons 1998; Cortell and Davis 1996). We employed a difference-in-difference statistical approach, since the result of time and treatment interaction provides the estimated isolated treatment effect on the treated group (Lechner 2010; Abadie 2005). The operationalization was conducted by the system GMM method to account for both unobservable heterogeneities among countries and endogeneity processes, especially owing to institutional effect and income (Arellano and Bover 1995; Arellano and Bond 1991).

In summary, the isolated effect of treatments associated with KP's implemented levels presented low effectiveness (but not ineffectiveness) in alleviating the trend of emissions on the treated group relative to its counterpart, which was displayed by the not statistically significant DD parameters in most equations. However, results indicated that not only formal and defined rules, such as binding targets but also the international discourse and repercussion of KP were influential factors to reduce the likelihood of increasing emissions. Especially among the Non-Annex I group, the demonstration of intent to cooperate with KP combined with the Protocol's support mechanisms was much likely to have avoided emissions, as displayed by the statistically significant coefficient of DD estimator and the reduction of the likelihood of an increase in emissions' trend (Tables 4 and 6).

Results indicated that the influence of domestic institutions over GHG emissions was statistically significate in most cases, and even higher than the effect of KP's associated treatments. Nevertheless, political, legal rights, and economic institutions affect emissions differently, and not necessarily higher institutional quality was associated with higher mitigation. In general, increased political freedom and democracy were influential to reduce emissions, which was consistent with the tolerance and the inclusion of climate responsibility topics on the domestic agenda. However, the higher institutional quality of the enforcement of legal rights was likely to increase emissions' levels, which might be associated with the unequal distribution of rights to polluter actors.

On Annex B group of KP (treatment (d)), the effects of political and legal rights institutional qualities were the opposite from other treatments (a) to (c) and indicated that laws, rules, and regulations were beneficial to GHG mitigation, while democratic pressure corresponded to higher emissions. Lastly, institutions associated with market freedom and market mechanisms were linked to elevated emissions' trend, but in lower magnitude than the other two institutional indexes, and not being statistically significant on Annex B treatment. This might indicate that domestic market mechanisms were less effective to constrain emissions in comparison to democracy but less impactful than legal rights associated with polluter actors to increase emissions.

Lastly, the international discourse might have influenced compliance since the results suggested that emissions' trends during 2005-2012 were more likely to increase GHG emissions than in the other two periods analyzed for three out of the four treatments analyzed. In addition, the rapid growth of middle-income countries within the international arena highlighted economic growth and social development, while climate issues were less prioritized. Besides, the groups in all samples were likely to be dependent on technologies that emit GHG, with a low pace of change to less environmentally detrimental ones, since the emissions from two previous years were carried over the current period in three out of the four models, while in the remaining model, it was only in one year prior.

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