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Trade in Low Carbon Technologies:

The Role of Climate and Trade Policies

Samuel Pienknagura

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Trade in Low Carbon Technologies: The Role of Climate and Trade Policies
Prepared by Samuel Pienknagura*

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WORKING PAPERS

Trade in Low Carbon Technologies:

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Prepared by Samuel Pienknagura¹

¹ I thank Hasan Dudu, Zeina Hasna, Andrew Hodge, Florence Jaumotte, Amit Kara, Geoffrey Keim, Koralai Kirabaeva, Gregor Schwerhoff, and Nate Vernon for comments and suggestions. The views expressed in the paper are those of the authors and do not necessarily represent the views of the IMF, its Executive Board, or IMF management.

Trade in Low Carbon Technologies: The Role of Climate and Trade Policies *

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April 2024

Abstract

Curbing carbon emissions to meet the targets set in the Paris Agreement requires the deployment of low carbon technologies (LCTs) at a global scale. This paper assesses the role of climate and trade policies in fostering LCT diffusion through trade. Leveraging a comprehensive database of climate policies and a new database identifying trade in low carbon technologies and the tariffs applied to these goods, this paper shows that the introduction of new climate policies has a positive and significant impact on LCT imports. Zooming into specific climate policies, the paper finds that, except for non-binding ones, all climate policies stimulate LCT imports. The paper also highlights the role of trade policies as an engine of LCT diffusion—reductions in tariffs applied on LCT goods have a sizeable impact on LCT imports. On the flip side, results suggest that more protectionist measures would impede the spread of low-carbon technologies.

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1 Introduction

Curbing greenhouse gas (GHG) emissions is a global priority in the fight against climate change and its adverse consequences for economic and financial stability. Key to this objective is the deployment of low-carbon technologies (LCTs) (Rogelji, Shindell, and Jiang 2018). The deployment of LCTs is especially important in emerging market and developing economies (EMDEs), which typically are not producers of LCTs and have much higher emissions per unit of output than advanced economies (see Capelle et al., 2023) and where the adoption of LCTs can result in substantial emission reductions (Glennerster and Jayachandran, 2023). Yet, policy and structural factors can affect the diffusion of LCTs across countries.¹ Much emphasis has been recently given to the importance of expanding climate-related finance (IMF, 2023a). Less is known, however, about the potential catalytic role that climate and trade policies can play in promoting LCT diffusion at a global scale.

This paper studies the role of climate and trade policies in boosting the diffusion of low carbon technologies (LCTs) through trade. Leveraging a comprehensive database of climate policies, and novel databases capturing the evolution of LCT trade and tariffs across countries, I estimate the dynamic impact of both changes in the number climate policies and in tariffs applied to LCT goods through the local projections method proposed by Jordà (2005).

I find that the introduction of new climate policies results in an increase in LCT imports, with effects peaking after four years. The estimated impacts are statistically and economically significant. A one standard deviation increase in the number of climate policies, which is roughly the number of policies introduced every three years by the average country, increases LCT imports by over 1 percent on impact, and by close to 2 percent after four years. Importantly, the impact of climate policies on LCT trade is almost four times larger in EMDEs, suggesting that climate policies can play an important role in helping EMDEs overcome their emissions gap relative to advanced economies. I also show that results are not driven exclusively by changes in one direction, as increases in the number of climate policies yield higher LCT imports while reductions depress them.

Trade policy also has a large impact on the deployment of LCTs through trade. An increase (reduction) in LCT tariffs equivalent to a one standard deviation of the year-on-year change in tariffs is estimated to lead to a reduction (increase) in LCT imports of over 5 percent on impact, and almost 10 percent at the peak after a couple of years. The estimated impact implies that if the average EMDE removed LCT tariffs completely, LCT imports would increase by 30 percent. Note that the shock considered is large—it is bigger than the average reduction in tariffs seen in the late 1990s, when trade liberalization was at its peak.

¹Budina et al. (2023) showed that structural reforms (governance, business deregulation, trade and capital account liberalization) help boost the share of renewable energy.

On the flipside, the large estimated impact of trade policy on LCT imports highlights the risks for LCT deployment of protectionism and of a more fragmented global economy.

Turning to the role of specific climate policies, as countries embark on the green transition, there is a growing debate about the optimal design of climate policy portfolios. Considerations such as a policy’s effectiveness, ease of implementation, and potential side effects, are at the center of this debate.² I find that all types of climate policies except those that neither have a budgetary impact on the government nor impose regulations on firms or consumers stimulate LCT imports, highlighting the importance of policies being binding in nature.

The results described above are robust to the use of alternative measures of climate policies, to additional specifications, and to an IV exercise tackling endogeneity concerns. Compared to other data sources, the climate policy database, which is the main source of climate policies in the analysis, is the most comprehensive in terms of both policies and countries covered. However, one limitation is that it does not capture the intensity of policies. To address this shortcoming, I re-estimate the main specification using the OECD’s environmental policy stringency (EPS) index, and find qualitatively similar results. Results are also robust to alternative specifications that control for oil prices and for future changes to climate policies. I also study the impact of climate and trade policies on LCT imports relative to GDP. Consistent with findings using real LCT values, I find that an increase in climate policies boosts LCT imports as a share of GDP, especially in the initial years. Reductions in LCT tariffs also stimulate LCT imports relative to GDP. Finally, I tackle endogeneity concerns through an IV exercise where the change in climate policies is instrumented with the distance-weighted change in climate policies in other countries. Endogeneity concerns may arise, for example, because countries may find it easier to expand their country policy portfolios when they expect an increase in imports of the goods that facilitate the green transition. Results from the IV exercise confirm the positive impact of climate policies on LCT imports, with the timing of impacts tracking closely those of the baseline exercise. Moreover, the estimated impact of climate policies on LCT trade is substantially larger compared estimates obtained in the baseline exercise.

This paper contributes to the growing literature on the impact of climate policies in promoting the diffusion of climate-related technologies. The definition of LCT trade stems from recent contributions by Pigato et al. (2020) and Howell et al. (2023). The

²For example, carbon prices can promote innovation in, and the adoption of, new low carbon technologies (Acemoglu et al., 2012; IMF, 2023b). However, carbon taxes typically face higher public resistance than other policies (Dabla-Norris et al., 2023). Meanwhile, subsidies, which have garnered attention after the passage of the US Inflation Reduction Act and the Green Deal Industrial Plan proposed by the European Commission, help tackle market failures that typically hamper the creation of new alternatives to fossil fuels and the diffusion of mature clean technologies, but can create distortions and cause retaliation across countries, especially when they do not comply with international trade rules.

scope of the paper is closely related to Bellelli and Xu (2022), who study the impact of climate policies, identified from the WTO’s trade policy review (TPR) and trade-related member notifications, on innovation and trade. As in the case of this paper, the authors find that climate policies have a positive impact on trade in environmental goods. This paper expands the analysis in Bellelli and Xu (2022) along three dimensions. First, I focus on the narrower concept of trade in low-carbon technologies, which are goods associated to “mitigation technologies” aimed at reducing GHG emissions (Howell et al., 2023). Second, this paper looks at a broader set of climate policies, not just those identified by the TRP and trade-related notifications by WTO members, which allows to get a fuller understanding of how the introduction of new climate policies affects trade in key products. Finally, I complement the analysis of the impact of climate policies with an assessment of how imports of LCT goods are impacted by the tariffs applied to them.

More broadly, the paper contributes to the discussion about the economic impact of climate policies and potential complementarities with other policy levers. The literature has pointed to the positive long-term benefits of climate policies, especially through their impact in reducing climate disasters (Acemoglu et al., 2012; Fernandes et al., 2021). Climate policies have also been found to foster green innovation, which can also lead to positive medium-term economic dividends (Eugster 2021; Battarelli and others 2023, Hasna et al., forthcoming). Empirical assessments of the economic impact of climate policies have found mixed results: some studies find either zero or small positive impacts of reforms implemented in Europe (Barker et al., 2009; Enevoldsen, Ryelund, and Andersein 2009; Metcalf and Stock 2020) and North America (Murray and Rivers 2015; Bernard and Kichian 2021; Metcalf 2019), and others find negative impacts (Kanzig and Konradt 2023). This paper sheds light on one potential channel through which climate policies can support economic activity—namely by stimulating trade in low carbon technologies. Moreover, as show by the results on tariffs, the positive impact of climate policies on trade can be amplified when complemented with policies that lower trade costs.

The rest of this paper is organized as follows. Section 2 discusses the data and econometric strategy used in the analysis. Section 3 presents the baseline results as well as extensions and robustness exercises. Finally, Section 4 concludes.

2 Data and Econometric Approach

This section describes the data sources and econometric strategy used in Section 3. Additional details about specific variables constructed for the analysis are presented in Annex A.

2.1 Data

LCT Trade data: Data on LCT trade comes from the IMF’s climate change dashboard.³ The database reports the dollar value for each country-year pair. Values are deflated using the US’ CPI deflator. The dashboard defines LCT products as those that ”produce less pollution than their traditional energy counterparts, and will play a vital role in the transition to a low carbon economy”. They include equipment like wind turbines, solar panels, biomass systems and carbon capture equipment. Aggregate LCT imports are constructed by using the classification presented in Howell et al. (2023). These comprise 124 5-digit HS codes (2017 vintage), and data are extended to construct country-level series dating back to 1994. LCT goods comprise a subset of ”environmental goods” (OECD/Eurostat, 1999).⁴

As shown in Figure 1, after slowing in the aftermath of the global financial crisis, LCT imports recovered their dynamism since 2016, in the aftermath of the Paris Agreement, especially when measured as a share of total imports (Panel B).⁵ This pattern is seen across regions, but is particularly evident in high-income countries. Notably, low-income countries, which started far behind high- and middle-income countries in terms of LCT imports in the early 2000s, both as a share of GDP and total imports, closed most of that gap by 2015 when looking at LCT imports as a share of total imports. Middle-income countries such as China, Mexico, and Vietnam stand out for their high share of LCT imports (see Hasna et al., 2023).

Climate Policies: Data on climate policies come from two sources. The main source is the Climate Policy Database (CPD)⁶, which provides the most comprehensive international dataset on climate policies, although it is not exhaustive (see Nascimento, 2021 and Linsenmeier, Mohommad, and Schwerhoff, 2022). The dataset is based on other international datasets, reports and country-specific documents, and it incorporates a variety of other popular datasets covering climate policies (or in some cases more broadly environmental policies), such as the Climate Change Laws of the World and the Organisation for Economic Co-operation and Development (OECD) policy instruments database. The dataset can generally be considered complete for G20 economies (including EU member countries that are individual members of the G20, but not other EU members) and 18 other countries, and also includes advanced and emerging economies in Europe, Asia and Latin America and some less-developed countries.

As in Linsenmeier, Mohommad, and Schwerhoff (2022), I only include policies that

³<https://climatedata.imf.org/>

⁴Environmental goods are defined as both goods connected to environmental protection, such as goods related to pollution management and resource management, and adapted goods, which are goods that have been specifically modified to be more ”environmentally friendly” or ”cleaner.”

⁵All Figures are presented in Annex C.

⁶<https://www.climatepolicydatabase.org/>

have climate change mitigation as one of their objectives (roughly 93 percent of policies). EU policies are applied to each member country's policy portfolio. If a country became a member after the policy was decided in the EU, the date of policy adoption is the year of joining the EU. I exclude sub-national policies, which may contaminate results.

The main variable of interest will be the change in a country's total number of active climate policies (in some exercises we also explore the impact of changes in subset of policies). One limitation of the CPD is that it does not contain information about the stringency of a country's climate policy portfolio. Given this, I also employ the OECD's environmental policy stringency index (EPS), which has a more limited country, sectoral, and instrument coverage compared to the CPD, but captures the intensity of policies, as a robustness exercise.⁷

Every policy in the CPD carries information on policy objectives, administrative level, and instrument types. Using this information, policies are classified based on their impact on the government's budget. In particular, I create four categories: (i) policies that generate revenue (such as carbon taxes or schemes capping emissions), (ii) policies that generate expenses (e.g., R&D subsidies or feed-in-tariffs), (iii) regulations with no budget impact, and (iv) nonregulatory budget neutral policies (e.g., national strategies, voluntary emission restrictions). Additional details of the classification are found in Annex A.

Countries have introduced climate policies to address the challenges of climate change. This process accelerated in high-income countries following the Kyoto Protocol and the third Intergovernmental Panel on Climate Change (IPCC) assessment report. Around the time of the fourth assessment report the process sped up in middle-income and low-income countries, but there are still noticeable differences in the number of policies per country across income groups (Figure 2, Panel A). There are also notable differences in the composition of climate policy portfolios across income groups. Figure 2, Panel B, shows that although budget-neutral measures are the most common in all countries, almost one-fifth of policies in advanced economies generate government expenditure (compared with over 15 percent and 10 percent in middle-income and low-income countries, respectively). This may reflect greater fiscal space in advanced economies. In addition, revenue-generating measures are used more frequently in advanced economies and, to a lesser extent, in middle-income countries. This may reflect the more advanced stage of climate policies in these countries (Linsenmeier, Mohommad, and Schwerhoff, 2022).

LCT tariffs: Tariffs applied on low carbon technologies (LCT) goods, as defined in Howell et al. (2023), are constructed using tariff information from UNCTAD's Trade Analysis

⁷For the latest EPS update see Kruese et al. (2022) The latest update of the EPS index consists of three equally-weighted subindices, which respectively group market based (e.g. taxes, permits and certificates), non-market based (e.g. performance standards) and technology support policies, and quantifies the intensity of environmental regulations in a way that is comparable across countries and over time.

Information System (TRAINS). In particular, I map HS codes to the LCT classification in Howell et al. (2023) and construct a country pair-year trade-weighted average applied tariff for LCT goods, by applying either the preferential or MFN tariff depending on the status of the country pair on a given year.⁸ Next, I aggregate information at the importer country-year level by constructing a trade-weighted average.

Figure 3 shows the average applied tariff for LCT goods and other goods across income groups for three periods—before the global financial crisis (2000-07), after the global financial crisis and before the Paris Agreement (2010-15), and after the Paris Agreement (2015-21). Three patterns emerge. First, across income groups, LCT goods typically face lower tariffs. Second, tariffs are noticeably higher on average in middle- and low-income countries than in high-income countries for all goods, including LCT goods. Finally, progress in terms of tariff reductions has stalled in recent years (LCT applied tariffs have actually increased).

Additional country-level macroeconomic variables: Data on country-level variables come from two sources. Real GDP come from the Penn World Tables, version 10.1. Data on average applied tariffs come from the World Bank’s World Development Indicators (WDI).

The full set of countries used in the analysis is listed in Table 2 in Annex B.

2.2 Econometric Approach

To study the impact of climate policies and LCT tariffs on LCT imports, I follow the local projection method proposed by Jordà (2005). The method has the advantage that it does not constrain the shape of the impulse response functions. The benchmark specification is as follows:

$$m_{i,t+h} - m_{i,t-1} = \alpha_i^h + \beta^h \Delta CP_{i,t} + \gamma^h \Delta \tau_{i,t}^{LCT} + \sum_{j=1}^2 \omega^h X_{i,t-j} + \varepsilon_{i,t+h} \quad (1)$$

where $m_{i,t+h}$ is the natural logarithm of real LCT imports in country i at time $t + h$; $h = \{0, 1, 2, 3, 4\}$ is the horizon after the shock, $\Delta CP_{i,t}$ is the year-on-year change in the count of climate policies in country i in year t , $\Delta \tau_{i,t}^{LCT}$ is the year-on-year change of the average applied tariff on LCT goods, and $X_{i,t-j}$ is a vector of controls that includes two lags of the change in LCT imports, and two lags of the year-on-year changes in climate policies, LCT tariffs, and non-LCT tariffs. The inclusion of these additional controls aims at taking into account past dynamics of our variables of interest, which may be important determinants of current values. As in Bettarelli et al. (2023), I also include a country-specific time trend

⁸Note that for a given year, some countries report tariff data using multiple HS vintages. In such cases, I took the most recent vintage.

aimed at capturing secular changes in LCT imports and policies at the country level. The two lags follows the rule of thumb proposed by Chudik and others (2016) to minimize omitted variables and endogeneity concerns. I reassess these issues through an instrumental variables (IV) approach described below. The focus will be on β^h and γ^h , which track the impact of the climate policy shock and the tariff shock.

To study the impact of specific climate policies, I extend the specification in (1) as follows:

$$m_{i,t+h} - m_{i,t-1} = \alpha_i^h + \sum_{p \in P} \beta_p^h \Delta CP_{i,t}^p + \gamma^h \Delta \tau_{i,t}^{LCT} + \sum_{j=1}^2 \omega^h X_{i,t-j} + \varepsilon_{i,t+h} \quad (2)$$

where $\Delta CP_{i,t}^p$ is the year-on-year change of climate policy type $p \in \{\text{revenue, expenditure, regulations, non - regulatory}\}$.

Beyond levels, I also estimate the impact of climate policies and tariffs on LCT imports as a share of GDP. I do so by extending equation (1) in two ways. First I replace the left-hand side variable of (1) with the LCT imports to GDP ratio at different horizons. I also take the log difference between real LCT imports and real GDP as the left hand side variable. In both cases, I include lags in the log difference of real GDP as additional controls.

3 Results

In this section, I present the estimated effects based on equations (1) and (2). I begin by presenting the baseline estimates of the impact of climate and trade policies on LCT imports. Then I explore heterogeneity in the impact of the variables of interest on LCT imports across income levels and policy instruments. Next, I study the robustness of results to the use of alternative climate policy metrics. I also present results for an instrumental variables exercise where climate policies are instrumented with a distance-weighted measure of policies in other countries. Finally, I further explore the link between policies and LCT imports by presenting estimates using the share of LCT imports over GDP as the left-hand side variable.

3.1 Baseline Results

Figure 4 presents the baseline estimates of the local projections described in equation (1). As can be seen, changes in climate policies have a positive and economically meaningful impact on LCT imports. A one standard deviation change in climate policies, which is equivalent to the number of policies introduced by the average country every three years, increases LCT imports by 1.3 percent on impact, and the effect peaks at 2 percent four years

after the policy change. The increase of LCT imports after the introduction of new climate policies may reflect the fact that action on the environmental policy front increases demand for LCT goods (Bellelli and Xu, 2022).

Next I turn to the impact of trade policy. Figure 5 shows the evolution of real LCT imports in the aftermath of an increase in tariffs applied to LCT goods. Note that we are assuming the effects are symmetric, such that the impact of a reduction in tariffs would be the mirror image of Figure 5. The estimates imply that a one standard deviation increase (reduction) in LCT tariffs would result in a reduction (increase) in LCT imports of over 5 percent on impact, with a peak effect of almost 10 percent after two years. Effects are short-lived, however; LCT imports return to pre-shock levels in the medium-term. Note that this is a large shock—it is bigger than the average reduction in tariffs seen in the late 1990s, when trade liberalization was at its peak.

3.2 Heterogeneity by Income Group and Policy Instrument

So far I have shown evidence of the impact of policies on the average country in the sample. However, for climate and trade policies to serve as a conduit for the diffusion of LCTs, it is important that these effects are present for middle- and low-income countries. Yet, as argued in Pigato et al. (2020), weak fundamentals (such as low human capital or weak rule of law) could hamper low- and middle-income countries’ ability to leverage climate policies to boost LCT deployment, including through trade. Against this backdrop, I explore if such constraints to LCT deployment are present in data.

To gauge whether the impact of climate and trade policies on LCT imports varies by income groups, Figures 6 and 7 plot the estimates from equation (1) for an exercise where we split the sample based on the World Bank’s income level classification into high-income countries and middle/low-income countries. As shown in Figure 6, additional climate policies and tariff reductions stimulate LCT imports in both high-income and middle/low-income countries. However, there are differences between the two income groups in the magnitude and the timing of impacts, especially in the case of climate policies. For an increase in climate policies of equal magnitude, the impact in low/middle-income countries is four times as large compared to that seen in high-income countries, and the impact is more immediate. In the case of tariffs, responses are similar between the two income groups (Figure 7).

Next we study another potential source of heterogeneity, namely differences in the impact of different climate policies. Zooming into this dimension of heterogeneity is important given the recent debate about both the appropriateness of subsidies in recently passed climate policy packages in key advanced countries and the support for and perceived economic

impact of carbon taxes and other climate policies (see for example, Dabla-Norris, 2023). As argued in Section 2, we separate climate policies according to their impact on a government’s budget balance into revenue creating measures, expenditure measures, regulations, and non-binding policies.⁹ The latter are policies such as self-imposed emission targets at the firm or industry level, or the introduction of national climate strategies. Importantly, results assessing the impact of different policies should be viewed as qualitative, given data shortcomings. As discussed, CPD data, while comprehensive in its coverage of policies and countries, does not capture intensity nor the impact of policies on emissions. This makes it difficult to compute shocks to policy subcategories that can be interpreted as of similar magnitude (for example, from an emissions-reduction perspective), thus complicating the comparison across policy instruments. Our results, therefore, give a good indication of the direction of the relationship between policy subcategories and the variable of interest but do not provide an accurate comparison of the magnitude of effects across instruments.

Figure 8 shows the impact of each policy type on LCT imports. Results suggest that expenditure and revenue measures lead to a gradual increase in LCT imports. Regulations also lead to an increase in imports, albeit the effect is short-lived. Non-binding policies, on the other hand, if anything have a negative impact. Thus, the evidence points to the importance of binding constraints in fostering diffusion through trade.

3.3 Extensions and Robustness Exercises

Next I check whether the results presented earlier are robust to the use of alternative climate policy indices. In particular, I explore the robustness of the results to the use of a commonly used index—the environmental policy stringency (EPS) index. The EPS has the advantage that it captures the stringency of policies, which the CPD does not. The downside, however, is that it has a more limited country and policy coverage.

Figure 9, Panel A, shows the impact of a one standard deviation increase of the EPS on LCT imports. As shown, LCT imports increase gradually in the first few years following the increase in stringency, with effects peaking after about three years. After that, LCT imports decline to pre-shock levels. For comparability with previous charts, Figure 9, Panel B, shows the response of LCT imports to the CPD shock for the sample of countries that have information on the EPS. As expected, the magnitude of results is close to the one found for high-income countries, given that the EPS mostly covers OECD countries. (Figure 7). The shape of the response, on the other hand, resembles the one found using the EPS, namely a rise in LCT imports in the initial years, followed by a decline to pre-shock levels in the outer years, thus highlighting the robustness of our previous results.

⁹Annex A provides details on the classification

I turn to studying whether the impact of climate policies on LCT is affected by changes in the controls included in (1). As shown in Figure 10, Panel A, the inclusion of oil prices, which affects incentives to invest in green projects (Hasna et al., 2023), does not affect the estimated effect of climate policies on LCT trade, albeit it does reduce the precision of the estimates. Next, we present two variants of (1)—one where we exclude tariffs and one where tariffs are introduced in levels (as opposed to changes). As shown in Panels B and C, the effects of climate policies on LCT trade is not affected by these modifications. The exclusion of tariffs increases slightly the estimated coefficients, but they fall within the confidence interval of the baseline estimates. Finally, Panel D shows results of an exercise that controls for changes in climate policies from period t to period $t + h$. As discussed in Teulings and Zubanov (2014), excluding future shocks may bias the estimates of the dynamic response of the dependent variable to contemporaneous shocks. Panel D shows, that if anything, the dynamic response of LCT trade to change in climate policies in t is stronger when controlling for future changes in policies. All this suggests that the results in 10 are robust to these alternative specifications.

Figure 11 explores potential asymmetries in the response of LCT trade to increases and decreases in climate policies and tariffs. To do so, I extend the baseline econometric specification by allowing the coefficients β and γ to differ depending on whether climate policies and tariffs increase or decrease. Findings suggest that, as expected, an increase in climate policies boosts LCT imports, while a reduction hampers them (Panel A). Note that the estimated impact of improvements in climate policies is lower compared to the impact of decreases, but it is statistically and economically significant. For tariffs, we find that the response of increases and decreases is largely symmetric (Panel B). These results show that the baseline results are not driven exclusively by movements in climate policies and tariffs in one direction.

An additional concern about the results in the previous section regards the endogeneity of climate policies. In particular, it is plausible that countries are more likely to expand their climate policy portfolios when they expect an increase in imports of the goods that facilitate the green transition.

To address endogeneity concerns, Figure 12 presents results of an IV exercise where the change in climate policies is instrumented with the distance-weighted change in climate policies in other countries. The assumption behind the strategy, which was previously used in Acemoglu et al. (2019), David, Komatsuzaki, and Pienknagura (2022) and Hadzi-Vaskov, Pienknagura, and Ricci (2023), is that policy changes occur in regional waves, and that the impact of policy changes abroad affects the outcome of interest mostly through the effect it has on domestic policy choices. Results confirm the positive impact of climate policies on LCT imports—a one standard deviation increase in climate policies bolsters

LCT imports, with effects peaking after four years. As is common in the literature, the effect is significantly larger than the OLS estimates (see for instance, Acconia, Corsetti, and Simonelli, 2014). The larger IV coefficients may reflect anticipation effect, whereby the expectation of future policy changes leads agents to boost their LCT imports before changes in climate policies materialize. This would dampen our estimates. In addition, compared to OLS, IV is capturing a local treatment effect (as opposed to an average treatment effect), since we are only capturing the response of countries that see changes in climate policies in nearby countries. Regardless, this result further reassures the robustness of the results of the paper.

Finally, I check whether the increase in LCT imports also holds as a share of GDP. To do so, I estimate equation (1) now using the ratio of LCT imports over GDP and the log difference between LCT imports and GDP. As with levels, an increase in the number of climate policies leads to a rise in LCT imports as a share of GDP (Figure 13). Note that while the percentage point increase in the LCT imports is relatively small (Panel A), the increase is large when considering the percentage increase in the ratio. This reflects the fact that LCT imports account for a relatively small fraction of GDP. Effects, however, are only statistically significant in the first few years of the estimation. This suggest that climate policies lead to an initial acceleration in LCT imports, followed by an equal acceleration in activity. This is consistent with findings in Hasna et al. (forthcoming), who show that green innovation, which is positively affected by climate policies, can boost economic activity. Consistent with Figure 5, Figure 14 shows that increases (reductions) in tariffs applied to LCT products reduce (increase) LCT imports, with effects concentrated in the early years.

4 Conclusions

In addition to their essential direct role in curbing emissions and reducing the macro-critical risks associated with climate change, climate policies can play a key role as countries seek technology-based solutions to climate change. This paper shows that the introduction of new climate policies, especially those that affect governments' budgets (revenue and expenditure measures) and those imposing regulations, result in higher LCT imports, thus stimulating the diffusion of low carbon technologies across countries. Importantly, the impact of climate policies on LCT imports is highest in middle- and low-income countries, which typically do not produce these technologies, making diffusion particularly relevant.

Beyond climate policies, this paper stresses the importance of lowering the costs of LCT goods faced by middle- and low-income countries in order to facilitate their access to these technologies. Lowering tariffs, an important component of the cost of LCT goods, can yield a significant increase in LCT imports.

The results in this paper also highlight the risks for the fight against climate change from a more fragmented global economy. First, the result on the link between LCT tariffs and imports suggests that protectionist policies that increase the costs of LCT goods can have a detrimental impact on the pace of diffusion of LCTs. More broadly, climate policies that are not consistent with multilateral rules, such as those of the World Trade Organization, can result in slower LCT trade and in smaller global markets which hamper incentives to innovate (Hasna et al., 2023).

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A Classification of Climate Policies by their Impact on the Government’s Budget

In order to assess the impact of different policies on LCT imports, we map the different types of policies recorded in the climate policy database into those generating government revenue (e.g. taxes and tariffs), those generating expenses (e.g. subsidies and feed-in-tariffs) and those that are budget neutral. Among the latter, we distinguish between regulation, which typically impose compliance costs for users/firms, and those that are non-regulatory (e.g. self-imposed firm and sectoral targets). Table 1 provides the full list of policies and their classification.

Table 1: Classification of Policies by Impact on Governments’ Budget

CPD classification	Type of Policy by Impact on Government Budget
Direct investment; Funds to sub-national governments; Infrastructure investment; Demonstration projects; Research program; Technology development; Technology deployment and diffusion; Feed-in-tariffs or premiums; Loans; Grants and subsidies; Retirement premium; Tax relief	Expense
Removal of fossil fuels; CO2 taxes; Energy and other taxes; User charges; GHG emission reduction crediting and offsetting; GHG emission allowance	Revenue
Grid access and priority for renewables; Performance label; Institutional creation; Strategic Planning; Auditing; Codes and standards; Building Standards; Industrial air pollution standards; Product standards; Sectoral standards; Vehicle air pollution standards; Vehicle fuel-economy and emission standards; Monitoring; Obligation schemes; Other mandatory requirements	Neutral, regulations
Formal and legally binding climate strategy; Political and non-binding climate strategy; Procurement rules; Tendering schemes; Green and white certificates; Advise or aid in implementation; Information provision; performance label; Comparison label; Endorsement label; Professional training and qualification; Institutional creation; Strategic planning	Neutral, non-regulatory

Note: See Hasna et al. (2023) for further discussion.

B Sample Details

The analysis in the paper relies on data ranging from 1995 to 2019. We restrict the data to countries having at least 20 years of data. The sample consists of 121 countries—46 high-income countries and 75 middle- and low-income countries (see Table 2)

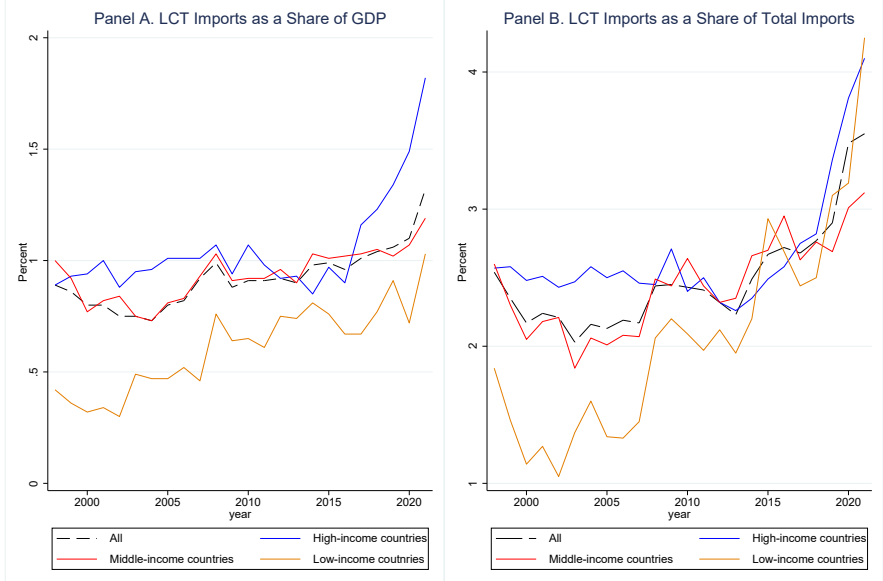
Table 2: Sample of Countries Used in the Analysis

3-digit ISO code	Income Level
AUS; AUT; BHR; BEL; BRN; CAN; CHL; HRV; CYP; CZE; DNK; EST; FIN; FRA; DEU; GRC; HUN; ISL; IRL; ISR; ITA; JPN; KOR; LTU; LUX; MLT; MUS; NLD; NZL; NOR; OMN; PAN; POL; PRT; ROU; SAU; SYC; SGP; SVK; SVN; ESP; SWE; CHE; TTO; USA; URY	High-income Countries
ALB; DZA; ARG; ARM; AZE; BLR; BLZ; BEN; BOL; BWA; BRA; BGR; BFA; BDI; CMR; CHN; COL; CRI; CIV; DOM; ECU; EGY; SLV; SWZ; ETH; FJI; GMB; GHA; GRD; GTM; GUY; IND; IDN; JAM; JOR; KAZ; KEN; KGZ; LBN; MDG; MWI; MYS; MDV; MLI; MEX; MNG; MAR; MOZ; NAM; NIC; NER; NGA; MKD; PRY; PER; PHL; RUS; RWA; WSM; SEN; ZAF; LKA; VCT; SUR; TZA; THA; TGO; TUN; TUR; UGA; UKR; VEN; VNM; ZMB; ZWE	Middle- and Low-income Countries

Note: Income level based on the latest World Bank definition.

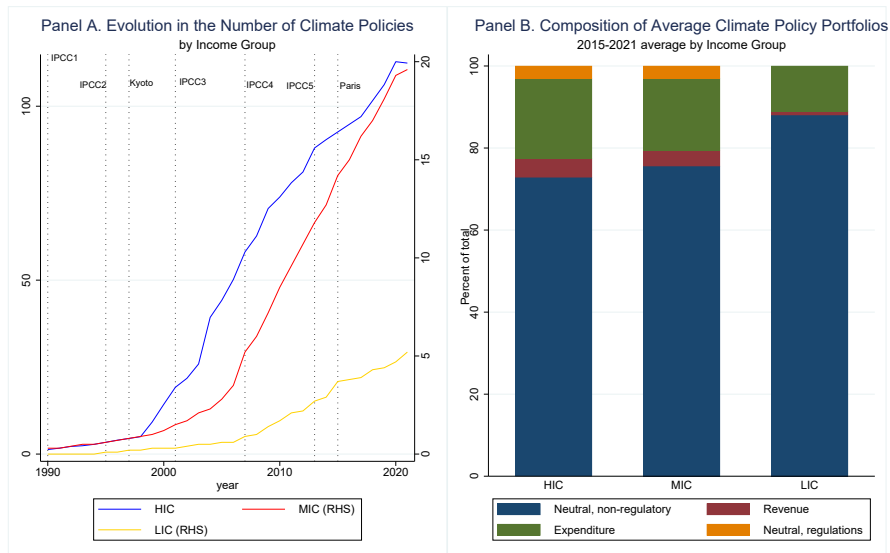
C Figures

Figure 1: Evolution of LCT Trade Across Income Groups



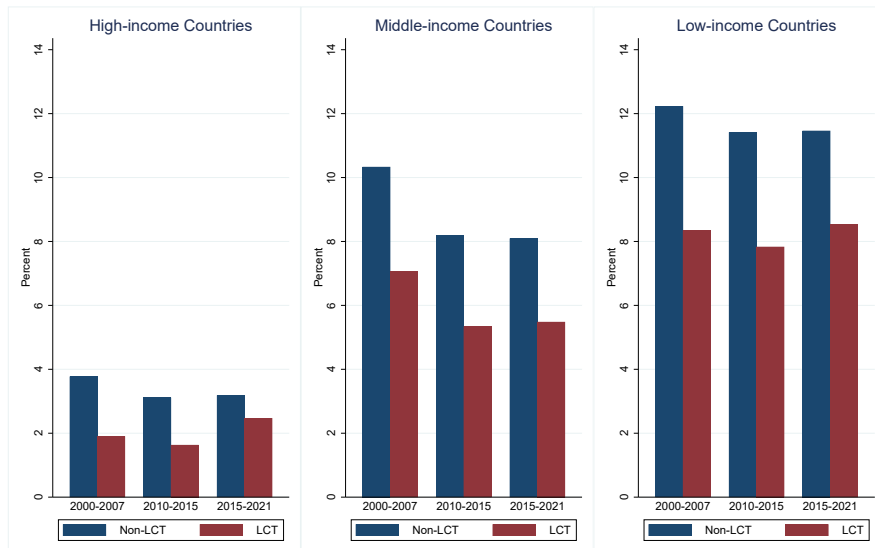
Source: Hasna et al. (2023) based on the IMF's Climate Policy Dashboard.
Note: Income groups are based on the World Bank's income classification.

Figure 2: Evolution and Composition of Climate Policies Across Income Groups



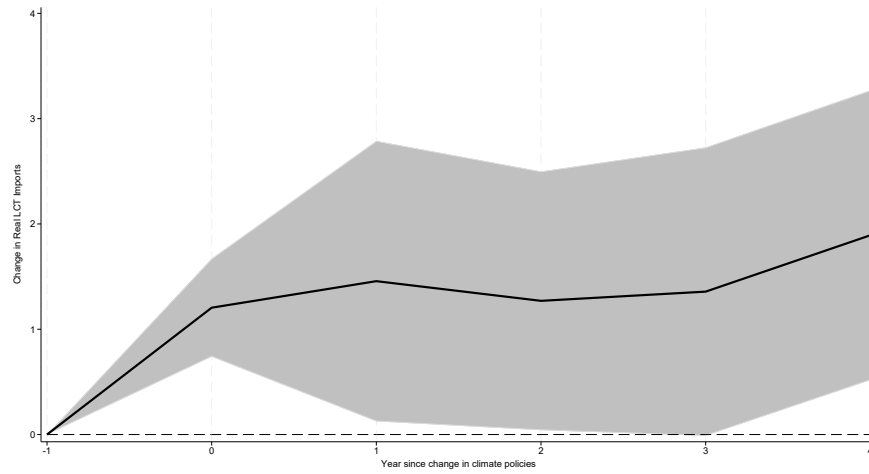
Source: Hasna et al. (2023) based on the Climate Policy Database.
 Note: Income groups are based on the World Bank's income classification. In Panel A, dashed lines mark the dates of key international climate policy milestones. HIC= High-income country; MIC= Middle-income country; LIC= Low-income country

Figure 3: Evolution of Applied Tariffs Across Income Groups



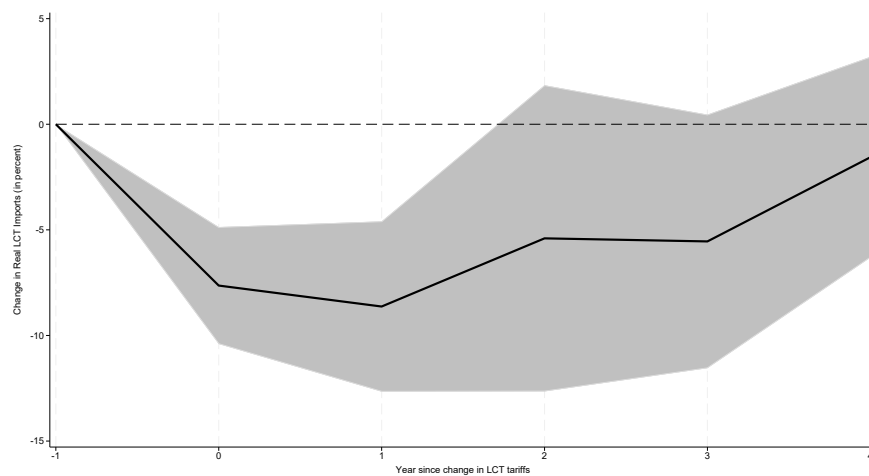
Source: Hasna et al. (2023) based on United Nations Conference on Trade and Development (UNCTAD) Trade Analysis Information System (TRAINS) database.
 Note: Bars show the simple average by income level of trade-weighted applied tariffs. Income groups are based on the World Bank's income classification.

Figure 4: Impact of an Increase in Climate Policies on LCT Imports
(response to a one st. dev. change)



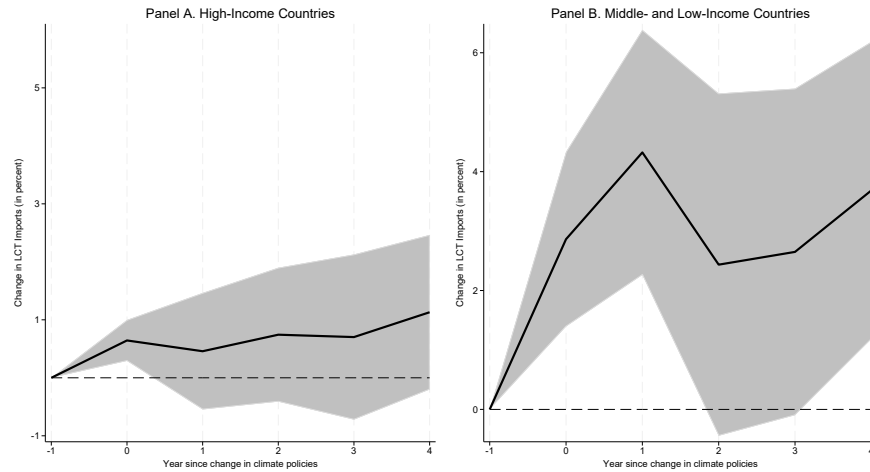
Note: Shaded area indicates 90 percent confidence interval with standard errors clustered at the country level.

Figure 5: Impact of an Increase in LCT Tariffs on LCT Imports
(response to a one st. dev. change)



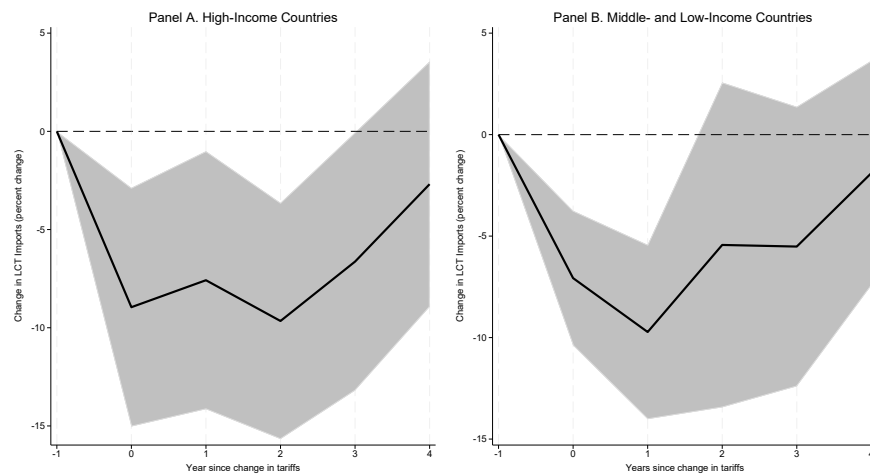
Note: Shaded area indicates 90 percent confidence interval with standard errors clustered at the country level.

Figure 6: Impact of an Increase in Climate Policies on LCT Imports —by Income Level
(response to a one st. dev. change)



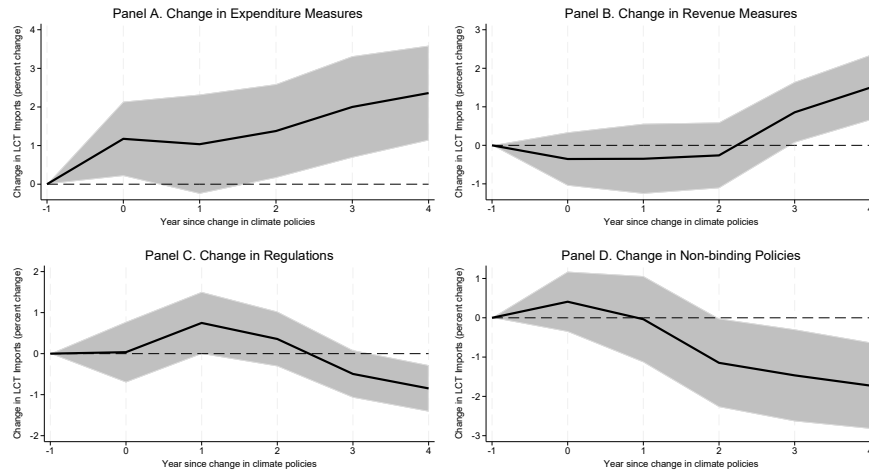
Note: Shaded area indicates 90 percent confidence interval with standard errors clustered at the country level.

Figure 7: Impact of an Increase in in LCT Tariffs on LCT Imports —by Income Level
(response to a one st. dev. change)



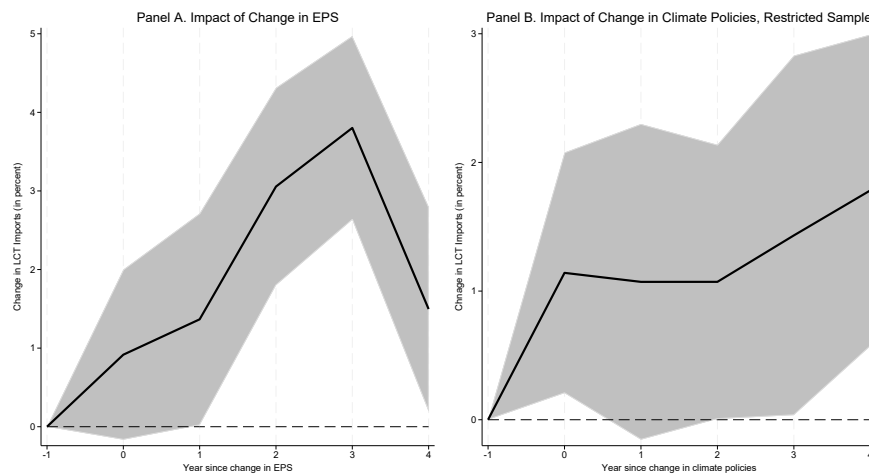
Note: Shaded area indicates 90 percent confidence interval with standard errors clustered at the country level.

Figure 8: Impact of an Increase in Climate Policies on LCT Imports —by Policy Instrument
(response to a one st. dev. change)



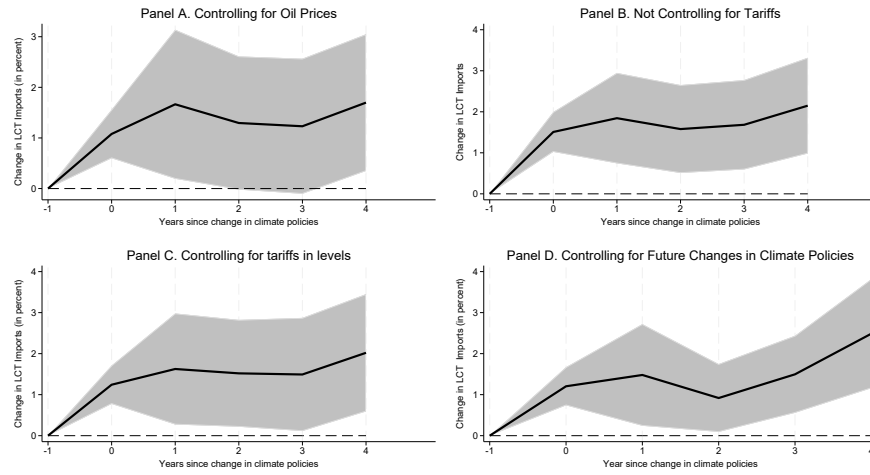
Note: Shaded area indicates 90 percent confidence interval with standard errors clustered at the country level.

Figure 9: Impact of an Increase in Climate Policies on LCT Imports —EPS
(response to a one st. dev. change)



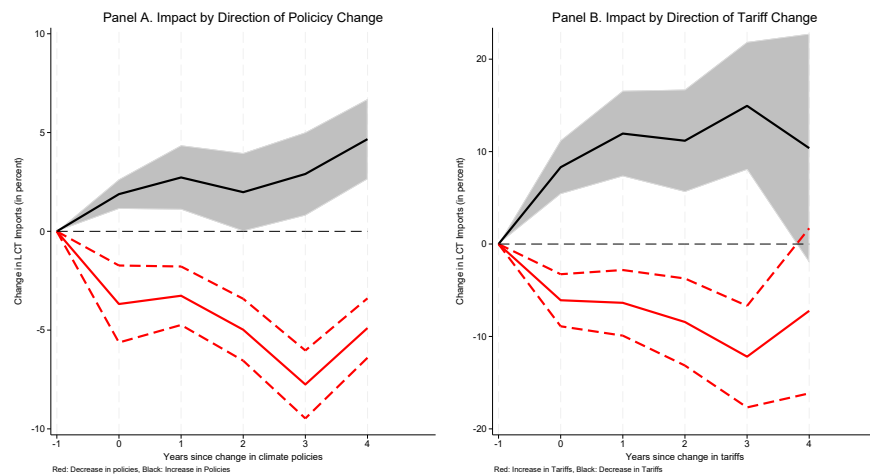
Note: Shaded area indicates 90 percent confidence interval with standard errors clustered at the country level.

Figure 10: Impact of an Increase in Climate Policies on LCT Imports—Robustness exercises
(response to a one st. dev. change)



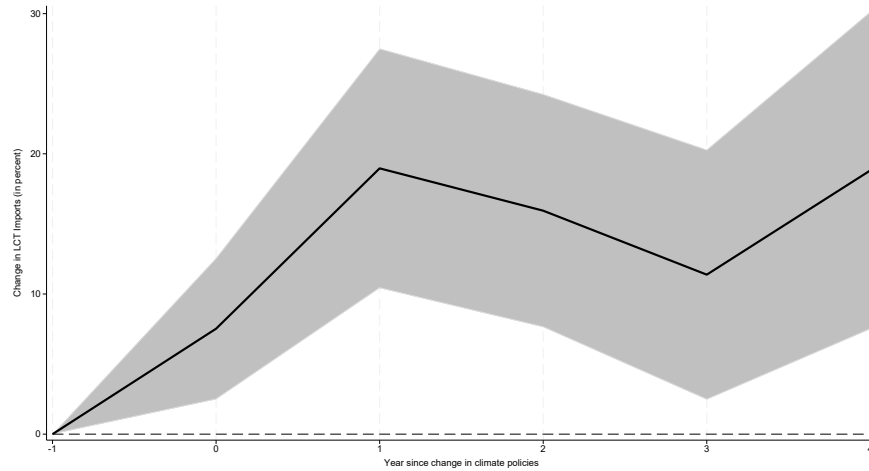
Note: Shaded area indicates 90 percent confidence interval with standard errors clustered at the country level.

Figure 11: Impact of Climate Policies and LCT Tariffs on LCT Imports—Direction of shock
(response to a one st. dev. change)



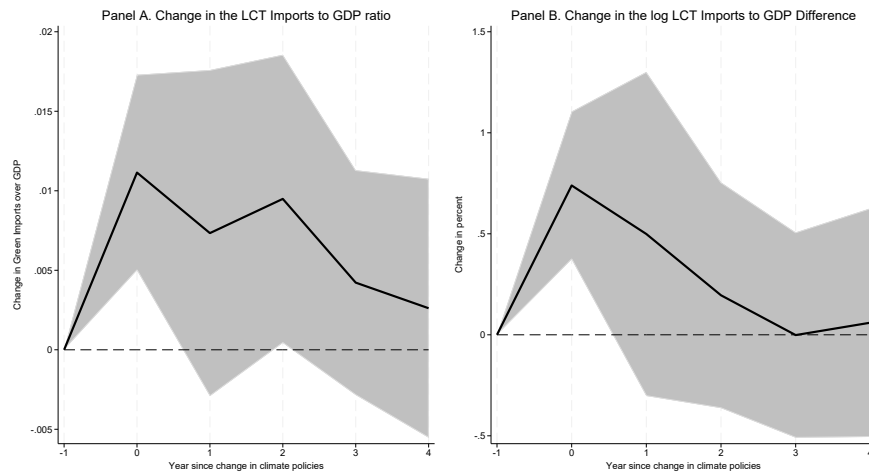
Note: Shaded area indicates 90 percent confidence interval with standard errors clustered at the country level.

Figure 12: Impact of an Increase in Climate Policies on LCT Imports —IV Exercise
(response to a one st. dev. change)



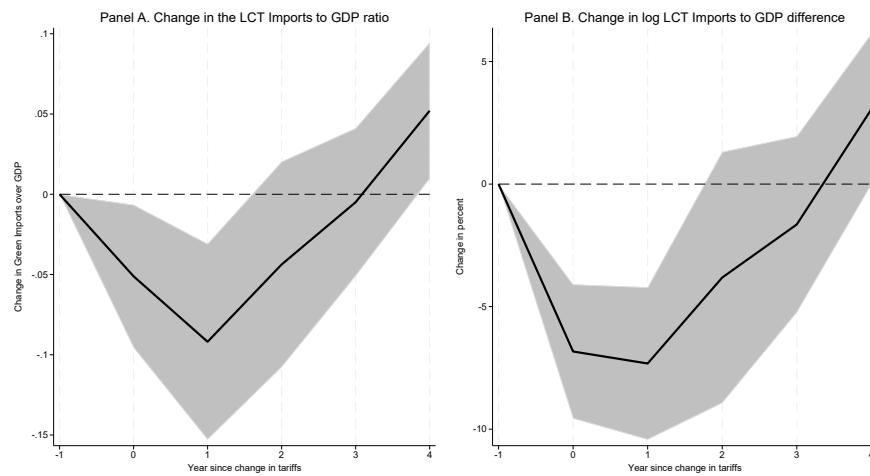
Note: Shaded area indicates 90 percent confidence interval with standard errors clustered at the country level.

Figure 13: Impact of an Increase in Climate Policies on the LCT Imports to GDP ratio/difference
(response to a one st. dev. change)



Note: Shaded area indicates 90 percent confidence interval with standard errors clustered at the country level.

Figure 14: Impact of an Increase in LCT Tariffs on the LCT Imports to GDP ratio/difference
 (response to a one st. dev. change)



Note: Shaded area indicates 90 percent confidence interval with standard errors clustered at the country level.



PUBLICATIONS

Trade in Low Carbon Technologies: The Role of Climate and Trade Policies
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