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EMISSIONS TRADING AND THE ECONOMIC IMPACT OF THE PARIS AGREEMENT ON NEW ZEALAND

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Resumen

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Un nuevo acuerdo internacional sobre el cambio climático bajo el Marco de la Convención de las Naciones Unidas sobre el Cambio Climático se celebró en París en diciembre de 2015. El Acuerdo de París (PA) afirma que las vías de emisión de gases de efecto invernadero (GEI) deben ser compatibles con mantener el aumento de la temperatura global por debajo de 1,5°C o 2°C por encima de los niveles pre-industriales. Nueva Zelanda (NZ) se ha comprometido a reducir las emisiones un 30% por debajo de los niveles de 2005 para el año 2030. El propósito de este trabajo es estimar los costos económicos de los términos PA cuando el potencial de mitigación se basa en la fijación de precios/no fijación de precios y la vinculación de las emisiones agrícolas/no la vinculación de las emisiones transables NZ Scheme (NZ ETS) a otros mercados de permisos de emisiones en Australia, la Unión Europea y los Estados Unidos. A través de un modelo de equilibrio general encontramos que Nueva Zelanda es capaz de cumplir con los términos PA; Sin embargo, el PIB se reduce en un 7% por debajo de la línea de base para el año 2030 debido a la rigurosidad de los objetivos. Si bien, la fijación de precios y la vinculación de la agricultura NZ ETS a otros mercados de emisiones, mitiga las pérdidas que vinculan a la Unión Europea ETS, puede no ser deseable debido a pérdidas significativas en la competitividad. Los resultados también muestran que la vinculación a Australia o los mercados de emisiones de Estados Unidos mitiga los costos de cumplimiento debido a los precios más bajos en los permisos de emisión.

Palabras Claves: *Vinculación de mercado, emisiones agrícolas, equilibrio general*

Abstract

A new international climate change agreement under the United Nations Framework Convention on Climate Change was concluded in Paris in December 2015. The Paris Agreement (PA) asserts that greenhouse gases (GHG) emission pathways should be consistent with holding the increase in global temperature below 1.5°C or 2°C above pre-industrial levels. New Zealand (NZ) has committed to reduce emissions to 30% below 2005 levels by 2030. The purpose of this paper is to estimate the economic costs from the PA terms when the mitigation potential relies on pricing/not pricing agricultural emissions and linking/not linking the NZ Emissions Tradable Scheme (NZ ETS) to other markets of emissions permits in Australia, the European Union and the United States. Through a general equilibrium model we find that NZ is capable of meeting the PA terms; however, GDP decreases by 7% below the baseline by 2030 because of the stringency of the targets. Although, pricing agriculture and linking the NZ ETS to other emissions markets mitigates losses, linking to the European Union ETS, may not be desirable because of significant losses on competitiveness. Results also show that linking to Australia or the US emissions markets mitigates compliance costs because of lower prices on emissions permits.

Keywords: *Market linking, agricultural emissions, general equilibrium*

JEL codes: *C68, Q51, Q54, Q56,*

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1. Introduction

Negotiations towards a new international climate change agreement under the United Nations Framework Convention on Climate Change (UNFCCC) concluded in Paris in December 2015. The Paris Agreement (PA) asserts that future greenhouse gases (GHG) emissions pathways should be consistent with holding the increase in the global average temperature below 1.5°C or 2°C above pre-industrial levels. The PA is due to enter into force by 2020 and seeks global emissions to peak as soon as possible and then to undertake rapid reductions thereafter (UNFCC 2015).

New Zealand (NZ) committed to reduce GHG emissions to 30% below 2005 levels by 2030 (59.2 Mtons CO2e) and has also announced a target of reducing emissions to 50% of 1990 levels by 2050 (33.4 Mtons CO2e). Thus, meeting the reduction targets requires the implementation of mitigation policies, e.g., carbon markets, environmental taxes, and incentives to develop clean technologies. Those policies imply limits on emissions and, consequently, impacts on production systems and usage of GHG-intensive inputs across economic sectors. Furthermore, other countries, including NZ's trade partners, also committed to reduce their own GHG emissions, which may imply changes in the trade flows and the competitiveness position of NZ. Thus, there is a multiplicity of effects that need to be considered to evaluate if NZ could cost-effectively meet its reduction targets. Hence, the purpose of this paper is to estimate the economic costs derived from the commitment under the PA when the mitigation potential relies on pricing/not pricing agricultural emissions and linking/not linking the NZ Emissions Tradable Scheme (NZ ETS) to international markets of emissions permits.

To estimate the economic impacts we use the Climate and Trade Dynamic General Equilibrium (CliMAT-DGE) model developed by Landcare Research, NZ. We first develop emissions pathways consistent with holding the increase in the global average temperature below 2ºC above pre-industrial levels. We simulate 8 scenarios where we allow pricing/not pricing agriculture emissions, and linking/not linking the NZ ETS to Australia (AUS), the European Union (EU), and the United States (US). We found that for 2030, NZ is capable of meeting the reduction targets in the PA terms; however, negative impacts occur on Gross Domestic Product (GDP) and welfare. Impacts are mitigated if agriculture emissions are priced and if the NZ ETS is linked to Australia or the US emissions markets. Because of competitiveness effects, linking to the EU emissions market may not be advantageous compared to keeping the NZ ETS unlinked.

The paper is structured as follows: section 2 describes the modelling approach, section 3 presents the results, section 4 discusses our results in the light of previous research and current NZ political context, and section 5 concludes.

2. Modelling Approach

In the following, we present the quantitative framework of our economic analysis. We first introduce the modelling approach and then the scenarios for simulation.

2.1 Climate and Trade Dynamic General Equilibrium (CliMAT-DGE)

CliMAT-DGE is a multiregional, multi-sectoral, forward-looking dynamic general equilibrium model with a relatively long time horizon of 100 years or more (Fernandez and Daigneault 2015). This model is suited to studying the efficient (re) allocation of resources within the economy and over time in response to resource or productivity shocks. CliMATDGE primarily uses the Global Trade Analysis Project (GTAP) version 8 dataset. The base year of the benchmark projection is 2007. The model then develops a benchmark projection of the economic variables and GHG emissions, and simulates scenarios to evaluate the impacts of mitigation policies. Based on long-run conditions and constraints on physical resources, which restrict the opportunity set of agents, the model predicts the behaviour of the economy, energy use, and emissions by region and sector (Fæhn et al. 2013). CliMAT-DGE is coded using the Mathematical Programming System for General Equilibrium (MPSGE) package in GAMS (Rutherford 1999).

The sectors covered in this study are listed in Table 1. Coal, oil, gas, petroleum refining, renewable electricity and fossil electricity sectors are defined as separate sectors. Renewable and fossil electricity generation sectors are disaggregated from the single electricity GTAP sector. All production sectors are modelled using nested Constant Elasticity of Substitution (CES) production functions, which capture the potential substitution between production technologies. The nesting structure in CliMAT-DGE partly follows Paltsev et al. (2005).

Table 1: CLIMAT-DGE Aggregated GTAP Production Sectors

Primary production sectors	Secondary energy sectors
Grains including rice (GRA)	Coal (COA)
Other crops (CRO)	Oil
Oil seeds and sugar cane (OSC)	Gas
Plant based fibres (PFB)	Petroleum, coal products (P_C)
Cattle, sheep and goats, horses (CTL)	Fossil electricity (EFS)
Raw milk (RMK)	Carbon-free electricity (ECF)
Forestry (FST)	
Logs (LGS)	
Manufacturing and Value-added sectors	
Food products: meat products, dairy, oils, rice, sugar, beverages and tobacco (FOO)	
Harvested wood products (HWP)	
Energy-intensive manufacturing (EMT)	
Non-energy-intensive manufacturing (NSV)	
Transport (TPT)	

Model dynamics follow a forward-looking behaviour where decisions made today about production, consumption and investment are based on future expectations (Fernandez and Daigneault 2015). The economic agents have perfect foresight and know exactly what will happen in all future periods of the time horizon. Thus, households are able to smooth their consumption over time so that the savings rate varies endogenously. As expectations about the future affect current behaviour of agents, the forward-looking approach adds flexibility to adjust savings and consumption over time to partially mitigate the negative impacts of an environmental policy in the short run (Babiker et al. 2008; Dellink 2005).

The supply of labour in each region is undifferentiated by skill level and exogenously specified as part of the baseline scenario. We assume a full employment model closure, where a shock to the economy causes wages and rents to adjust until the fixed supply of each factor is again fully employed (Burfisher 2011). An exogenous growth of labour supply is assumed to reflect increases in the population and more efficient use of labour due to improving technology. Similarly, the supply of land and natural resources are assumed to be fixed in each period. Rents vary accordingly to keep full employment (Fernandez and Daigneault 2015).

The representative household chooses its path of consumption versus saving to maximize the discounted value of the utility attained from consumption in each period subject to an income constraint. This constraint implies that the present value of all future changes in a region's current account balance must be zero. Any region may run a current account surplus or deficit in any period but (i) global savings must equal global investment and (ii) the present value of a region's current and future surpluses must equal the present value of its current and future deficits (Fernandez and Daigneault 2015). International assets positions, financial stocks, and flows of financial assets are not explicitly modelled. Thus, while a current account deficit is financed by a capital account surplus, we cannot say anything about the composition of the capital account.

Carbon sequestration from forestry, and carbon capture and storage (as backstop technology) were both acceptable forms of GHG emissions reductions for all policy scenarios. For further technical details see Fernandez and Daigneault (2015).

2.2 Policy Scenarios

CliMAT-DGE develops a baseline scenario where the global economy is projected from the base year of 2007 to 2082 in the absence of mitigation policies for climate change. The impacts of the PA terms are analysed in terms of deviations (or percentage changes) of the variables of interest relative to the baseline.

To simulate the PA terms (GHG reduction targets), we imposed caps to the baseline emissions pathways so that they followed trajectories consistent with temperature increases of 2°C by 2100. Simulation scenarios are constructed around pricing/not pricing agricultural emissions, and linking/not linking the NZ ETS to other emissions markets (Australia, EU, US). The scenarios investigate the possibilities for

NZ to find cost-effective means to meet the reduction targets. The background of the scenarios relies on NZ being in a unique position as a developed country because of its unusual emissions profile. Agricultural non-carbon dioxide emissions (e.g. methane and nitrous dioxide) make up about half of New Zealand's gross emissions, and a large share of electricity generation (80%) comes from renewable (carbon-free) sources (Ministry for the Environment 2015). Thus, severe limits may arise if mitigation relies only on input substitution and domestic abatement. Hence, NZ may need to affect agriculture emissions to meet its reduction targets (Kerr and Sweet 2008). On the other hand, linking to other emissions markets means that permits allocated in a domestic ETS can be used for compliance with policies in a non-domestic ETS (Gruell and Taschini 2012). Linking may be a cost-effective alternative to climate change mitigation (Alexeeva and Anger 2015; Babiker, Reilly, and Viguier 2004), compared with a fragmented approach, under which a number of regions would meet their emission reduction objectives in isolation (Dellink et al. 2010).

3. Simulation Results

This section presents the simulation results of the environmental, macroeconomic and competitiveness impacts of meeting the reduction target. We report the effects of the PA terms on emissions abatement, purchase of permits (Section 3.1), the associated macroeconomic impacts (Section 3.2), and the competitiveness effects (Section 3.3). As a baseline we take as focal year 2030 where GDP reaches NZ$ 349.3 billion, aggregate consumption is NZ$ 15.12 billion, terms of trade are 1.023, and greenhouse gas emissions are 94.4 MtCO2e.

3.1 Impacts on emissions market

The effects on domestic abatement and the import of permits are presented in Table 2. If agriculture emissions are priced, the permits price resulting from a non-linked NZ ETS amounts to NZ$276 per ton of CO2e, and linking to the EU decreases the permit price to NZ$213 per ton of CO2e. This decrease implies that sectors in the EU exhibit high marginal abatement cost levels compared to NZ. Even more, linking to Australia or the US decreases the permit price to NZ$82 and NZ$60 per ton of CO2e, respectively, which signals the relatively lower abatement cost levels compared to NZ.

If agriculture is not priced and the NZ ETS remains unlinked, permits price reaches almost NZ$3,000 per ton of CO2e. Linking to the EU or Australia significantly decreases the price to NZ$249 and NZ$212 per ton of CO2e, respectively, and further linking to the US decreases the price to NZ$65 per ton of CO2e. These results show that even if a large sector, such as agriculture, is not priced, market linking adds flexibility for the priced sectors in order to meet the reduction targets. That is, even if the emissions permits market is constrained to non-agriculture sectors only, linking to the US alleviates pressure on priced sectors and partially offsets the stringency of the reduction targets.

The reduction target for NZ in 2030 is 34.9 $MtCO_2e$.

Table 2 shows that NZ can meet this target; however, the mechanism differs across scenarios. If agriculture is priced, more than half of the mitigation effort comes from the import of permits when linked to Australia or the US, whereas mitigation from the import of permits from the EU is relatively low because of the higher permit price. In turn, if agriculture is not priced, import of permits from the EU should occur, despite the high price, because relying only on domestic abatement is more costly. Also, permits represent more than half of the mitigation effort if the NZ ETS is linked to AUS or US. Thus, results show that not pricing agriculture creates a highly constrained environment where NZ relies on a small number of sectors to meet reduction targets. However, as linking becomes available there is an offsetting effect because the permits prices are always lower than in any of the non-linking scenarios.

Table 2: Environmental impacts of alternative policy scenarios in 2030

	NZ ETS not linked	NZ ETS linked to AUS	NZ ETS linked to EU	NZ ETS linked to US
	Permits price (in $NZ per ton of CO_2e)			
Agriculture priced	276	82	213	60
Agriculture not priced	2914	212	249	65
	Emissions abatement and import of permits ($MtCo_2e$)			
	Agriculture priced			
Domestic abatement	34.90	12.33	29.41	9.00
International permits	0	22.32	5.41	26.18
	Agriculture not priced			
Domestic abatement	34.90	13.71	15.73	8.90
International permits	0	20.70	19.09	26.29

3.2 Macro economic impacts

From a general equilibrium perspective, the effects of climate change policies surpass those of the emissions market (Alexeeva and Anger 2015). The terms of the PA induce adjustments of production and consumption patterns towards less carbon intensity and associated energy use. The particular features to consider for NZ are that agricultural noncarbon dioxide emissions (e.g. methane and nitrous dioxide) make up about half of the country's gross emissions, and a large share of electricity generation (80%) comes from renewable (carbon-free) sources (Ministry for the Environment 2015; Kerr and Sweet 2008). Thus, the interaction between pricing agricultural emissions and linking the NZ ETS to other markets leads to differential impacts on GDP and welfare.

If agriculture is priced,

Table 2 shows that linking the NZ ETS to Australia or the US moderates the negative GDP impacts, whereas linking to the EU would lead to a 3.8% decrease below the baseline. That is, the EU may not be a good match for the NZ ETS because of the significantly different sizes of both economies, likely distortions in the permit trade (Doda and Taschini 2015), the EU's own commitment to reduction targets, and high marginal abatement costs in the EU which lead to a high permits price. On the other hand, if agriculture is not priced and the NZ ETS remains unlinked, GDP decreases by 7.3% below the baseline. However, linking adds flexibility to non-primary sectors as the GDP impact is lower across all linking scenarios.

Table 2 also shows that if agriculture is priced, welfare increases for NZ across all linking scenarios. These increases result from the lower import prices for food commodities, increases in the domestic production of petroleum commodities, and the combined mitigating potential of pricing agricultural emissions and international linking of the NZ ETS. In turn, if agriculture is not priced, welfare decreases mainly because of losses in competitiveness in non-primary sectors.

Table 3: Macroeconomic impacts of alternative policy scenarios in 2030

	No linking	AUS linking	EU linking	US linking
	GDP Impact (% change with respect to baseline)			
Agriculture priced	-4.49	-1.41	-3.8	-0.88
Agriculture not priced	-7.3	-2.77	-2.93	-0.48
	Social welfare impact (in % of Hicksian Equivalent variation)			
Agriculture priced	0.98	0.41	1.04	0.44
Agriculture not priced	-2.51	-4.98	-4.9	-0.85

3.3 Effects on international competitiveness

We evaluate economy-wide competitiveness effects, measured by changes in the terms of trade (ToT), and sectoral impacts through the Revealed Comparative Advantage (RCA) indicator. The RCA examines the export specialization pattern and compares the trade performance of an economic sector with the performance of all sectors within the region (Balassa 1965; Malmberg and Maskell 2007).

Table 4 shows that, if agriculture is priced, NZ faces ToT gains when the NZ ETS is unlinked or linked to the EU, whereas losses occur when the NZ ETS is linked to Australia or the US. In turn, if agriculture is not priced, all linking schemes lead to competitiveness losses, whereas gains occur if the NZ ETS remains unlinked. Hence, although linking the NZ ETS mitigates the negative impacts on GDP, it does not necessarily improve national competitiveness. Moreover, although permits prices are much lower for any of the linking scenarios, relative to the no linking scenario, this does not fully offset the negative effects of the stringency of the reduction targets given the effects import and export activities, costs of domestic production, and consumption (Alexeeva and Anger 2015).

To decompose the national competitiveness effects at the sectoral level we use the RCA indicator. If agriculture is priced, linking the NZ ETS to the US market improves the competitiveness of NZ primary sectors. Improvements are motivated by the higher exports of cattle products and grains. In turn, losses in the competitiveness of primary sectors occur if is the NZ ETS is linked to Australia or, to a greater extent, the EU. The losses are motivated by greater imports of food products. Competitiveness of non-primary sectors improves if the NZ ETS remains unlinked or is linked to Australia or the EU. Improvements are due mainly to export increases of oil products. On the other hand, if agriculture is not priced, primary sectors gain competitiveness across all linking scenarios, and even if the NZ ETS remains unlinked.

Competitiveness effects depend on the exposure of a sector to the world market. Agriculture in NZ is highly exposed to the world market but it may be also outside the NZ ETS. The percentage changes of the RCA show that, even when agriculture is not priced, the primary sectors are more responsive than the non-primary sectors inside the NZ ETS. Thus, agriculture is indirectly affected by the reduction targets inside the NZ ETS as well (Klepper and Peterson 2004).

Furthermore, linking the NZ ETS to other markets leads to negative distortionary or ToT effects that may outweigh the efficiency gains from enabling international emissions trade. However, the competitiveness effects may not be a result only of linking but also of the stringency of the reduction targets. In fact, if agriculture is priced and the NZ ETS is linked to Australia or the US, there is indeed a mitigation of the negative effects of reaching the target reductions compared to an unlinked NZ ETS.

Table 4: Competitiveness impacts of alternative policy scenarios in 2030

	No linking	AUS linking	EU linking	US linking
Terms of trade impacts (in % vs. Business as usual) for entire economy				
Agriculture priced	1.22	-2.43	0.08	-3.42
Agriculture not priced	9.30	-1.05	-0.81	-1.77
Relative comparative advantage (in % vs. Business as usual) for primary sectors				
Agriculture priced				
Primary sectors	-10.01	-0.11	-7.76	0.25
Non-primary sectors	3.03	0.03	2.35	-0.08
Agriculture not priced				
Primary sectors	13.05	5.35	2.62	1.22
Non-primary sectors	-3.9	-1.6	-0.8	-0.4

4. Discussion

The PA terms for NZ are ambitious and not free of controversy. Prior work has documented that meeting reduction targets or INDCs requires policy measures and, consequently, responses from economic sectors. The purpose of this paper is to estimate the economic costs derived from the commitment under the PA when the mitigation potential relies on pricing/not pricing agricultural emissions and linking/not linking the NZ ETS to international markets of emissions permits.

Prior research has focused on the effects on welfare and competitiveness of ETS linking, both from a global perspective and for the largest economies or contributors to GHG emissions. Alexeeva and Anger (2015) find that while EU Member States improve their terms of trade by integrating the EU ETS with other emerging ETS, non-EU linking candidates face competitiveness losses. Lanzi et al. (2013) show that in the global climate mitigation scenarios presented in the OECD Environmental Outlook to 2050, macroeconomic and sectoral competitiveness impacts are the largest when ETS are not linked and the stringency of mitigation action varies substantially across countries. Linking can thus smooth distortions across the countries taking action on climate change (Jaffe and Stavins 2007). In this paper we found that linking the NZ ETS to Australia or the US mitigates the negative impacts of the PA terms and, if agriculture is priced, welfare increases for the representative household because of lower import prices for food products, and other increases in the domestic production of petroleum commodities. Furthermore, linking to Australia or the US may imply improvements in the competitiveness of primary sectors but detriment to nonprimary sectors.

The economic impacts of linking are dependent on the modelling assumptions and the regional and institutional context. Anger (2008) shows that in the presence of parallel government trading under a post-Kyoto agreement, linking the EU ETS to Canada, Japan and the former Soviet Union, can reduce EU compliance costs by more than 60%. Anger, Brouns, and Onigkeit (2009) show that benefits of linking depend on the stringency of targets, which in turn affect abatement efforts and compliance costs. We found that linking the NZ ETS to Australia and the US decreases permits prices given the differential abatement costs across the regions. However, linking to the EU leads to complex competitiveness effects that may operate against the efficiency principle of creating a larger pool for permits. Our results agree with McKibbin, Shackleton, and Wilcoxen (1999) as we demonstrate how NZ may become subject to falling terms of trade after engaging in international emission trading with the EU. Hence, although the creation of a larger carbon market leads to more players and allowances, and thus to higher liquidity, it may not particularly benefit smaller countries such as NZ (Flachsland, Marschinski, and Edenhofer 2009a, b).

Pricing agricultural emissions has a significant role on the impacts of the PA terms. Agricultural emissions are a large pool to distribute the burden of mitigation efforts and may alleviate the stringency of reduction targets. Not pricing agriculture is welfare decreasing and when linking the NZ ETS, the primary gains from trading may be outweighed by pre-existing distortions and market imperfections such as distorted agricultural and energy markets in the EU (Babiker, Reilly, and Viguier 2004). Furthermore, it is not known when NZ will set up its emissions profile after the PA comes into force. Although since January 2012, the agricultural sector has to report their emissions under the NZ ETS, currently there is no legislated date for when agricultural emissions will be priced under the ETS (Climate Change Information 2012).

We show results for 2030 as focal date for the reduction targets set by NZ. An extensive analysis for 2050 would be desirable, but technological and other developments increase uncertainty around the results or the behaviour of the model over such a long time span. However, CliMAT-DGE failed to find a numerical solution for the scenarios where simultaneously no linking is available and agriculture is not priced. In other words, it was infeasible for NZ to meet the PA beyond 2030 if these two alternatives were not available.

5. Conclusions

In this paper, we analysed the economic costs for NZ of meeting the PA terms. We introduced two issues that affect the likelihood of achieving the committed reduction targets, namely, pricing agricultural emissions and linking the NZ ETS to international permits markets. We found that linking the NZ ETS to Australia or the US is desirable given the relatively lower impacts on GDP. Linking to the EU instead leads to complex responses from the terms of trade, and competitiveness issues. Agricultural emissions play a significant role in meeting the PA, as they represent a large pool for emissions to distribute the burden of the mitigation effort. However, agricultural exports are a large share of NZ total exports, creating a high degree of exposure to volatility of international permits markets. The gains from NZ ETS linking and pricing agriculture are important, but an open research path is whether and how those gains can be reaped in reality, given implementation, design and transaction costs.

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