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# Global imbalances and international trade in the era of climate challenges

Koutchogna Assogbavi

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POUR OBTENIR LE GRADE DE

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SCIENCES ÉCONOMIQUES

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**GLOBAL IMBALANCES AND INTERNATIONAL TRADE IN  
THE ERA OF CLIMATE CHALLENGES**

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Soutenue le 03 juillet 2024

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# RÉSUMÉ

Cette thèse examine empiriquement différentes questions-clés d'économie et de finance internationales sous le prisme de la montée des risques liés au changement climatique et aux politiques d'atténuation. Dans le chapitre 1, nous abordons la question des déséquilibres mondiaux des comptes courant en analysant les forces expliquant leur dynamique, notamment depuis la crise financière mondiale de 2008. Les importants excédents de la balance courante de certains pays sont devenus un sujet de discussion important dans les enceintes internationales. C'est ainsi que nous évaluons empiriquement les facteurs qui pourraient expliquer la persistance des déséquilibres mondiaux dans certains pays avancés, émergents et à faible revenus. En adoptant une approche de régression en panel sur un échantillon couvrant 84 pays, nous évaluons les déterminants de moyen terme de la balance des comptes courants. Nous prenons soin, dans cet exercice empirique, de distinguer les périodes avant et après la crise financière mondiale. La crise financière mondiale semble constituer, selon nos estimations, une rupture structurelle dans la détermination des déterminants de la balance des comptes courants. Par ailleurs, les résultats montrent que le développement financier, l'ouverture financière et les variables institutionnelles sont des facteurs significatifs qui influencent la balance des comptes courants par le biais de changements dans les comportements d'investissement et d'épargne. Nous utilisons ensuite nos estimations pour prédire les comptes courants d'équilibre et calculer la contribution des facteurs sous-jacents. Malgré une certaine incertitude autour des estimations, nos modèles sont en mesure d'expliquer la plupart des configurations observées des comptes courants, ne montrant qu'un excédent par rapport à l'équilibre dans le cas du Japon, de la Chine et, plus récemment, de l'Allemagne. Enfin, la prise en compte de l'impact de politiques d'atténuation du changement climatique montre qu'un durcissement de la politique environnementale ou un niveau élevé de taxes environnementales conduisent à des excédents de la balance courante.

Compte tenu de l'impact potentiel des politiques d'atténuation du changement climatique mentionné dans le chapitre 1, le chapitre 2 examine les effets d'une politique environnementale sur les flux de commerce international. Les politiques visant à réduire les émissions de carbone n'étant pas mises en œuvre de la même manière dans tous les pays,

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une "fuite de carbone" au niveau mondial peut compenser les réductions nationales de carbone en réorientant la production à forte intensité de CO<sub>2</sub> vers des lieux où la réglementation environnementale est moins stricte. Le chapitre 2 utilise un modèle de gravité standard avec des données de panel pour évaluer si un durcissement de la politique environnementale incite à la délocalisation d'activités très polluantes. Les résultats ne montrent aucune preuve de fuite de carbone par le biais du commerce international, étant donné qu'une politique environnementale stricte entraîne généralement une réduction des émissions de CO<sub>2</sub> incorporées dans les biens et services échangés, tant au niveau agrégé que sectoriel. Cependant, nous trouvons des preuves de fuites de carbone lorsque nous considérons les importations en provenance des pays ayant des politiques environnementales les moins strictes, ce qui suggère la nécessité pour les économies engagées dans des objectifs de neutralité carbone de s'attaquer à la question de la coopération mondiale en matière de politique climatique.

Enfin, le chapitre 3 examine les effets de différents types d'événements climatiques sur les différents postes de la balance des paiements. Nous appliquons la méthode de projection locale à des données de panel de 2000 à 2020 pour évaluer l'impact des catastrophes naturelles sur la balance des paiements. L'impact des catastrophes sur la balance des comptes courants est négatif à court terme, cet effet disparaissant ensuite en l'espace d'un an. Nos résultats montrent que toutes les composantes du commerce diminuent à la suite d'une catastrophe. Les exportations et les importations de biens et de services diminuent dans l'année qui suit la catastrophe. Les importations de services sont celles qui mettent le plus de temps à revenir à leur état initial. Une analyse de ces effets en fonction du niveau de revenu des pays montre que l'impact négatif des catastrophes sur la balance des paiements est plus important dans les pays émergents que dans les pays avancés. Il est intéressant de noter également le rôle important des caractéristiques géographiques. Dans les pays tropicaux, les catastrophes entraînent une augmentation de l'aide internationale et des transferts de fonds. De même, les importations et les exportations diminuent à la suite des catastrophes. Dans les pays insulaires les effets des catastrophes sont plus marqués que dans les autres groupes de pays. Le tourisme et les exportations de services sont les plus gravement touchés par les catastrophes, en particulier dans les îles et les pays côtiers.

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Vu sous trois angles différents, nos travaux montrent que les risques liés au changement climatique et aux politiques environnementales jouent un rôle important dans les échanges internationaux de biens et les flux de capitaux. Ces effets sont amenés à se renforcer au cours des prochaines décennies et pourraient constituer un facteur fondamental dans les dynamiques économiques et financières internationales en matière de défis climatiques.

**Mots-clés :** Balance des comptes courants, crise financière mondiale, politique environnementale, changement climatique, catastrophes naturelles, émissions de CO<sub>2</sub>, commerce international, modèles de données de panel, projection locale, modèles de gravité

*Code JEL :* C32, F18, F32, G01, P33, Q54, Q56

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# ABSTRACT

This thesis empirically examines various key issues in international economics and finance through the lens of rising risks associated with climate change and its corresponding mitigation policies. In [chapter 1](#), we address the issue of global current account imbalances by analyzing the forces explaining their dynamics, particularly since the global financial crisis of 2008. The large current account surpluses of some countries have become a major topic of discussion in international forums. In this chapter, we empirically assess the factors that could potentially explain the persistence of global imbalances in certain advanced, emerging, and low-income countries. Adopting a panel regression approach on a sample covering 84 countries, we assess the medium-term determinants of the current account balance. Here we explore different empirical strategies taking into consideration periods before and after the Global Financial Crisis (GFC). According to our estimates, the global financial crisis appears to constitute a structural break in the assessment of the determinants of the current account balance. Furthermore, the results show that financial development, financial openness, and institutional variables are significant factors influencing the current account balance through changes in investment and savings behavior. We then use our estimates to predict balanced current accounts and calculate the contribution of underlying factors. Despite some uncertainty around the estimates, our models are able to explain most observed configurations of current accounts, showing only a surplus relative to balance in the cases of Japan, China, and more recently, Germany. Finally, taking into account the impact of climate change mitigation policies, we find that tightening environmental policy or high levels of environmental taxes lead to current account surpluses.

Given the potential impact of climate change mitigation policies mentioned in [chapter 1](#), [chapter 2](#) examines the effects of environmental policy on international trade flows. Since policies aimed at reducing carbon emissions are not implemented uniformly across countries, a global "carbon leakage" may offset national carbon reductions by redirecting CO<sub>2</sub>-intensive production to locations with less stringent environmental regulations. [Chapter 2](#) uses a standard gravity model with panel data to assess whether tightening environmental policy encourages the relocation of highly polluting activities. The results show no

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evidence of carbon leakage through international trade, as stringent environmental policy generally leads to a reduction in CO<sub>2</sub> emissions embodied in traded goods and services, both at the aggregate and sectoral levels. However, we find evidence of carbon leakage when considering imports from countries with less stringent environmental policies, suggesting the need for economies committed to carbon neutrality goals to address the issue of global cooperation on climate policy.

Finally, [chapter 3](#) examines the effects of different types of climate events on various components of the balance of payments. We apply the local projection method to panel data from 2000 to 2020 to assess the impact of natural disasters on the balance of payments. The impact of disasters on the current account balance is negative in the short term, and then disappears within a year. Our results show that all components of trade decrease following a disaster. Both exports and imports of goods and services decrease in the year following the disaster. Imports of services take the longest to return to their initial state. An analysis of these effects based on the income level of countries, indicates that the negative impact of disasters on the balance of payments is more significant in emerging countries than in advanced countries. It is also interesting to note the important role of geographical characteristics. In tropical countries, disasters lead to an increase in international aid and remittances. Similarly, imports and exports decrease following disasters. In island countries, the effects of disasters are more marked than in other groups of countries. Tourism and service exports are the most seriously affected by disasters, particularly in island and coastal countries.

From three different perspectives, our work shows that the risks associated with climate change and environmental policies play an important role in international trade and capital flows. These effects will grow in the coming decades and could make climate change a fundamental factor in international economic and financial dynamics.

*Keywords:* Current accounts balance, Global Financial Crisis, Environmental policy, Climate change, Natural disasters, CO<sub>2</sub> emissions, international trade, panel data models, local projection, gravity models.

*JEL Classification:* C32, F18, F32, G01, P33, Q54, Q56

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# GENERAL INTRODUCTION

From the 16th to the 18th century, the world experienced major economic changes characterized by mercantilism policies, colonial expansion and the early stages of industrialization. This period was also marked by the transition from feudalism to capitalism and the expansion of global trade. Europe was at the centre of these changes through countries such as Great Britain, France, Portugal, Netherlands and Spain. In these countries, mercantilism was the dominant strategy to foster economic expansion. It is based on government control of the economy and the principle that a nation should increase its wealth by selling more than it bought from other nations. Under this policy, the aim was to accumulate gold and silver reserves through exports in excess of imports. In this context, powerful trading companies such as the British and Dutch East India Companies emerged to exploit colonial territories for resources and trade. These companies were important tools for these countries in implementing these export-led policies. These policies in Europe led to trade surpluses for some countries and deficits for others, creating the world's first trade and financial imbalance, and thus global imbalances (Smith, 1937; Rich and Wilson, 1967; Magnusson, 1994; Broadberry and Harrison, 2005; Elliott, 2006). More than four centuries later, the world is still grappling with global imbalances, and these continue to persist.

Global imbalances are a complex macroeconomic problem facing economists and policymakers alike. They point to problems and malfunctions in the global economy. They are often reflected in trade balances, investment flows, savings and interest rates. Defined by IMF (2022b), as the sum of the absolute values of current account deficits and surpluses, global imbalances have been one of the major themes of the IMF External Sector Reports (ESR) since it was first published in 2012. The report analyzes the external developments of the world's largest economies. It also provides these countries with multilaterally consistent assessments of their external positions.<sup>1</sup> The current account balance is the common indicator used to study them. It is *the sum of net exports of goods and services, net primary income,*

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<sup>1</sup><https://www.imf.org/en/Publications/SPROLLs/External-Sector-Reports#sort=%40imfdate%20descending>

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*and net secondary income.*<sup>2</sup> Using the relationship equation between GDP and its components, the current account (CA) is also equal to the difference between national saving (S) and national investment (I).<sup>3</sup> This identity allows us to understand how external imbalances also reflect internal imbalances. If there is an imbalance between a country's saving and investment, this will be reflected in its current account, leading to external imbalances.<sup>4</sup>

Various approaches have been developed to assess current account imbalances. The main, classical approach is based on inter-temporal optimization. It is often associated with the inter-temporal model of the current account and emphasizes the role of savings and investment decisions over time. This approach states that current account imbalances reflect disparities in saving and investment rates among countries. Current account deficits are observed in countries where the savings rate is lower than investment. Conversely, countries with higher savings rates record surpluses (Obstfeld and Rogoff, 1995a). Similarly the IS-LM-BP model, also known as the Mundell-Fleming Model has been traditionally used to assess current account imbalances. This approach combines national macroeconomic variables with exchange rate dynamics to assess the impact of fiscal and monetary policies on the current account. Changes in fiscal or monetary policy can affect the trade balance and current account throughout their influence on exchange rates, interest rates, and income levels (Obstfeld and Rogoff, 1996). The Balassa-Samuelson effect is another way of assessing the current account. It explains how differences in productivity growth between the tradable and non-tradable sectors can lead to real exchange rate appreciation and current account imbalances. It shows that countries with rapidly rising productivity in the tradable sector can experience an appreciation of their currency, making exports less competitive and contributing to current account deficits (Krugman and Obstfeld, 2009). Moreover, the "Elasticities approaches" which examines the price and income elasticities of demand for imports and exports, has been used to understand how trade flows react to changes in exchange

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<sup>2</sup><https://databank.worldbank.org/metadataglossary/world-development-indicators/series/BN.CAB.XOKA.GD.ZS>

<sup>3</sup>CA=S-I

<sup>4</sup>If  $S > I$ , that means that a country saves more than it invests, leading to a surplus of national savings which must be invested abroad. And conversely if  $I > S$ , this mean it will be a need to borrow from abroad to finance the additional investments.

rates, income and other factors. In this approach, the importance of demand-side factors are underlined in the determination of trade balances and current account outcomes (Krugman and Obstfeld, 2009). Finally, the "portfolio approach", which is based on capital flows and investors' portfolio decisions suggests that current account dynamics can be influenced by capital flows. Such an impact is explained by the changes in preferences for domestic and foreign assets, as well as the changes in risk perceptions and interest rate differentials (Obstfeld and Rogoff, 1996).

One of the seminal papers referring to changes in the current account through changes in imports and exports is Feldstein and Horioka (1980). Often referred to as the *Feldstein-Horioka conundrum*, it studies the relationship between national savings and international capital mobility. It shows that short-term fluctuations in the savings rate alter the current account through imports and exports. Bergsten (1987) was also one of the first to draw attention to the scale of global imbalances, pointing to the situation in the United States<sup>5</sup>. Since the 2000s, there has been growing interest in current account issues. Although some publications (Dean and Koromzay, 1987; Bergsten, 1987; Ostry, 1997; Milesi-Ferretti and Razin, 1998a; Edwards, 2004) have long addressed the issue of current account imbalances, it was in the run-up to the 2008 Global Financial Crisis (GFC) that the subject became the focus of much academic and policy debate.

The GFC led to sharp adjustments in global imbalances (Figure 1). Deficit countries reduced their current account imbalances, mainly due to a contraction in imports. For surplus countries, the slowdown in international trade following the crisis led to a slowdown in exports, and a drop in current account surpluses. However, this adjustment has led to changes in the configuration of global imbalances. Indeed, since the global financial crisis, surpluses are mainly (and are still in some countries) concentrated in European countries (led by Northern European countries) and in certain emerging and oil-exporting countries (see Figure 1 and Figure 2). Deficits, albeit lower, remain dominated by the United States.

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<sup>5</sup><https://www.project-syndicate.org/commentary/unbalanced-america-external-deficit-by-carmen-reinhart-2017-08>.

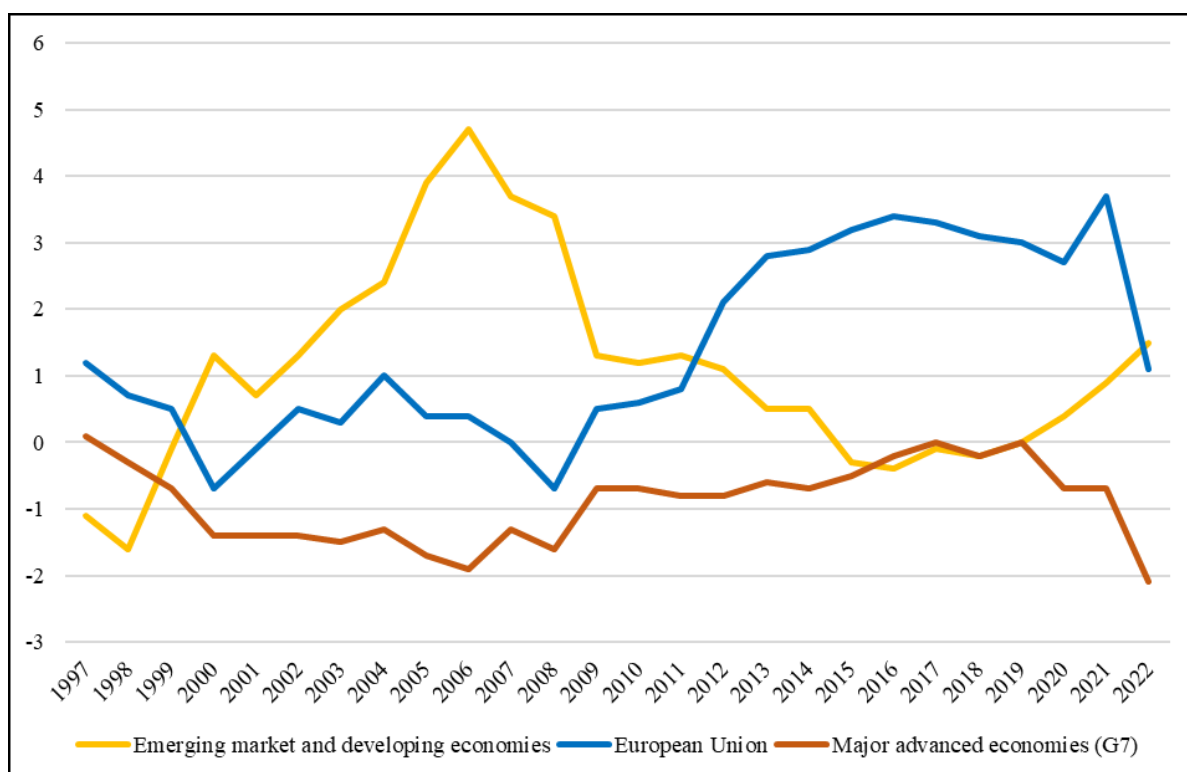


Figure 1: Current account balance, percent of GDP (data source: IMF)

Furthermore, beyond the size of current account deviations, global imbalances can also be defined in terms of the persistence of current account surpluses in one group of countries (e.g. Germany, Japan and China in the [Figure 2](#)) and deficits in another group of countries, including some large ones (e.g. the USA, France in the [Figure 2](#)). Although the size of the deficits and surpluses has been reduced following the GFC, their persistence remains a problem for the global economy (see [Figure 2](#)). Imbalances lead to significant capital flows from surplus to deficit countries and thus have a major impact on interest rates, asset prices and financial stability. In response, countries implement monetary and fiscal policies. As it happened during the GFC, large and persistent deficits or surpluses can create vulnerabilities and dependencies; a situation that could eventually lead to financial crises or disruptions in the international system. To protect themselves from the negative effects of imbalances, countries are inclined to set up trade barriers to protect their domestic industries. And to the extent that all countries want to implement policies to deal with a global problem that they sometimes cannot control, international cooperation through coordinated policies among

countries is necessary to mitigate the negative effects of imbalances and promote more sustainable and balanced global economic growth. The issue of global imbalances is important because of the threat it poses to global financial stability and the functioning of the international monetary system. Their consequences remain topical. Their manifestation can be analyzed from the point of view of its impact on financial flows, political responses, global economic stability, the risk of protectionism, and international cooperation. One might ask, given the threat, its manifestations, and its potential consequences, are current account imbalances uniquely bad?

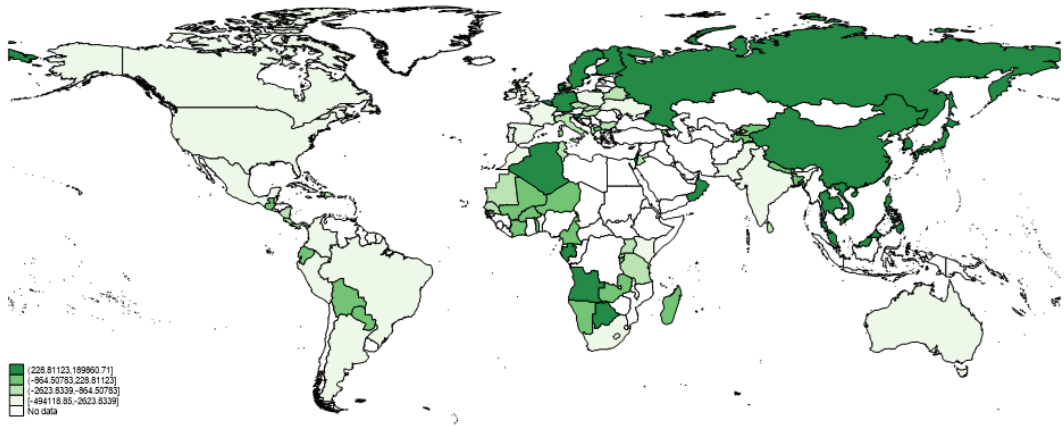
A current account deficit is not necessarily bad, and a surplus is not necessarily good. Current account deficits can be excellent macroeconomic outcomes. Whether they are bad or good depends on the cause of the deficit and the cause of the surplus.<sup>6</sup> The deficit corresponds to an inflow of money from other countries. [Blanchard and Milesi-Ferretti \(2010\)](#) has listed three categories of imbalances that can be considered "good" imbalances. They concern savings, investment and portfolio behavior. The first category concerns the fact that countries whose populations are aging faster than those of their trading partners are saving more in anticipation of the future dissaving that will occur as the workforce shrinks and the number of pensioners increases. This leads to current account surpluses. On the investment side, countries with attractive investment opportunities will be willing to finance these investments with foreign savings. This implies a series of current account deficits in these countries. Finally, countries with deeper and more liquid financial markets will attract foreign investors, which can lead to currency appreciation and hence current account deficits. In the case of deficits, when they are created by an overvalued exchange rate or when the funds earned through net foreign investment are used to purchase non-productive goods, the imbalance created is harmful to economies. On the other hand, when they are used to finance investment in research and development and infrastructure, and contribute to increasing the economy's productivity capacity, they are considered a good current account balance. In a context where international capital flows are facilitated, they become a source of challenges

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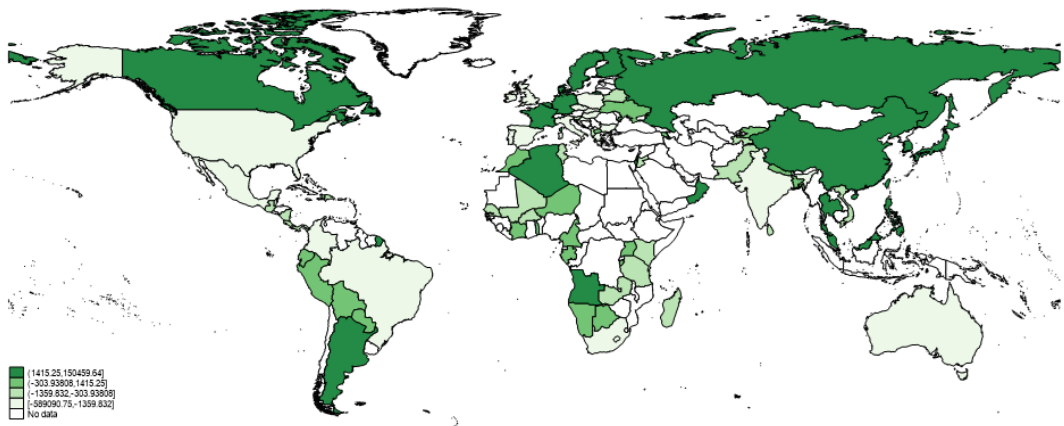
<sup>6</sup>As a reminder,  $CA = S - I$  (where CA is current account balance, S savings and I investments)



General (over the period of study: 2000 to 2019)



Before the GFC



After the GFC

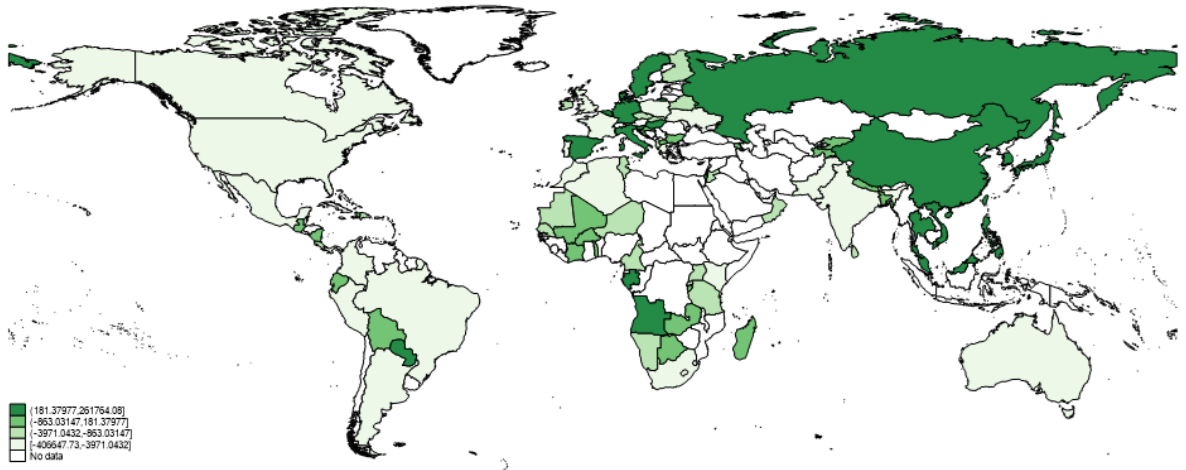


Figure 2: Current account Map

**Note:** This map shows our countries' average current accounts from 2000 to 2019 in billions of US dollars. The greener the color, the greater the country's current account surpluses.

for macroeconomic adjustment and financial stability. These challenges arise when the "rules of the game" of international monetary policy meet countries needs, and when the financial systems of countries receiving capital flows are not prepared to use this capital effectively. France and the United States ran current account surpluses in the late 1920s and early 1930s because their currencies were undervalued (see Figure 3)<sup>7</sup>.

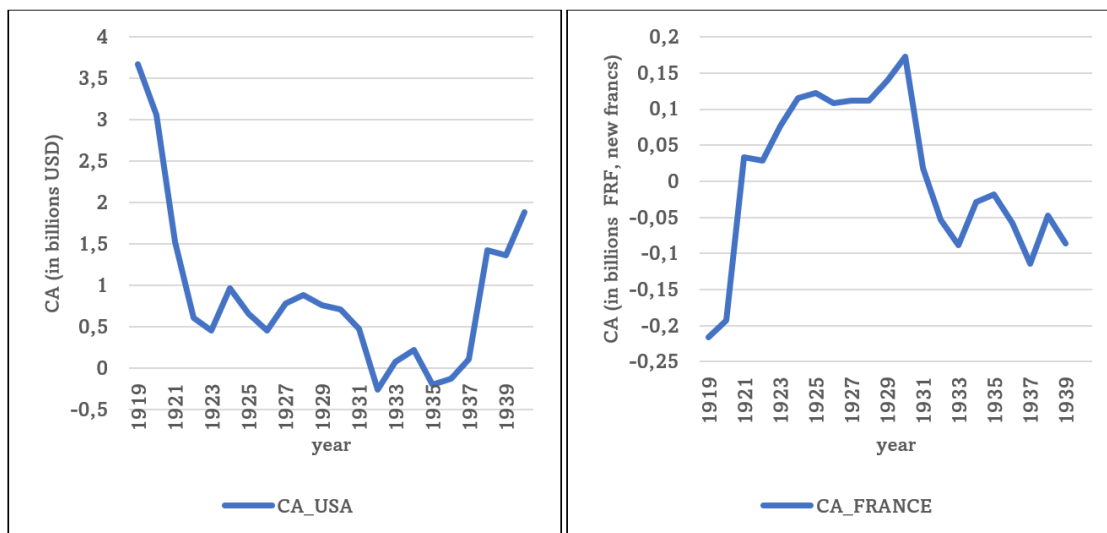


Figure 3: Current account trends in France and the United States from 1919 to 1939

**Note:** Current accounts for the United States are in billions of USD and those for France are converted to billions of FRF (new francs). Source of data : <https://www.macrohistory.net/database/>

During this period, instead of allowing capital inflows to reduce their external surpluses through their effects on the money supply and the appreciation of their currencies, they sterilized the effects of these capital inflows on their money supplies. As a result, their currencies remained constantly undervalued. The reluctance of these two countries to conduct their domestic policies according to the "rules of the game", combined with the structural vulnerabilities of their financial systems, contributed to destabilizing the financial system and triggering the Great Depression.<sup>8</sup> In a way, the Great Recession of 1929 was the result

<sup>7</sup>In 1960, France revalued its currency to 1/100th of the previous value. One hundred Francs became one New Franc (NF). Initially, old notes were overprinted with the new denominations, then new notes were issued denominated in "New Francs," and eventually the "New" designation was removed (source: <https://frenchbanknotes.com/france.php?section=New+Francs#>)

<sup>8</sup>Under the gold standard (it was a monetary system in which the standard economic unit of account is based on a fixed quantity of gold) "The gold standard took shape in the 1870s and lasted until the First World War. It was partially reestablished during the interwar pe-

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of global imbalances.

As in the Great Recession of 1929, global imbalances again played an important role in the Global Financial Crisis of 2008 (Bernanke, 2005; Obstfeld and Rogoff, 2009; Blanchard and Milesi-Ferretti, 2009; Bernanke et al., 2011). Excessive savings in surplus countries contributed to the subprime crisis in the United States. They boosted capital inflows, drove down interest rates and eased credit conditions. This environment then encouraged the proliferation of subprime lending and fuelled the expansion of the real estate bubble (Dupuy, 2023).

While current account imbalances continued to decline after the global financial crisis, eleven years later a serious global pandemic disrupted this trend. The pandemic worsened global current account balances. The Covid-19 crisis in 2020 led countries to implement exceptional support policies to avert a global economic depression. In the United States, for example, stimulus policies were more significant than in the rest of the world, leading to an increase in the US deficit. With the stock shortages and significant demand for medical supplies, the pandemic positioned China as a leading supplier of these goods. This boosted China's exports to the rest of the world during this period, leading to an improvement in its current account balance. As a result, Europe, the United States, and the rest of the world imported all these products from China, leading to a deterioration in their current account balances. Furthermore, the global lockdown led to a shift in household spending. Travel stopped for some time, oil prices fluctuated and savings soared as people stayed home during the global shutdown. Although the impact of the pandemic continued unevenly on countries current accounts, after wide fluctuations, commodity prices rose, exacerbated by the Ukraine-Russia war in 2022. This war, triggered by the invasion of Russia led surprisingly to an increase in the current account in both countries. The unexpected rise in Ukraine's current account in 2022, despite a significant trade deficit, can be attributed to secondary income, primarily consisting of foreign aid contributions. In the case of Russia, the significant rise in the current account surplus is attributed to various factors. The surge in gas and oil prices is a contributing factor. Sanctions have also played a role, as restrictions on exports

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riod. The Great Depression of the 1930s brought the gold standard to a final end" (source: [https://publications.banque-france.fr/sites/default/files/medias/documents/focus-052010\\_22\\_en.pdf](https://publications.banque-france.fr/sites/default/files/medias/documents/focus-052010_22_en.pdf)&<https://www.federalreserve.gov/newsevents/speech/bernanke20110218a.htm>)

to Russia resulted in reduced imports, positively impacting the current account.

Historical and recent events, be it financial crises, economic slowdowns or pandemics, all demonstrate that economic and financial imbalances most often result in massive current account adjustments. Faced with the new challenges ahead in terms of climate change and mitigation policies, it is important to study how the transition to low-carbon economies could affect the configuration of current accounts around the world and trigger new forms of global imbalances. Indeed, the role of climate and energy transitions in the coming years and decades must be taken into account when analysing global imbalances. Climate and energy transitions represent disruptive structural changes with profound and far-reaching implications for economies, societies and businesses. They are a complex and multifaceted transformation of the economy which involves shifts in industries, technologies, policies and consumer behaviour. Like globalisation, they are a transformative force, reshaping the economic landscape, requiring adaptation and providing opportunities for innovation and sustainable development. Effective management of these transitions requires strategic planning, cooperation and a forward-looking approach by governments, businesses and societies.

The relationship between climate change and economics has been popularized by the Stern Review [Stern \(2007\)](#). This report was commissioned in July 2005 by the British Chancellor of the Exchequer, Gordon Brown. Its main conclusion suggests that, under business-as-usual, the cost of climate inaction will be higher than the cost of strong and urgent action against climate change ([Dietz and Hope, 2007](#)). Moreover, numerous studies examine the impact of trade on global emissions and the environment from both theoretical ([Copeland and Taylor, 1994, 1995](#)) and empirical ([Antweiler et al., 2001](#); [Ederington et al., 2004](#); [Frankel and Rose, 2005](#)) perspectives. [Chen and Woodland \(2013\)](#) highlights the effects of trade on the effectiveness of national environmental policies through three points. Firstly, the carbon leakage that can occur when environmental policy is tightened ([Chua, 2003](#); [Fullerton, 2011](#)). Secondly, concern for international competitiveness can hamper the application of environmental regulations ([Porter, 1991](#); [Walley and Whitehead, 1994](#)). Finally, conflicts may

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arise between countries due to the problem of free riding by certain countries, given the low emission levels of others (Copeland, 2000, 2013).

On trade, climate and energy transition has the potential to reshape global trade patterns, with winners and losers depending on how countries adapt to and participate in the evolving landscape of sustainable and clean technologies. In anticipation of changing consumer behaviour towards fossil fuel goods, long-distance tourism and services requiring face-to-face interaction, there will be a reallocation of trade flows between industries. The sectors in which trade is likely to develop are minerals and goods with high levels of environmental and technological investment. This reallocation will have an impact on the trade balance and thus on the current account. The current account surpluses of fossil fuel exporters are likely to fall.

Indeed, when companies are competing in the same market, their performance is affected by implemented policies. In the case of asymmetric policies, the literature of the environmental economics highlights two principal views (Dechezleprêtre and Sato, 2017): the pollution haven and the Porter hypothesis. The first view, referred to as pollution haven effects, appears in the findings of McGuire (1982)'s paper in the early 80's. In the case of free mobility of factor of production across borders, McGuire (1982) found that the slightest regulatory difference between countries will completely relocate the regulated industry from the more regulated economy to the less regulated one. To explain this view, we will consider two different countries, country A and country B. It consists of an increase in polluting industries in country A as a result of stringency in environmental regulations in country B. This concept is based on trade theory. The principle is that stricter environmental regulations increase the production cost of goods with pollution-intensive production. For these goods, the compliance cost will also increase. Over time, the production of these kinds of goods will shift towards regions with lower abatement costs. This mechanism creates a pollution haven and causes policy-induced pollution leakage. Levinson and Taylor (2008a) while examining the effects of environmental regulations and trade flows, found that industries whose abatement costs increased the most experienced the largest net imports. The cost of key inputs for goods with pollution-intensive production rises. Environmental regulations reduce the

comparative advantage of jurisdictions in goods with pollution-intensive production. The theoretical foundation of this mechanism is provided by the Heckscher-Ohlin model. It states that a region or country exports goods that they produce efficiently and in abundance<sup>9</sup>. The second view is the Porter hypothesis. This concept is introduced in 1991 by Michael Porter. It presents the relationship between environmental regulations and economic performance. In opposite to what have been developed above, the Porter hypothesis states that when an environmental regulations is well designed it can spur innovation efficiency and competitiveness among industries (Porter and van der Linde, 1995; Soete and Freeman, 2012).

In a context where the effects of climate change are increasingly visible, public policies and economic decisions need to adapt. The aim is to invest in ecological transition and thus contribute to the fight against global warming. The adoption of environmental regulations can also have an impact on a country's domestic investments, and therefore on its current account balance. Investment in the production of fossil fuel-based goods, for example, may decline. The implementation of environmental regulations not only makes it possible to finance adaptation to climate change, but also to change habits, thereby limiting the occurrence of extreme climatic events. Climate inaction therefore leads to significant damage during climatic hazards events. To understand global imbalances, it is therefore essential to understand how natural disasters affect the balance of payments through its main components. The impact of natural disasters on the balance of payments may vary across the current account, depending on the severity of the disaster, the economic structure of the affected country and the response mechanisms in place. Moreover, these effects can unfold over different time horizons, with immediate, short-term and long-term effects on the balance of payments. In the aftermath of disasters, the disruption of economic activity and damage to infrastructure worsens the balance of trade (in goods and services), which is a component of the current account. Similarly, changes in capital and financial account balances due to the inflow of aid and financial assistance observed after disasters can affect the current account. It is important for policy makers to understand how long it takes for certain variables to return to their initial levels after a major natural disaster.

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<sup>9</sup><https://faculty.georgetown.edu/aml6/pdfs&zips/pollutionhavens.pdf>

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In light of the previous questions, we can see that one way to understand imbalances is to examine the factors that can affect trade or investment in one way or another. In the context of climate change, this means examining how environmental policies and extreme weather events affect the current account. Against this backdrop, this thesis addresses the question of the role or impact of environmental policies and natural disasters on global imbalances. We also ask how balance of payments variables, such as the current account, evolve after a natural disaster.

To understand the underlying mechanisms or address these questions, we propose three issues developed in our chapters. Firstly, what factors contribute to the persistence of global imbalances, and how do environmental policies affect the current account balance? Secondly, could environmental policies potentially lead to carbon leakage? Thirdly, what is the impact of natural disasters on the current account balance?

Against this background, our [chapter 1](#) aims at understanding the reasons of the persistence of global imbalances and the rotation of surpluses since the GFC from China to North European countries. We adopt an empirical approach following the methodologies developed in [Chinn and Prasad \(2003a\)](#) and in [Kamin et al. \(2005\)](#). We run a general model to analyse the traditional determinants of current accounts. Our results indicate that the impact of these determinants varies depending on a country's income level. The more integrated a country is in global value chains, the more likely it is to run current account deficits. Financial crises act as a stimulus to the current account in general and especially in emerging countries. Checking for structural breaks, we find evidence of the Global Financial Crisis (GFC) as an important change in current account dynamics. After the initial estimations, we divided our sample into pre- and post-GFC periods. Our results show that financial development, financial openness, and institutional variables are significant factors that impact current account determination through changes in investment and saving behaviours. Our estimates are used to predict current accounts for selected countries and calculate the contribution of underlying factors. We then evaluate the impact of climate change mitigation policies on current account balances, using climate change and environmental taxes as policy indicators. The results indicate that current account surpluses are associated with a tight-



ening of environmental policy or a high level of environmental taxes. When climate change mitigation policies are implemented unilaterally, they increase the current account balance against a reduction when policies are coordinated.<sup>10</sup>

Focusing on the links between climate change and the economy and especially with international trade, [chapter 2](#) assesses empirically the role of national climate-related legislation as a determinant to explain the bilateral trade in CO<sub>2</sub> emissions across countries. Following the literature on international trade flows, we rely on gravity models estimated on a large panel of countries. Our methodology is similar to [Aichele and Felbermayr \(2015\)](#) or [Duarte et al. \(2018\)](#) as we also base our analysis on gravity equations. We draw on a variety of measures assessing the stringency of environmental policies across countries at global level, enabling us to extend previous analyses to a wider range of policy actions likely to be more relevant in the current context. We use two environmental policy measures: *de jure* and *de facto* measures. Our *de jure* environmental policy measures are complemented with *de facto* measures based on environmental outcome, assessing the relative stringency of a country's policy in terms of *ex post* efficiency in reducing actual emissions. We find no evidence of carbon leakage through international trade at the global level. On the contrary, a tightening in environmental policy leads to a reduction in CO<sub>2</sub> emissions embodied in trade. Such emissions are rather explained by usual trade determinants, such as shipping costs or other gravity forces. When breaking down the data by sectors, the effects of environment policy on lowering emissions are even stronger for the most polluting sectors. Therefore, the apparent imbalances in CO<sub>2</sub> emissions embodied in trade do not seem to originate from differences in environmental policy but rather by usual specialisation motives. At the same time, however, we do find evidence of carbon leakage for importing countries with more stringent policy, as the CO<sub>2</sub> of their imports tend to increase when their environmental policy is tightened.

In addition to their role in regulating carbon emissions embodied in trade, environmental policies are necessary to mitigate climate change and limit global warming. However, global warming is already occurring and, although mitigation policies aim at limiting it, the physical consequences are unavoidable with an increase in the frequency and sever-

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<sup>10</sup>according to the scenarios tested in the [International Monetary Fund \(2022\)](#)



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ity of weather-related damages. Since the 1980s, temperatures have risen steadily over the decades. The last decade (2011-2020) is the warmest on record.<sup>11</sup> In terms of costs in the EU for example, climate-related extreme events are estimated to cost €650 billion (2022 prices) between 1980 and 2022.<sup>12</sup> Through the physical and economic destruction they cause, these events have multiple impacts on countries' trade and financial positions and thus on their balance of payments.

To understand global imbalances in the era of climate change, it is interesting to examine the impact of natural disasters on the balance of payments through its main components, i.e. how certain components react and how long it takes for certain variables to return to their initial levels after a major natural disaster. Chapter 3 helps to understand all these mechanisms.

[Lavell et al. \(2012\)](#) define disasters in their report *as severe alterations in the normal functioning of a community or a society due to hazardous physical events (natural, socio-natural or anthropogenic origins) interaction with vulnerable social conditions, leading to widespread adverse human, material, economic, or environmental effects that require immediate emergency response to satisfy critical human needs and that may require external support for recovery*. What impact do they have on the balance of payments?

[Agudelo-Rivera et al. \(2022\)](#) mention, according to the literature, four main channels through which natural disaster, like extreme weather events, can impact the balance of payments. The first concerns the destruction of transport infrastructure. Infrastructure is known to be an important determinant of trade performance ([Nordås and Piermartini, 2004](#); [IPCC, 2014](#)). Their destruction or deterioration has a severe impact on international trade ([Tamiotti, 2009](#); [IPCC, 2014](#); [Schweikert et al., 2014](#)). The second concerns negative shocks to agricultural productivity. [Zhai et al. \(2009\)](#) estimates the drop in global agricultural production at 7.4 percent by 2080, in the case of China. In New Zealand, climate change-related events account for around 35 percent of fluctuations in GDP and agricultural production ([Gallic and Vermandel, 2020](#)). In third place comes the fall in prices of mining and energy

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<sup>11</sup><https://www.un.org/en/climatechange/science/causes-effects-climate-change>

<sup>12</sup><https://www.eea.europa.eu/en/analysis/indicators/economic-losses-from-climate-related>

products (Arndt et al., 2019). In the aftermath of disasters, political decision-makers implement a range of measures to help contain the effects of climate change. These mitigation policies, designed to limit the impact of climate change, reduce the global demand for fossil fuels (Arndt et al., 2019). In countries heavily dependent on the mining and energy sectors, public revenues will be adversely affected (Burnete and Pilasluck, 2015; Carbone and Rivers, 2017; Bernal and Ocampo, 2020). As in South Africa, in countries dependent on fossil fuel and coal revenues, the transition to renewable energy or the achievement of the Paris Agreement climate targets represent a significant loss for these countries in terms of public revenues (Makarov et al., 2020). The anticipated drop in income and growth would hamper the investment decisions and would also raise uncertainty (Agudelo-Rivera et al., 2022). And finally, concerning the rising cost of sovereign borrowing, the disaster, as mentioned above, will lead to an increase in sovereign risk (Cevik and Jalles, 2020). In particular, agricultural or tropical countries will face sovereign default problems due to disasters (Sturzenegger and Zettelmeyer, 2007; Mallucci, 2020).

Following this literature, chapter 3 assesses the effects of large natural disasters<sup>13</sup> on the balance of payments and its various components. We use different measures of natural disasters and look for their differentiated effects according to geographical location and income levels. We assess empirically, the impact of natural disasters on the balance of payments by applying the local projection (LP) method developed by Jordà (2005). The findings indicate a decline in the deficit of the current account and the capital account a year after the disaster. In terms of trade, natural disasters lead to a drop in imports and exports of goods and services in the two years following the disaster. In terms of income level, the effects of disasters differ depending on whether we are in an advanced, an emerging market or in a low-income market. Our results also show that the impact of natural disasters depends on geographical location. Given the geographical characteristics, in tropical countries, it is the capital account that is most affected by a change. The results obtained in these countries underline the role that remittances and international aid play in the recovery process of these

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<sup>13</sup>We define large natural disaster according to the Munich Re (2005) convention, whereby a natural disaster is a large one if it: (i) killed at least 1 000 persons; (ii) affected not less than 100 000 persons or (iii) injured at least 1000 persons or (iv) caused a monetary damage of 1 billion US dollar or more (in constant 2012 US dollars)

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countries. Services are also found to be the main component affected in island countries. Overall, this chapter therefore contributes to the literature on disasters' effects on the current account imbalances, trade in goods and services, showing that natural disasters have a short-term negative impact on the current account balance, as well as on trade and its components.

GLOBAL ACCOUNT IMBALANCES SINCE THE GLOBAL  
FINANCIAL CRISIS: DETERMINANTS, IMPLICA-  
TIONS AND CHALLENGES FOR THE GLOBAL ECON-  
OMY

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## 1.1 Introduction

Since the Global Financial Crisis (GFC), issues related to global imbalances have attracted increasing attention in the public policy debate. For instance, discussions at the G20 summit in 2019 showed a renewed interest by policy leaders on the subject, while it was largely absent in the aftermath of the GFC. The [IMF \(2017\)](#) External Sector Report identified 40 episodes of large and persistent current account surpluses and 70 episodes of large and persistent current account deficits since 1960. Before the GFC, deficits were mainly concentrated in the U.S. and were financed by surpluses in China, oil-exporting countries, and other emerging economies. While deficits and surpluses can be explained by cross-country differences in key structural factors, the main questions concern the size and the dynamics of current account imbalances. In the U.S., for instance, the current account deficit was approximately six percent of GDP in 2006, its historical peak, while it was at 1.5 percent of GDP in the early 1990s. In 1997, China's current account surplus was 3.8 percent of GDP and reached 9.9 percent of GDP in 2007 at the eve of the GFC. In developing countries, the aggregate current account balance had already moved into surpluses in the early 2000s, well before the GFC, and increased to record levels in 2006.

The Global Financial Crisis (GFC) precipitated significant adjustments in global imbalances. Deficit countries saw reductions in their current account imbalances primarily due to a contraction in imports. Conversely, surplus countries experienced a slowdown in exports amid the post-crisis international trade deceleration, resulting in the decline of their current account surpluses. Nonetheless, this adjustment has brought about alterations in the configuration of global imbalances. Indeed, since the GFC, the surpluses have been mainly concentrated in Northern European countries and some emerging and oil-exporting countries. In Europe, Germany is running the largest current account surplus and has become the main surplus country at the global level. Policy makers and academics explain the persistence of German surpluses by structural factors that created a gap in productivity between the manufacturing and service sectors ([Coricelli et al., 2013](#)). As shown by [Figure 1.1](#), the German surpluses increased mainly after the Asian crisis of 1998. It reached a record high of

8.6 percent of GDP in 2016 before moderating thereafter.

Taking a global perspective, we notice that, from 2000 to 2014, the current account surpluses were mainly concentrated in emerging markets and developing countries. We also observed the plummet of oil and natural gas prices in 2014 led the current accounts of these countries into deficit. It should also be noted that the surpluses in emerging countries are driven by oil-exporting countries. Combining German and Japanese current accounts, these two countries have accounted for larger current account surpluses since 2014 than those of China and emerging/developing economies combined except in 2022. In 2018, the current account surplus in China declined to 0.02 percent of world GDP, while that of German remained 0.23 percent, moderating somewhat after reaching its record level in 2015 (0.29 percent). At the same time, the U.S. current account was still in deficit, a recurrent situation since 1997, with a record of -1.57 percent of world GDP in 2006 (figure 1.1).

While declining after the 2008 financial crisis, global imbalances increased again after the COVID-19 crisis (IMF, 2021)<sup>1</sup>. In 2020, travel declined, oil demand collapsed, medical product demand surged, and household consumption shifted. These factors continued to drive the trend of current accounts globally in the aftermath of the COVID-19. More interestingly, emerging and less advanced countries went from a deficit in 2020 to a surplus in 2021 and 2022. China's surplus increased to the point where it exceeded the combined surpluses of emerging markets, developing countries, Germany, and Japan.

In 2021, German surpluses remained close to seven percent of GDP (7.7), while the U.S. deficit reached 3.5 percent of GDP. The IMF External Assessment Report (IMF, 2019) assessed that approximately 35–45 percent of current account surpluses and deficits were excessive. The IMF pointed to higher-than-warranted surpluses in some euro area countries, such as Germany and the Netherlands, as well as Korea and Singapore. On the deficit side, the imbalances remained concentrated in the United Kingdom and the U.S. By contrast, China's external position was assessed to be in line with fundamentals. Going forward, current ac-

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<sup>1</sup>The sum of absolute deficits and surpluses among all countries was 2.8 percent of world GDP in 2019, compared to 3.2 percent of GDP in 2020 (<https://www.imf.org/en/Blogs/Articles/2021/08/02/blog-how-the-pandemic-widened-global-current-account-balances>)

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counts are projected to narrow in the coming years, with China's surplus and the US' deficit contracting according to the World Economic Outlook report (IMF, 2021). The report forecast that this adjustment will lead global current account to reach 2.5 percent of world GDP in 2026. Against this background, our chapter aims to understand the reasons for the persistence of global imbalances, paying particular attention to the GFC. It also assesses the role of the energy transition on global imbalances. We adopt an empirical approach inspired by that developed in Chinn and Prasad (2003a); Kamin et al. (2005). First, we run several models using traditional current account determinants, including fiscal balance, net foreign assets, income per capita, GDP growth, financial crisis, trade openness, exchange rate, youth age, and old age dependence ratios. Our database covers advanced, emerging countries and low income countries. In the main models exchange rate, financial and trade openness are negatively associated with the current accounts. Financial crises are positively associated with current accounts in general, significant in emerging countries and negative in low-income countries. We also find that fiscal balance as well as net foreign assets impact the current accounts positively, as usually found in the literature assessing the current account determinants. However, when we break down our sample by income levels, these impacts vary depending on whether countries are advanced, emerging or low-income.<sup>2</sup> The basic estimation shows that the impact of the per capita income and the population ratios depends on the sample of countries. After these basic estimations, we run the Chow tests to check for the presence of structural breaks. It shows an evidence of the GFC as an important structural change in current account dynamics. We decompose our sample into pre- and post-GFC periods. This decomposition allows us to emphasize that current account dynamics are not only different across countries but also across time. We also use another approach based on dummy variables to go deeper in the analysis.

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<sup>2</sup>Advanced Countries group together developed nations with high levels of industrialization, advanced infrastructure, and high GDP per capita (the United States, Japan, and Germany for example). Emerging Countries group together developing nations experiencing rapid economic growth and industrialization, with potential for future development (China, India, and Brazil for example). Low-Income Countries group together countries with low levels of economic development, often characterized by low GDP per capita, limited infrastructure, and high poverty rates Countries in Sub-Saharan Africa like Malawi and Niger for example. sources: [World Bank (<https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups>) and IMF (<https://www.imf.org/en/Publications/WEO/weo-database/2021/October/weo-report?c=>)]

Following this first set of results, we specify more comprehensive models to improve our understanding of current account dynamics across countries and over time. In particular, we include the role of financial development, currency misalignment, financial openness, and institution quality variables in explaining current account developments and differences across countries. Our results show that financial development, financial openness, and institutions variables are significant factors impacting current account. We then use our estimates to predict current accounts for selected countries and compute the contribution of the underlying factors. In most cases, our models are able to explain most of the current account configuration. In the aftermath of the GFC, surpluses in China were mainly explained by GDP per capita, productivity, net foreign assets and openness determinants, while in Germany income factors (GDP per capita) remain the main factor explaining the excess of savings. While the surplus observed in the past years show a convergence of the Chinese current accounts towards its equilibrium levels, it remains higher than our predictions in the case of Germany, implying some relative signs of disequilibrium. In the United States, the current account is mainly determined by the fiscal balance, net foreign assets, demographic determinants and institutional variables.

Finally, another important dimension to take into account going forward is the role of the energy transition on global imbalances. The decline in the demand for fossil fuel will both affect oil exporting and importing countries. At the same time, new players, such as the exporters of transition critical minerals, may reshape the configuration of current accounts worldwide. By redirecting trade flows and impacting savings-investment dynamics, the green transition is a key element to introduce in the current account analyses. We therefore factor in the impact of climate change mitigation policies on the current accounts by introducing in our empirical framework new policy indicators, such as environmental policy indices and environmental taxes. The results suggest that a tightening of environmental policy or a high level of environmental taxes are associated with current account surpluses.

Our chapter is organized as follows. Section 2 provides some brief review of the literature. Section 3 gives an overview of the determinants of the current accounts. Section 4 sheds light on details about the empirical methodology and data. Sections 5 to 9 report and



comment on our empirical results. The last section presents some concluding remarks.

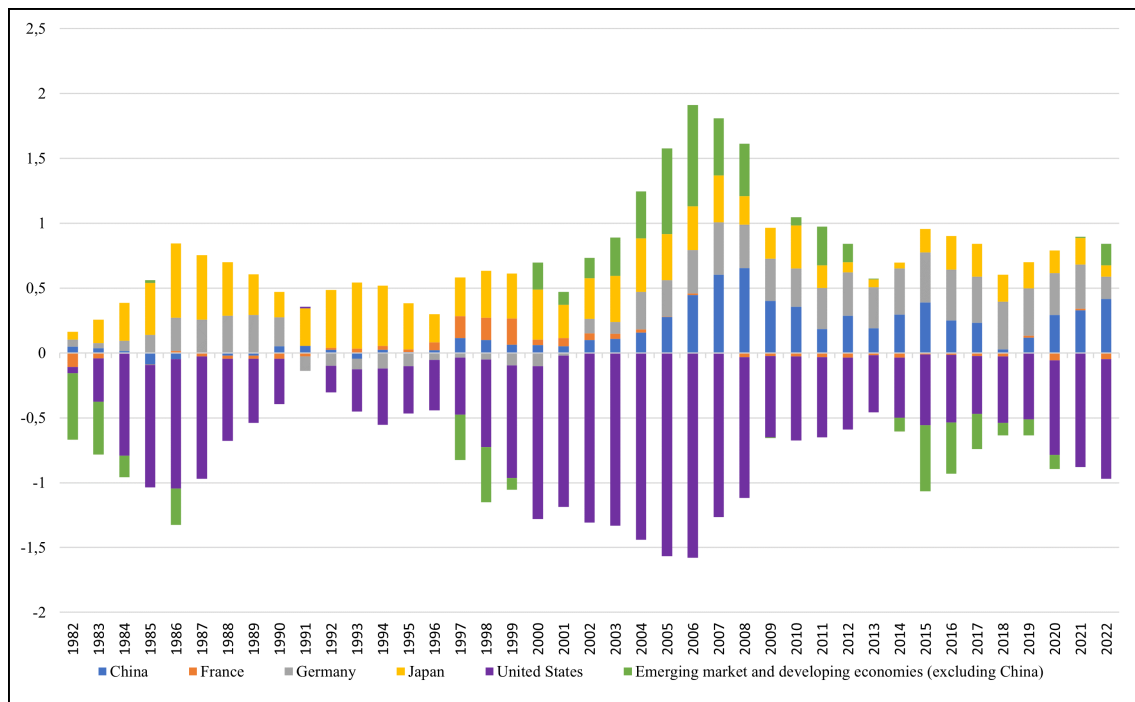


Figure 1.1: Global Current Account (as a percentage of world GDP) (Data source: IMF)

## 1.2 Literature review

A pivotal paper discussing fluctuations in the current account resulting from shifts in imports and exports is the work of [Feldstein and Horioka \(1980\)](#). Widely known as the Feldstein-Horioka conundrum, it examines the correlation between national savings and international capital mobility. It shows that there is a strong correlation between the country where economic agents live and the place where they invest, whereas neoclassical theory deduces that economic agents, as maximizers, invest in those investments which have the highest rates of return regardless of the country of investment. After an emerging literature in the 1990s ([Dean and Koromzay, 1987](#); [Ostry, 1997](#)), there has been a renewed interest in current account issues since the 2000s, especially with the widening of current account imbalances in the wake of the Global Financial Crisis ([Edwards, 2004](#); [Milesi-Ferretti and Razin, 1998a](#); [Obstfeld and Rogoff, 2005](#)) and its aftermath ([Gruber and Kamin, 2007](#); [Chinn and Ito, 2007, 2008](#); [Belke and Dreger, 2011](#); [Chinn, 2013a,b](#)).

From an historical point of view, [Oliveira-Martins and Plihon \(1992\)](#) analyzed current account imbalances through three different periods, representing the various stages of global economic developments. From 1967 to 1973, the configuration of current accounts at the global level was characterized by large surpluses in industrialized countries, financing the deficits of peripheral countries. The second stage concerned the period from 1974 to 1982. This period was characterized by “South-South” imbalances, with oil-producing countries using their surpluses to finance developing economies through the banking systems of advanced economies. The third stage concerned “North-North” imbalances, with the United States (the U.S) deficit being financed by European countries and Japan. While the analysis by [Oliveira-Martins and Plihon \(1992\)](#) is dated, we can observe that the current configuration of global imbalances still indicates that American deficits are being financed by European countries and Japan. At the same time, it should be pointed out that China has become a key player in the evolution of global current accounts, being the main surplus country financing the US deficit in the run-up to the Global Financial Crisis. However, in recent years, while the US current account has remained in deficit, there has been a rotation in the composition

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of surplus countries. While current account surpluses have continued to shrink in China and the oil-exporting countries, the surplus countries of Northern Europe, including Germany, have recorded sustained current account surpluses.

Theoretically, [Sachs et al. \(1981\)](#) was among the first to provide an analysis of global current account imbalances through the intertemporal approach. This first contribution was then extended by [Obstfeld and Rogoff \(1984\)](#), [Milesi-Ferrett and Razin \(1996\)](#) and [Milesi-Ferretti and Razin \(1998b\)](#). In this approach, current accounts reflect global savings and investment choices, which are based on equality between current consumption and the present value of expected future net income (or net assets). Consequently, any shock leading to a change in current consumption will imply a change in current accounts. These shocks can be linked to changes in interest rates or to expectations of future income due to productivity shocks or government policies ([Chinn et al., 2014](#)). This approach has proved useful in providing various determinants to explain the determination of current accounts at the national level ([Obstfeld and Rogoff, 1995b](#)). However, to explain current accounts at global level, it is also necessary to determine whether the global configuration reflects equilibrium conditions or imbalances that need to be corrected.

Global current account configurations represent equilibrium conditions only if their determinants are self-sustained. For instance, [Caballero et al. \(2008\)](#) explains that the lack of financial development in emerging economies (characterized by underdeveloped financial markets or financial crises) create a "global savings glut" ([Bernanke, 2005](#); [Clarida, 2005](#)) spurring capital flows from underdeveloped financial system to world financial centers ([Chinn and Ito, 2019](#)). This explanation of current accounts imbalances lead to the "safe asset" argument used by commentators of the U.S. current account deficit. Hence, continuous flows from emerging economies to the U.S. allow a sustainable financing of the U.S. current account deficits. By contrast, [Obstfeld and Rogoff \(2005\)](#), [Obstfeld and Rogoff \(2009\)](#), [Gourinchas and Rey \(2007\)](#) and [Blanchard et al. \(2005\)](#) suggest that real and financial adjustments are necessary because of unsustainable net foreign asset positions at the global level. Using a general equilibrium model, [Obstfeld and Rogoff \(2005\)](#) and [Obstfeld and Rogoff \(2007\)](#) show that a reversal in the US current accounts would lead to a significant depreciation in the real effective

exchange rate, with serious consequences for economic growth. However, the link between current accounts and exchange rate movements is ambiguous. [Blanchard and Giavazzi \(2002\)](#) argue that current account imbalances are not linked to exchange rate misalignment, but are the consequence of imbalances between savings and investment. Consequently, misalignment would be an indicator, but not the primary cause, of external imbalances.

Numerous empirical studies have been carried out to understand global current account imbalances ([Chinn and Prasad, 2003a](#); [Chinn and Ito, 2005](#); [Kamin et al., 2005](#); [Gruber and Kamin, 2007](#); [Chinn and Ito, 2007, 2008](#); [Chinn, 2013a](#); [Chinn and Ito, 2019](#)). [Chinn and Prasad \(2003a\)](#) provide an empirical assessment of the determinants of current accounts in industrialized and developing countries, and find a positive relationship between the current account, the fiscal balance and initial stocks of net foreign assets ([Ali Abbas et al., 2011](#)). In another study, [Chinn and Ito \(2007\)](#) confirms these results for industrialized countries and the United States. They also find that in developing countries, current accounts are positively associated with financial deepening, while they are negatively associated with financial openness. However, [Gruber and Kamin \(2007\)](#) fails to explain the US current account deficit, but finds better results for surplus Asian countries once the impact of previous financial crises is taken into account.

Some empirical literature has also focused on the dynamics of current account adjustments in industrialized countries through the role of monetary factors. For instance, [Freund \(2005\)](#) find that reversals of current accounts are associated with 10-20 percent real exchange rate depreciation. Assessing the role of exchange rates in current account persistence, [Gnimassoun and Mignon \(2015\)](#) show that current account imbalances among industrialized countries are due to exchange rate misalignment. [Arghyrou and Chortareas \(2008\)](#) also find significant relationships between the current accounts and the real exchange rate while examining the link between current account adjustments and effective exchange rates for the euro zone. For his part, [Cheung et al. \(2013\)](#) shows that the real effective exchange rate is one of the cyclical factors that narrow the current account. Furthermore, according to the exchange rate regime of a country the scale of current accounts is different. The current account is more likely to be large in the member countries of a monetary union as a result

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of the unique monetary policy (Herrmann and Jochem, 2013).

Overall, the literature remains mostly inconclusive with regard to the fundamental drivers of global current account imbalances. On the one hand, structural factors that drive disequilibria between savings and investment seem fundamental, including demographic trends and productivity developments. On the other hand, policy and institutional factors, such as fiscal and exchange rate policies, openness to trade, and financial market developments, are also likely to explain a large part of the current account configuration at the global level.

## 1.3 Global imbalances and current accounts

### 1.3.1 Definitions

Global imbalances are defined in a number of ways. Chinn (2013a) defined it as pertaining to international relationships. They include the current account, the private financial account, or official reserves transactions. The link between these variables is presented as follow:

$$CA + KA + ORT \equiv 0 \quad (1.3.1)$$

where CA is the current account, KA the private financial account and ORT the official reserves transactions.

In policy debates “global imbalances” expression usually refers to “current account imbalances” (Borio, 2016; Chinn, 2013a). The term “imbalances” refers to an excess in current accounts (deficits or surpluses) (Chinn, 2013a). Statistically, according to the IMF “the current accounts shows flows of goods, services, primary income, and secondary income between residents and nonresidents”<sup>3</sup>. From this definition, we can note:

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<sup>3</sup><http://datahelp.imf.org/knowledgebase/articles/484331-what-is-the-current-account-in-the-balance-of-paym>

$$CA = TB + IB + SB \quad (1.3.2)$$

where TB is the trade balance, IB the primary income balance and SB the secondary income or transfers. Simplifying 1.3.2 by setting income balances equal to  $rB_{-1}$ , we can write:

$$CA = TB + rB_{-1} \quad (1.3.3)$$

It is equal to the sum of the net investment income ( $rB_{-1}$ ) and the balance of trade (TB). It emphasizes the importance of both the dynamics of trade and the flow of income from foreign investments in determining the overall external position of a country.

Note also that the net external position, B, cumulates the current account and interest payments on previous net asset positions:

$$B = (1 + r)B_{-1} + CA \quad (1.3.4)$$

where B is the net external position and r the interest rate. It suggests that the overall external position in the current period is equal to the external position in the previous period, adjusted by the rate of return on foreign assets plus the current account balance.

## 1.3.2 Current account determinants

### 1.3.2.1 The accounting of current accounts

The analysis of current accounts imbalances usually starts with simple national account identities. Equation 1.3.5 provides the equality of Gross Domestic Product (GDP) with its demand components:

$$Y = C + I + G + X - M \quad (1.3.5)$$

where Y is GDP, C is private consumption expenditures, I is gross private domestic investment, G is government spending, X exports and M imports.

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Noting that the trade balance is:  $TB = X - M$ ; and the national income is  $N = Y + rB_{-1}$ , Eq. 1.3.3 and 1.3.5 can be written as:

$$N = C + I + G + CA \quad (1.3.6)$$

As savings,  $S$ , can be defined as national income less private and public expenditures, i.e.  $S = N - C - G$ , the current account is therefore the difference between savings and investment:

$$CA = S - I \quad (1.3.7)$$

We can finally decompose savings into private savings  $S_p = N - C - T$  and public savings  $S_g = T - G$ , where  $T$  represent taxes.

$$CA = S_p + S_g - I \quad (1.3.8)$$

This accounting reminder is useful as it allows us to articulate the various determinants that will be tested in the remainder of our chapter. We can classify the various determinants into five broad categories:

First, Eq (1.3.3) states the relationships between the current account and the trade balance. Hence, any factor that affect the trade performance will have an impact on current account developments. This includes competitiveness indicators as well as openness to trade. Second, Eq (1.3.3) also relates the current account with income payments on net foreign assets. Therefore, the net external position matters in defining current account sustainability. Third, Eq (1.3.8) points to determinants that influences private sector savings. Structural factors, such as demographic trends, that justify saving accumulation by households may therefore be important motives to explain the current account determination. Fourth, Eq (1.3.8) also points to the role of public sector savings as a current account determinant. The literature on twin deficit focuses on the relationship between current accounts and fiscal deficits. Finally, the last term of Eq (1.3.8) relates to investment. Factors influencing invest-

ment like productivity or convergence forces of poor countries towards frontier technology levels can therefore justify current account deficits. Factors that strengthen the attractiveness of countries (institutions, financial market development) can also represent driving forces for investment and could justify a country to run current accounts deficits. Let us see now these various factors in more detail, in particular as regards their measurement.

### 1.3.2.2 Trade factors

Trade factors include both openness and competitiveness variables. Trade openness is one of the current account determinants identified by [Chinn and Prasad \(2003a\)](#). It was also used to explain the global pattern of current account imbalances by [Gruber and Kamin \(2007\)](#). The trade openness is the sum of imports and exports relative to GDP. We expect that the larger the opening, the more negative the current account, as in [Chinn and Ito \(2007\)](#).

Competitiveness variables include both a positive and normative indicators. The positive indicator is the Real Effective Exchange Rate, which *measures the development of the real value of a country's currency against the basket of the trading partners of the country. An increase in the index indicates appreciation of the home currency against the basket of currencies of trading partners*<sup>4</sup>. The increase also indicates that exports become more expensive and imports become cheaper. Hence, an increase indicates a loss in trade competitiveness (IMF<sup>5</sup>). A change in the variable is therefore related to movements in the prices of imported and exported goods with possible impact on the current account. For the expected sign of this variable, we will refer to the Marshall-Lerner (M-L) conditions on the appreciation/revaluation and depreciation/devaluation of the exchange rate and the trade balance. Provided that the sum of the price elasticity of demand for exports and imports are greater than 1, the Marshall-Lerner conditions indicates that a depreciation leads to an improvement in the trade balance, and the same holds when an appreciation leads to a trade balance deterioration. We, thus, expect a negative relationship between the Real Effective Exchange Rate and the current account ([Aristovnik, 2006](#); [Altayligil and Çetrez, 2020](#)). In our empirical

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<sup>4</sup><https://www.bruegel.org/2012/03/real-effective-exchange-rates-for-178-countries-a-new-database/>

<sup>5</sup><https://datahelp.imf.org/knowledgebase/articles/537472-what-is-real-effective-exchange-rate-reer>



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analysis, we will use annual data for a panel of bilateral pairs of 172 trading partners for each country.

We also use a measure of currency misalignment as a normative indicator. *A currency misalignment can be defined as a gap between a country's real exchange rate and its equilibrium level* (Coudert et al., 2013). Some studies in industrialized countries found that this variable is one of the determinants of the persistence in current account imbalances (Gnimassoun and Mignon, 2015). In particular, this indicator allows us to account for exchange rate policy (or exchange rate manipulation) in the persistence of current accounts surpluses.

### **1.3.2.3 Net external position factors**

Expressed as a share of GDP, the Net Foreign Assets (NFA) help to determine the role of net external position on the current accounts, as it affects current accounts through the net investment income. A negative value of the NFA refers to a high level of indebtedness. In countries where the NFA is negative, the current account is expected to improve in order to meet their long-term debts and financial obligations. At the same time, these countries record negative income flows that have important effects on the current account. Thus, the expected sign is ambiguous. In our regressions we will use its lagged value expressed as a ratio to GDP (as in Gruber and Kamin, 2007). This way of using the variable in our regression avoids the problem of correlation with our dependent variable, as this variable is the accumulation of past current account balances.

### **1.3.2.4 Private saving factors**

The determinants of private savings behaviors all relate to a countries' demographic structure. To capture the impact of demographic variables on the current accounts, we use two population proxies: youth dependence ratio and old-age dependence ratio. The youth dependent ratio is the ratio of younger dependents, people younger than 15 years old, to the working-age population, aged between 15-64. The old-age dependent ratio is the ratio of older dependents—people older than 64 years, to the working-age population aged between

15 and 64. Some predictions of the life-cycle consumption theory give us pieces of information about consumption behaviors at different ages. While young households tend to borrow, middle-age households save for retirement and households in retirement dissave (Modigliani and Brumberg, 1954; Gruber and Kamin, 2007). In this context, countries with elderly and young populations will run current account deficits due to the consumption behavior of these age groups of the population. We expect therefore that high dependence ratios have negative impacts on current accounts as in Chinn and Prasad (2003a) and Gruber and Kamin (2007).

#### **1.3.2.5 Public saving factors**

To account for public finances, we use the cyclically-adjusted balance of the general government sector, i.e. adjusted for the effects of the business cycle. It is expressed as a percentage of potential GDP (named also as fiscal balance in the rest of our analysis). These include temporary movements in the financial sector and in asset prices, as well as in the one-off or temporary income or expense items. According to the theory we expect that the fiscal balance has a positive impact on the current account (Obstfeld and Rogoff, 1998), as it is known as one of the determinants of current account persistence (Clower and Ito, 2012). A deterioration in public finances leads to a current account deterioration. This is known in the literature as the twin deficits and has been interpreted using two perspectives. The first perspective is related to the Mundell–Fleming model (Fleming, 1962; Mundell, 1963) and suggests that current account deficits are caused by budget deficits through an increase in consumer spending and hence imports (Alleyne et al., 2011). The second is related to the Ricardian Equivalence Hypothesis (Barro, 1989), under which a deterioration in public finances is counterbalanced by an equivalent improvement in private savings so that the overall impact on the current account is marginal.

#### **1.3.2.6 Investment attractiveness factors**

The factors explaining investment are multiple. They concern first the future economic prospects of a country. If a country is in a convergence process, a variable like GDP per

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capita can be used to capture capital flows among countries with different levels of GDP. According to the Lucas' paradox theory, capital should flow from capital-intensive, richest countries to labor-intensive, poor countries, the latter running as a result, current account deficits while the developed countries run current account surpluses. We expect therefore a positive relationship between GDP per capita and current accounts as in [Gruber and Kamin \(2007\)](#) and [Roldos \(1996\)](#). Measures of productivity can also be used to account for investment needs. The GDP growth will first be used as a proxy of changes in productivity growth. An increase of GDP growth should lead to a deficit in the current account ([Gruber and Kamin, 2007](#)). We will also use the data of total factor productivity expressed at constant national price.

Attractiveness factors also depend on the quality of institutions. To capture the impact of institutions on current account variations, we use indicators for government stability, socioeconomic conditions, corruption, investment profile, law and order as well as internal conflict.

- Government stability refers to its ability to implement the declared programs. It refers also to the government's ability to stay in office. This index score ranges from 0 to 4. The score 4 means that the risk is very low and a score 0 corresponds to a very high risk. This index is the sum of three subcomponents, including government unity, legislative strength and popular support.
- The socioeconomic condition indicator corresponds to the *assessment of the socioeconomic pressures at work in society that could constrain government action or fuel social dissatisfaction*. It is calculated by taking into account three sub-components: unemployment, consumer confidence and poverty. These sub-components are rated on a scale of 0 to 4. When a sub-component scores 4, it expresses a very low level of risk and when it takes the value of 0, it represents a very high risk. The main variable is the sum of these sub-components (rate from 0 to 12 points).
- The corruption variable refers to the assessment of corruption within the national political system. This kind of corruption can be a threat and obstacle to foreign invest-

ment. It can have negative consequences on the economic environment, reduce the efficiency of governmental actions and businesses and create political instability.

- The investment profile of a country captures all the other factors impacting the risk to investment that are not covered by political, economic and financial components. The risk is rated from 0 to 4 points which respectively means very high and very low levels of risk. The risk rating of this variable is the sum of three subcomponents: contract viability/expropriation, profits repatriation, payment delays.
- Law and order refers to the strength and the impartiality of the legal system and the popular observance of the law. The rate is ranged from 1 to 3. A high rating 3 means that the country can enjoy a high level of its judicial system. When the country suffers from a very high level of crime and when the law is not applied, the rate is 1.
- Internal conflict refers to political violence in countries and its impact on governance. The highest rate corresponds to countries where the government does not face armed or civil opposition. It refers also to the situation where the government does not use arbitrary violence, direct or indirect violence against its people. The lowest rate refers to the situation of countries that are deeply involved in a civil war. The rate is ranged from 0 to 4. A very low risk corresponds to 4, while the very high risk corresponds to 0. The subcomponents that make up this variable are : civil war, terrorism and civil disorder.

Finally, we include indicators that reflect the financial development and the financial stability of a country. With a poorly developed (or unstable) financial system, it is unlikely that foreign investors will channel investment in a country and national savers will tend to buy foreign assets to store their savings. We use three indicators to measure the quality of the financial system. First, we use a financial development index, calculated as a relative ranking of countries on the depth, access, and efficiency of their financial institutions and financial markets (Svirydzenka, 2016). This variable is an aggregate index of financial institution and financial market indexes. It impacts the current account through savings behaviors.

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A country with well-developed financial system will benefit from improved resource allocation and lower risk. According to the theory, however, higher returns – due to a better resource allocation – and lower risks have an ambiguous effect on the saving rate (Levhari and Srinivasan, 1969) and our empirical evidence will shed some light on such effects. Second, we also include the Financial Openness indicator as measured by Chinn and Ito (2006), this index captures the level of capital openness of a country. Third, we add to our determinants, a financial crisis indicator. For this indicator, we construct our own variable based on past financial crises. We use the recent database constructed by Nguyen et al. (2022). For each country, they list the number of crises that have occurred in the course of a year. These include banking, currency, debt, twin, and triple crises. We create an "all crises" variable (the sum of all crises). Finally, we construct a crisis dummy variable as an indicator for financial crisis. It takes the value one if a country has experienced a crisis (if there is at least one crisis) and zero otherwise. To reduce the influence of the dummy variable in the case of frequent crises, we construct a new crisis variable using the method of Gruber and Kamin (2007). We transform our crisis dummy into a relative measure. We thus compute a weighted average of the GDP per capita of the crisis dummy. We then correct this value for the initial value to obtain the new crisis variable.

## 1.4 Model and data

### 1.4.1 Methodology

To understand the relationship between the current account balance and its determinants, we use a panel data model. Our estimation strategy is mainly inspired by the approach in Chinn and Prasad (2003a) and Gruber and Kamin (2007). We run a fixed effects model taking into account cross-sectional dependence. Instead of constructing multi-year averages of annual observations as in Chinn and Prasad (2003a) and Gruber and Kamin (2007), we use an unbalanced panel data covering the period 2000 to 2019 with 84 advanced, emerging and low income countries. In our study, the current accounts—expressed as a share of GDP—serve as our dependent variable and the econometric specification used is as follows:

$$Y_{it} = \alpha_i + \beta X_{it} + \mu Z_{it} + u_{it}$$

Where  $i$  and  $t$  are respectively the country index and the time index.  $Y_{it}$  (for country  $i$  at time  $t$ ) represents the current account balance,  $X$  is a vector of macroeconomics variables and  $Z$  represents the set of the other variables, including financial indicators and institutional variables.  $\alpha_i$  is the unobserved time-invariant individual effect,  $u_{it}$  the error term,  $\beta$  and  $\mu$  the estimated parameters. To analyze the relationship between our dependent and independent variables, we perform the Hausman test to verify the nature of the specific effects. Between the fixed-effects model and the random model, the test suggests the use of the fixed model. The results are presented in the table [Table 8](#).

The fixed-effects model suggested by the test results ([table 8](#)) cannot be used here in its basic form due to certain particularities of our study. These particularities stem from the potential problem of cross-sectional dependence. Indeed, in our study we take into account the cross-sectional dependence that may occur in a simple fixed-effects analysis using the test proposed by [De Hoyos and Sarafidis \(2006\)](#) and [Pesaran \(2004\)](#). The test does not reject the cross-sectional dependence hypothesis (see [Table 9](#)). In the presence of cross-sectional dependence, it is also important to test the presence of an autoregressive order one process. Following the approach described in [Baltagi \(2012\)](#), we find the presence of an autoregressive order one process (see [Table 10](#)). To correct problems that may occur, we use a panel-corrected standard error estimation proposed by [Blackwell III \(2005\)](#). [Blackwell III \(2005\)](#) proposed an estimator that allows us to deal with the presence of cross-sectional dependence and the presence of an autoregressive order one process. This procedure consists of adding an option to the model using a panel-specific AR(1) autocorrelation structure.<sup>6</sup>

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<sup>6</sup><https://www.stata.com/manuals13/xtxtpcse.pdf>

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## 1.4.2 Data

There are numerous empirical studies that have examined the determinants of current account imbalances, allowing us to include some common variables used in the literature. These variables are net foreign assets, oil dependence, trade openness, fiscal policy, the stage of economic development, institutional variables, financial and economic crises, exchange rate, and demographic variables. The impact of these variables on the current account differs across empirical strategies used and across countries. Following the theoretical discussions, we include in our exercise variables such as GDP per capita, growth, population variables composed of age dependency ratios, trade openness variable, financial development. We include other control variables such as currency misalignment, net foreign assets, real exchange rates, total factor productivity variable, financial openness, the financial crisis indicator (mentioned above), and institutional variables. Data sources are listed in the appendix ([Table 2](#)).

## 1.5 Results

### 1.5.1 Data snapshot

The sample in this chapter covers a total of 84 countries. It is divided into emerging markets (40 countries), advanced markets (24 countries), and low-income countries (20 countries). The study period spans from 2000 to 2019. Before running our regressions, we drop some outlier countries that have a lot of missing data. A quick analysis shows that during our study period, the maximum value comes from Algeria in 2006 (25 percent of GDP). The minimum value comes from Tajikistan, on the eve of the GFC, in 2007 (-32 percent of GDP). On average over our period, the current account is in deficit, with an average of -2 percent [Table 3](#). The same is true for emerging markets and low-income countries, where the average is -1.3 and -5.5 respectively. In the advanced market subsample, however, it is almost balanced (0.1) (see [Table 4](#) and [Table 5](#) and [Table 6](#)). The graph below, in line with what has been said, shows the average current account balance over the period 2000-2019 for our three sub-samples.

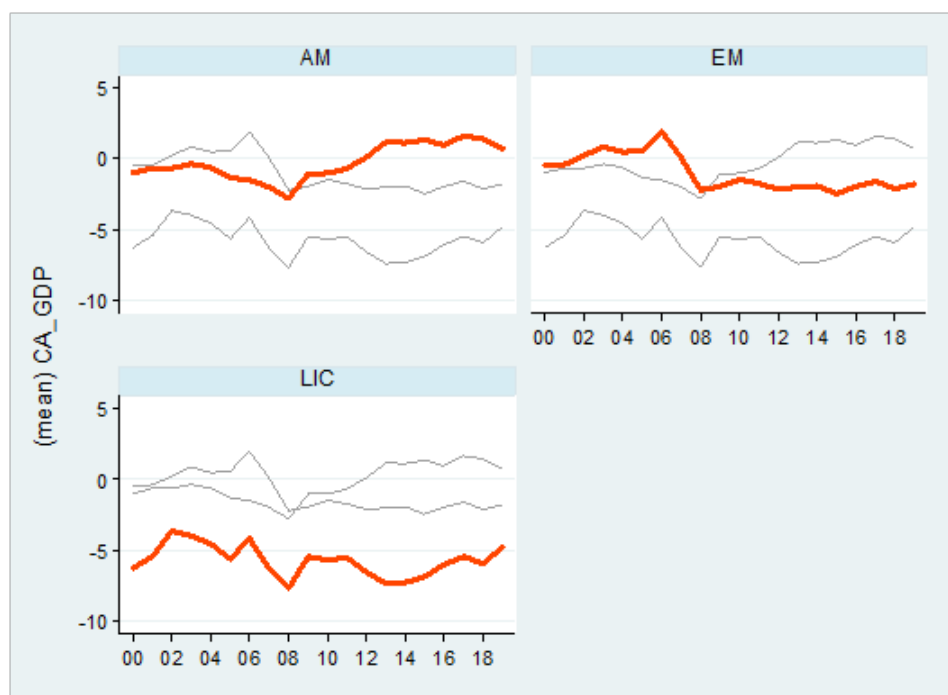


Figure 1.2: Current Account (mean)

**Note:** x-axis represents year, AM: Advanced Market, EM: Emerging Market, LIC: Low Income Countries. The graphs are produced by calculating the average current account for each sub-sample.

## 1.5.2 Estimation results

Table 1.1 presents our econometric estimates for several traditional current account determinants. The model is estimated using an initial sample of 84 countries.

The first three models test some traditional determinants of the current account (fiscal balance, demographic factors, net foreign assets, GDP per capita, GDP growth, real exchange rate, trade and financial openness). The variables used in the first row are those most commonly used in empirical studies. Since our paper pays special attention to the global financial crisis, we add variables related to the financial crisis (columns 2 and 3). In column 3, we try to estimate the impact of a future crisis. Finally (column 4), we add to the variables in column 2 a variable that takes into account openness in the context of a financial crisis (we test the impact of the interactive variable of economic crisis and trade openness). The first row for each variable in our tables shows the estimated coefficients, and the second row shows the value of the t-statistic. The stars next to the estimated coefficients indicate the



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level of significance of our variables.

The results of the first three models give us estimated coefficients with the expected signs. In the full sample results, current account surpluses are associated with higher levels of fiscal balance, net foreign assets and per capita income. Lower current account balances are associated with higher, old age ratio, real effective exchange rate, trade openness and financial openness. Large surpluses are associated with higher income levels in all models whether in emerging, advanced or low-income countries. The effect on GDP growth is ambiguous depending on the model. Larger current account balances are associated with higher growth in advanced and low-income countries while they are associated with lower growth in emerging markets, with significant effects (Chinn and Prasad, 2003a; Gruber and Kamin, 2007; Chinn and Ito, 2005). The youth dependency ratio variable (youth age ratio) is positively associated with current account balances except in low-income countries. The positive effect of the youth dependency ratio is consistent with the life-cycle theory. A higher youth dependency ratio should have a positive impact on the current account balance by increasing the share of savers in the population. In our context in the General Model, in both emerging and advanced countries, we can say that the youth age ratio is driven more by the working-age population. This is the case in the baseline models (as in Gruber and Kamin (2007)). The effect is significant for advanced countries. In low-income countries, the youth age dependency ratio is negatively associated with the current account balance. In contrast to emerging and advanced countries the results show that the youth dependency ratio in low-income countries is driven by the birth rate. And when the birth rate drives the youth age dependency ratio, it implies that the share of non-savers in the population is important (The IMF (2017) External Sector Report).

As for the old-age ratio (old dependence ratio), it does not seem to be significant in our general models. However, when we look separately at advanced, emerging, and low-income economies, we find that it has opposite signs across subsamples. In emerging markets, the old-age ratio is negatively associated with the current account balance, as in the general models. Although not significant, this result is consistent with the life-cycle model, which suggests that a higher old-age dependency ratio should lead to a lower current account

balance. It is a consequence of the higher share of consumers or borrowers relative to savers (The IMF (2017) External Sector Report). In advanced economies, the old-age ratio is positive and significant. This effect can be interpreted as a problem in terms of public policy to encourage consumption. It can also be a consequence of uncertainty, with consumers preferring to save their money rather than spend it. We can also interpret it as solidarity between the older and younger generations. The older generation may be concerned about the future of their children or grandchildren, so they reduce their consumption and continue to save to help the younger generation face possible economic problems. In low-income countries this may be mainly due to lack of investment.

Another finding of this first set of estimation results concerns the role of the real exchange rate. An appreciation of the country's currency leads to a lower current account balance. The appreciation makes imports cheaper and exports more expensive, leading to a deterioration of the trade balance through competitiveness losses.

In terms of trade and financial openness, lower current account balances are associated with higher trade and financial openness. It is worth noting that for developing countries, trade openness could play the same role as the financial openness indicator. Based on the analysis of Chinn and Prasad (2003a), trade openness can be used as a proxy for trade liberalization, receptiveness to technology transfer and the countries capacity to service external debt through exports earnings. Following this reasoning, foreign capital may tend to go to countries with more exposure to international trade. In their paper, they examined the positive relationship between trade openness and national investment in developing countries and found results consistent with those reported in Lane (2004). Our results are in line with these findings. Higher trade openness is associated with current account deficit. Looking at the subsample decomposition, we can say that the results are mainly driven by low-income countries, where the impact is significant, and by emerging economies (Chinn and Prasad, 2003a). In advanced countries, the impact is not significant but it gives us information about the impact of a country's integration into global value chains. At a general level, we find that the more a country is integrated into global value chains, the more likely it is to run current account deficits. But this is not the case for advanced countries, where it

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is associated with surpluses.

Our results on the financial openness variable show that in surplus countries excessive capital mobility could lead to a current account reversal, while in deficit countries excessive capital mobility can worsen external accounts. We also find that, at least for advanced countries, the combined effect of trade openness and financial crisis is associated with current account deficits in emerging and advanced countries, but not in low-income countries. The explanation for the positive and significant effect of the interactive variable in low-income countries comes from the role of trade openness described above. We mention that trade openness could lead to an increase in foreign capital and thus domestic investment. Logically in the presence of a financial crisis, the inflow of foreign capital decreases and so does domestic investment.

Regarding the fiscal balance variable, our estimated coefficients are significant and larger than those estimated by [Gruber and Kamin \(2007\)](#), [Chinn and Prasad \(2003a\)](#) and [Busière et al. \(2005\)](#). The value ranges (for significant values) from 0.33 to 0.79. An increase in the budget balance leads to current account surpluses. According to the relationship between the current account and the budget balance described above, this result confirms the twin deficit hypothesis. In an economy where economic agents are not fully Ricardian, the fiscal balance (either through tax cuts or spending increases) could lead to trade and current account deficits. This positive relationship between the fiscal balance variable and the current account appears in all of our models except in advanced markets, unambiguously confirming that agents are not fully Ricardian.

Turning to the financial crisis indicator, we find that it has a positive impact on the current account. This effect may be due to the policies adopted by countries during the crisis period. We have tried to understand the impact of future crises by introducing a crisis variable, which is calculated by taking into account the financial crisis variable one year ahead to compute the current year estimates (model 2.1 in [Table 1.1](#)). A future crisis occurrence appears to have also a positive impact on the current account balance.

Overall, this first set of results confirms the role of the traditional determinants

of the current account, while showing different effects depending on the type of countries considered.

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 2.1	(4) Model 3	(5) Emerging Market	(6) Advanced Market	(7) LIC
<i>Fiscal balance</i>	0.330*** (0.0455)	0.332*** (0.0458)	0.332*** (0.0454)	0.333*** (0.0455)	0.791*** (0.0629)	-0.0711 (0.0633)	0.124*** (0.0384)
<i>LagNFAGDP</i>	1.426** (0.648)	1.533** (0.650)	1.481** (0.649)	1.526** (0.651)	2.304*** (0.712)	0.600 (0.597)	1.575* (0.911)
<i>logGDPpercapita</i>	3.156*** (0.976)	3.108*** (0.946)	3.086*** (0.955)	3.116*** (0.945)	0.280 (0.992)	0.121 (1.655)	0.267 (1.463)
<i>GDPgrowth</i>	-0.00637 (0.0398)	0.000847 (0.0408)	-0.00579 (0.0401)	0.00159 (0.0408)	-0.0901* (0.0521)	0.0296 (0.0555)	0.0183 (0.0587)
<i>Youth ratio</i>	0.00709 (0.0336)	0.00752 (0.0324)	0.00796 (0.0329)	0.00839 (0.0322)	0.0346 (0.0377)	0.221*** (0.0750)	-0.151*** (0.0483)
<i>Elderly ratio</i>	-0.0634 (0.0561)	-0.0536 (0.0549)	-0.0569 (0.0547)	-0.0511 (0.0545)	-0.0357 (0.0765)	0.337*** (0.0713)	0.0806 (0.543)
<i>Exchange rate</i>	-0.0238** (0.0108)	-0.0224** (0.0108)	-0.0241** (0.0107)	-0.0229** (0.0108)	-0.0109 (0.0108)	-0.0116 (0.0131)	-0.0329 (0.0224)
<i>Trade openness</i>	-0.0277*** (0.00951)	-0.0262*** (0.00942)	-0.0265*** (0.00937)	-0.0265*** (0.00942)	-0.00832 (0.00816)	0.00407 (0.00795)	-0.133*** (0.0178)
<i>Financial Openness</i>	-2.280** (1.072)	-2.211** (1.057)	-2.189** (1.037)	-2.235** (1.061)	-2.288* (1.177)	0.368 (2.385)	-0.269 (1.563)
<i>Financial_Crises</i>		0.565* (0.327)		0.160 (0.650)	1.740** (0.764)	-0.0185 (0.887)	-3.038** (1.427)
<i>Financial_Crises<sub>+1</sub></i>			0.0761 (0.316)				
<i>CrisesxOpenness</i>				0.00533 (0.00933)	-0.0155 (0.0109)	-0.00297 (0.0108)	0.0771*** (0.0251)
Constant	-23.74** (10.12)	-23.78** (9.804)	-23.32** (9.934)	-23.84** (9.776)	1.572 (10.79)	-15.71 (15.85)	15.28 (14.77)
Observations	1,660	1,660	1,660	1,660	793	475	392
R-squared	0.159	0.165	0.162	0.165	0.338	0.147	0.413
Number of idcoun	84	84	84	84	40	24	20

Standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

**Notes:** Prais–Winsten regression, correlated panels corrected standard errors (PCSEs) estimations. Standard errors are reported in parentheses

Table 1.1: Basic estimations

Our results show that the less integrated a country is in global value chains, the more it runs current account deficits. As noted in [Gruber and Kamin \(2007\)](#), financial crises act as a stimulus to the current account in general. In our case, this positive effect is mainly due to emerging countries. This result may explain the surpluses observed in these emerging countries over our study period (see [Figure 1.1](#)). Furthermore, we note that trade openness could lead to an increase in foreign capital and therefore domestic investment. In the pres-

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ence of a financial crisis, the inflow of foreign capital logically declines, as does domestic investment. It is interesting to note that in low-income countries, financial crises combined with a high level of openness lead to current account surpluses, mainly due to a decrease in foreign capital, which also leads to a decrease in domestic investment.

Given the impact of the GFC on the overall current account (presented in [Figure 1.1](#)) and the results of the variable financial crisis, we check whether the GFC has implied structural changes between the current account and its traditional determinants. To this end, we perform Chow tests to check whether the coefficients are different according to the different samples considered. These results are presented in the appendix ([Table 7](#)). The results do not fail to reject the hypothesis of no structural break. Thus, the GFC seems to play an important role in the determination of the current account balance. We then run our regressions taking into account the global financial crisis. We divide the time into before and after, and also use a multivariate approach. Moreover, since these determinants are structural, they could also incorporate changes that the crisis could have brought about.

### **1.5.3 Estimation before and after the GFC**

#### **1.5.3.1 The sample division approach**

To better understand the implications of our results, we conduct another set of estimations dividing our regression period into two subsamples. The first period is the the pre-GFC years (from 2000 to 2007), and the second period is the the post-GFC years (from 2009 to 2019). As above, we distinguish—in addition to a whole sample model—separate models for emerging and for advanced economies.

[Table 1.2](#) shows the estimates of the general model using model 3 from our first estimation table (the results of the other models are presented in the Appendix, [Table 13](#), [Table 14](#)). Comparing the first and second columns, we find notable differences for certain variables, such as the real exchange rate, the old-age ratio and trade openness. Current account surpluses are associated with a higher exchange rate after the GFC. Before the crisis,

the real exchange rate contributed to current account deficits, while after the crisis, the real exchange rate leads to current account surpluses. The negative impact of the old-age ratio highlighted above is significant before the GFC and becomes positive and insignificant afterwards. This effect in the general model is similar to the results for this variable in emerging markets. Furthermore, with respect to the two age-related ratios as a whole, we find that they affect countries differently in the three country subsamples considered. In advanced countries, both before and after an increase in the age ratio, the variables are positively associated with an increase in the current account balance. In low-income countries, they are associated with current account deficits. While the role of trade openness changes in emerging and advanced countries after the GFC, the negative effect described above does not hold for low-income countries. The positive effect in emerging and advanced countries can be interpreted on the export side, as the post-crisis economic recovery boosts exports.

Net foreign assets seem to play a significant role both before and after the GFC. In the subdivided sample, their role is the same in terms of the sign of the effect. With the exception of the pre-crisis model in advanced markets, the effect is significant everywhere. The effects of financial openness remain the same before and after the GFC. Financial openness always has a negative and significant effect on the current account balance, with the same sign as in [Table 1.1](#). However, in the subsample of emerging and advanced countries, its effect is insignificant in some models. The financial crisis variable is significant only in pre-crisis models (in country group models). In emerging and advanced countries, the effect is similar to that in the global models. The occurrence of a financial crisis is associated with current account surpluses. In low-income countries, they reduce current account balances. The interactive variable of financial crisis and openness reduces pre-GFC current account balances in emerging markets, while it has a positive impact on current accounts in low-income countries. The effect of GDP per capita does not change between pre- and post-crisis. In the country subsample models, the effect is significant only in the pre-crisis model for advanced markets and in the post-crisis model for low-income countries.

VARIABLES	(1) Pre-GFC	(2) Post-GFC	(3) EM Pre-GFC	(4) EM Post-GFC	(5) AM Pre-GFC	(6) AM Post-GFC	(7) LIC Pre-GFC	(8) LIC Post-GFC
<i>Fiscal balance</i>	0.226*** (0.0589)	0.490*** (0.0599)	0.659*** (0.104)	0.838*** (0.0749)	0.121 (0.111)	0.0655 (0.0671)	0.0921** (0.0387)	0.494*** (0.144)
<i>LagNFAGDP</i>	2.791*** (1.026)	3.543*** (0.746)	3.329*** (0.868)	3.674*** (0.975)	0.626 (0.669)	2.902*** (0.773)	1.661** (0.770)	3.479* (1.913)
<i>logGDPpercapita</i>	4.753*** (1.039)	2.569*** (0.687)	0.832 (0.628)	0.422 (0.908)	6.264** (2.432)	-1.289 (2.257)	1.534 (2.752)	3.372** (1.361)
<i>GDPgrowth</i>	0.107 (0.0839)	-0.00878 (0.0433)	0.0566 (0.0889)	-0.0505 (0.0629)	-0.0337 (0.115)	0.0663 (0.0625)	0.129 (0.0973)	-0.152* (0.0861)
<i>Youth ratio</i>	0.00164 (0.0454)	0.00901 (0.0253)	0.0214 (0.0414)	0.0291 (0.0366)	0.234*** (0.0533)	0.255*** (0.0769)	-0.0959** (0.0438)	-0.127*** (0.0282)
<i>Elderly ratio</i>	-0.320*** (0.0891)	0.0269 (0.0356)	-0.273*** (0.0780)	0.0532 (0.0499)	0.255*** (0.0771)	0.250*** (0.0593)	-0.814 (0.548)	-0.642* (0.350)
<i>Exchange rate</i>	-0.0126 (0.0150)	0.0198* (0.0109)	0.0134 (0.0157)	0.0102 (0.0120)	-0.0179 (0.0181)	0.0326** (0.0159)	-0.0119 (0.0328)	-0.0156 (0.0201)
<i>Trade openness</i>	-0.0300* (0.0153)	0.00646 (0.0109)	-0.00755 (0.0148)	0.0181* (0.0100)	-0.0287*** (0.00667)	0.0366*** (0.00920)	-0.194*** (0.0359)	-0.126*** (0.0260)
<i>Financial Openness</i>	-4.364*** (1.334)	-1.869** (0.815)	-3.756*** (1.021)	-1.094 (0.811)	-3.974 (3.465)	-5.156* (2.798)	-2.020 (2.790)	-1.521 (1.445)
<i>Financial_Crises</i>	0.539 (1.228)	-0.686 (1.014)	4.453*** (1.384)	0.146 (1.034)	2.686** (1.258)	-0.263 (1.123)	-6.847*** (1.684)	1.310 (2.045)
<i>CrisesxOpenness</i>	0.0143 (0.0194)	0.0154 (0.0134)	-0.0474** (0.0229)	0.00975 (0.0130)	-0.0336 (0.0246)	0.00579 (0.0125)	0.167*** (0.0397)	-0.0248 (0.0337)
<i>Constant</i>	-34.18*** (11.04)	-25.68*** (8.040)	-1.801 (6.020)	-5.292 (10.79)	-69.54*** (23.27)	-0.0604 (21.32)	6.435 (22.25)	-6.634 (12.86)
Observations	654	922	313	440	187	264	154	218
R-squared	0.314	0.306	0.536	0.408	0.455	0.328	0.514	0.460
Number of idcoun	84	84	40	40	24	24	20	20

Standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 1.2: Estimations before and after the 2008 GFC

### 1.5.3.2 The dummy variable approach

As described above, the first approach helps to understand the dynamics of current accounts before and after the GFC, but it leads us to observations losses. We complete the analysis with another approach. Indeed, to avoid the loss of observations, we conduct a second approach based on dummy variables. We first create a dummy variable for periods before and after the GFC. We then interact our main variables with the dummies, as the [Table 11](#) shows. When we detail our results ([Table 11](#)), we find that they are not so different from the previous approach. The fiscal balance variable remains positive and significant after the GFC. The youth ratio remains negative and significant before and after the GFC. This approach shows us that GDP per capita, net foreign assets, old age ratio, trade openness and GDP growth are only significant before the GFC. [Table 11](#), which presents the results of all variables in-

teracting with the before/after crisis variable, shows that the impact of the financial crisis is negative and non significant before and after the GFC. The interactive variable of crises and openness remains positive over the two periods. Financial openness changes sign and becomes significant after the GFC.

We also run a series of regressions that include a year dummy variable. We create a dummy variable for each year and also specifically for the years 2007 and 2008 which are the years of the beginning of the GFC. The estimation (see [Table 12](#)) using the dummy of the year 2008 gives the expected result about the negative impact of the GFC (which occurs in the year 2008) on the current account. For the 2008 dummy, the impact is significant. It leads countries into deficits and also reduces surpluses through public spending in response to the crisis. Regarding the financial crisis variable, the general estimation (column 1 of the [Table 12](#)) shows a positive and insignificant impact. The rest of the results are consistent with the baseline model.

The results of these different approaches tell us a number of things. The fiscal balance, net foreign assets and GDP per capita appear to play an important role, both before and after the GFC. The role of the exchange rate differs before and after the GFC. Before, it contributed to current account deficits but afterwards, it contributes to surpluses. Age ratios are particularly important in the current account surpluses of advanced countries before and after the GFC. In low-income countries, they are associated with current account deficits. In emerging countries, their role is ambiguous. In both emerging and advanced countries, trade openness is sensitive to the global financial crisis. In both categories of countries, it is negatively associated with the current account balance before the GFC, and significant only in emerging countries. After the crisis, it contributes significantly to current account deficits in both cases. The positive effect for emerging and advanced economies can be interpreted on the export side, as the economic recovery after the crisis stimulates exports.

Again, we find that the interactive variable of financial crises and openness leads to current account surpluses. The mechanism is the same as explained above. Indeed, in these countries, financial crises combined with a high degree of openness lead to current account



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surpluses, mainly due to a reduction in foreign capital, which also leads to a reduction in domestic investment. In the case of emerging markets, this may be mainly due to savings behavior. Savings may decline with the crisis. Even if the effect is not significant in advanced countries, deficits can be explained by lower savings.

This section helps us to better understand the role of crises and the GFC in particular. The first approach shows that financial crises generally play an ambiguous role in determining the current account. They play an important role in emerging, advanced and low-income countries. In the first two categories of countries, they contribute to current account surpluses, while they reduce them in the last category of countries. We use the dummy year 2008 to assess the impact of the major event that occurred in that year on the current account. 2008 was the year of the GFC. The results suggest that the GFC was associated with the current account deficit.

In addition to the variables used in this section, in the following section we specify more comprehensive models to improve our understanding of current account dynamics across countries and over time. In particular, we include the role of financial development, currency misalignment, financial openness and institutional quality variables in explaining current account trends and differences across countries.

#### **1.5.4 Financial development, currency misalignment, institutional quality and current accounts**

To improve the ability of our model to explain global imbalances, we introduce additional variables to account for financial development, exchange rate policy, and institutional quality. The results are reported in Table 1.3. As described above, we use the financial development index developed by the IMF in our regressions. In the literature, some authors have used the share of private credit in GDP and financial depth as measures of financial development (Kennedy and Slok, 2006; Gruber and Kamin, 2007; Cheung et al., 2013; Allegret et al., 2014; Altayligil and Çetrez, 2020). High financial development is associated with current account deficits. Our results are significant in the first model and insignificant in the others,

but the negative impact remains consistent. The negative effect can be interpreted as a consequence of financial development on saving behavior. Indeed, financial development eases the access to capital for financing investment and allows an increase in capital inflows into countries. A country with a better financial system is associated with less risk and lower information costs to obtain credit from banks. The cumulative effects of financial development and financial openness reduce the savings rate and thus increase investment. The increase in investment tends to reduce the current account balance and thus increase deficits. Our results are consistent with previous work on the role of financial development in explaining the current account balance (Chinn and Ito, 2005; Cheung et al., 2013; Kennedy and Slok, 2006; Altayligil and Çetrez, 2020). In their study, Gruber and Kamin (2007) also found negative effect, but they were not significant but Altayligil and Çetrez (2020) found significant impact.

Currency misalignment appears to increase current account deficits in our sample. When the gap between the real exchange rate and its equilibrium level is large, it leads the current account into a deficit position. Referring to the definition of currency misalignment given above, it appears that an overvaluation of the currency leads to current account deficits. These results are consistent with the work of Gnimassoun and Mignon (2015) concerning industrialized countries.

Among the institutional variables, we find that the ability of governments to implement declared programs (the government stability variable) is a factor in improving current accounts. Savings increase due to confidence in governments. Indeed, stability in government also prevents the implementation of sudden policies that could undermine savings. When a country's population has a high level of trust in the government, people are more likely to save. Citizens in this situation can then plan for the future with confidence through all kinds of investment plans. This situation is explained in the case of some northern European countries running surpluses. We also use the corruption variable as an institutional variable. It renders public policy ineffective. Corruption leads to illicit financial flows between countries. Corruption increases the cost of investment and therefore the amount of investment. This has a negative impact on current account balances (Keita et al., 2023). It is

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also a source of political instability in a country. The strength and impartiality of the judicial system and the population's respect for the law, as measured by the "law and order" variable, are negatively associated with current account balances. When a country has a high standard of justice, it attracts foreign capital. Domestic investment will therefore increase, leading to a decrease in the current account balance. In addition to the law and order variable, socioeconomic conditions (very low risk of socioeconomic pressure), an internal conflict (very low risk of conflict), and the country's investment profile lower (very low investment risk) are negatively associated with current account balances through their impact on domestic investment.

Like the financial development variable, the financial openness indicator contributes to current account deficits by allowing capital to move between countries and then increasing investment in countries that can attract capital flows. These are the countries with the most developed financial sectors. And, as mentioned above, countries with investment needs have current account deficits, which explains the negative signs associated with this variable in our results.

Finally, we test the impact of productivity on the current account balance. This test is carried out using the "real total productivity" variable. As a reminder, productivity is defined as the ratio, in volume, between production and the resources used to obtain that production (INSEE, The French National Institute of Statistics and Economic Studies)<sup>7</sup>. An improvement in productivity means that the economy becomes increasingly competitive and able to produce goods at a lower cost. Our results show that an increase in productivity leads to a decrease in the current account balance. Indeed, an increase in productivity that leads to the production of goods at a lower cost makes the country more competitive vis-à-vis foreign countries and thus contributes to an increase in the country's exports and thus to an improvement in the current account balance. However, this is not the case in our results. The negative impact is consistent with previous works on productivity and current accounts (Glick and Rogoff, 1995; Bussière et al., 2010; Dieppe et al., 2012; Pivoňka, 2014). This can be explained by the fact that when productivity improves in good times, the increase it generates

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<sup>7</sup><https://www.insee.fr/en/metadonnees/definition/c1452>

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5	(6) Model 6
<i>Fiscal balance</i>	0.155*** (0.0441)	0.181*** (0.0445)	0.195*** (0.0446)	0.200*** (0.0449)	0.195*** (0.0450)	0.210*** (0.0448)
<i>LagNFAGDP</i>	0.492 (0.517)	1.458*** (0.508)	1.406*** (0.504)	1.415*** (0.504)	1.566*** (0.498)	1.522*** (0.498)
<i>logGDPpercapita</i>	5.347*** (1.148)	5.059*** (1.124)	5.015*** (1.078)	5.016*** (1.093)	5.538*** (1.202)	5.510*** (1.157)
<i>GDPgrowth</i>	0.0298 (0.0415)	0.0360 (0.0425)	0.0344 (0.0424)	0.0350 (0.0423)	0.0385 (0.0424)	0.0355 (0.0423)
<i>Youth ratio</i>	0.113*** (0.0409)	0.102*** (0.0356)	0.0950*** (0.0340)	0.0917*** (0.0338)	0.0991*** (0.0365)	0.0912*** (0.0345)
<i>Elderly ratio</i>	0.144** (0.0589)	0.143*** (0.0548)	0.142*** (0.0546)	0.137** (0.0549)	0.145*** (0.0547)	0.148*** (0.0545)
<i>Exchange rate</i>	-0.00856 (0.0129)	0.00361 (0.0127)	0.00193 (0.0126)	0.00236 (0.0127)	0.00150 (0.0126)	0.000355 (0.0125)
<i>Trade openness</i>	-0.0362*** (0.00941)	-0.0168** (0.00760)	-0.0159** (0.00737)	-0.0166** (0.00741)	-0.0170** (0.00775)	-0.0168** (0.00758)
<i>Financial Openness</i>	-4.092*** (1.191)	-3.529*** (1.170)	-3.446*** (1.141)	-3.614*** (1.158)	-3.360*** (1.178)	-3.246*** (1.145)
<i>Financial_Crises</i>	0.00668 (0.643)	-0.0457 (0.626)	-0.0238 (0.621)	-0.000721 (0.631)	0.110 (0.646)	0.112 (0.641)
<i>CrisesxOpenness</i>	0.00574 (0.00925)	0.00123 (0.00905)	0.000707 (0.00895)	0.000555 (0.00903)	-0.000807 (0.00930)	-0.00105 (0.00922)
<i>Productivity</i>	-10.62*** (3.111)	-10.83*** (2.812)	-10.69*** (2.797)	-10.69*** (2.768)	-11.58*** (2.727)	-11.30*** (2.708)
<i>Financial development</i>	-3.801** (1.864)	-2.463 (1.717)	-2.341 (1.689)	-2.107 (1.703)	-0.117 (1.673)	-0.200 (1.667)
<i>Currency misalignment</i>	-4.210*** (1.581)	-3.870** (1.523)	-3.586** (1.509)	-3.559** (1.526)	-3.838** (1.516)	-3.517** (1.515)
<i>Investment profile</i>		-0.566*** (0.119)	-0.487*** (0.122)	-0.491*** (0.122)	-0.465*** (0.113)	-0.399*** (0.116)
<i>Government stability</i>				0.000607 (0.0937)	0.00711 (0.0896)	0.0705 (0.0932)
<i>Socioeconomic conditions</i>					-0.386** (0.167)	-0.399** (0.164)
<i>Corruption</i>					-0.469* (0.240)	-0.502** (0.231)
<i>Law and order</i>					-0.184 (0.278)	-0.0876 (0.274)
<i>Internal conflict</i>			-0.326*** (0.109)	-0.342*** (0.115)		-0.317*** (0.116)
<i>Constant</i>	-41.43*** (11.44)	-36.21*** (11.15)	-33.27*** (10.57)	-32.83*** (10.82)	-37.34*** (11.99)	-35.26*** (11.35)
Observations	1,325	1,249	1,249	1,249	1,249	1,249
R-squared	0.144	0.177	0.187	0.189	0.187	0.203
Number of idcoun	67	63	63	63	63	63

Standard errors in parentheses

\*\*\* p&lt;0.01, \*\* p&lt;0.05, \* p&lt;0.1

Table 1.3: Estimation of the general model taking into account exchange rate and institutional factors

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does not cover the deficit created by consumers spending on imports. In fact, current account deficits are cyclical. Their evolution follows the mechanism of increased imports in periods of favorable economic growth.

With regards to financial development, the variable is significant only in the first model. Current account deficits are associated with financial development. This result complements the work of [Gruber and Kamin \(2007\)](#) and is in line with [Chinn and Ito \(2005\)](#), who use private credit as an indicator of financial development. We also find that currency overvaluation leads to current account deficits. All institutional variables used (with the exception of the government stability variable) are negatively associated with current account deficits. A country's productivity also plays an important role in understanding the current account balance. We find that it is negatively associated with the current account balance. As a robustness analysis, we carry out the same analyses using a more powerful estimator that takes into account possible endogeneity problems: the system-GMM. We also run this with models before and after the GFC.

## 1.6 Robustness analyses

### 1.6.1 Generalized Method of Moments

To check the robustness of our results, we perform a system-GMM (Generalized Method of Moments) estimation using the same models as in [Table 1.3](#) (the pre- and post-GFC results are presented in the [Table 14](#), Appendix). It is an extension of the standard GMM method for dynamic panel data models first proposed by [Arellano and Bover \(1995\)](#) and further developed by [Blundell and Bond \(1998\)](#). The table below shows the Stata output for the estimator incorporating the moment condition from the level equations and also from the first-differenced equation. This method, by using additional first-differences moment conditions, helps to simultaneously address the issues of endogeneity and serial correlation that can arise in dynamic panel data models. As instruments we use two lags of the dependent variable and one lag of the fiscal balance variable. For the dependent variable (current account balance), the

use of lags stems from the fact that past imbalances affect current consumption and investment decisions through their impact on available resources and financing options (Obstfeld and Rogoff, 1996). And for the fiscal balance, fiscal deficits can lead to higher interest rates and crowd out private investment, thereby reducing net exports (crowding out effect). The results are presented in Table 1.4. The Hansen test and the Arrellano-Bond for AR(2) do not allow us to reject the hypothesis of non-validity of our lagged variables as instruments in level or in difference. The effects for most of our variables are consistent with the baseline results. Fiscal balance, GDP per capita, trade openness, currency misalignment, financial openness, productivity, and some institutional variables (the country investment profile, the internal conflict) have the same sign and significant impact on the current account. Variables with a different impact in terms of sign are not statistically significant. An important observation from these estimates is the role of lagged current accounts. The current account position in the previous year has a positive impact on the current account position. The results show a persistence of imbalances over time. In other words, if a country runs current account surpluses after facing structural challenges or imbalances, these surpluses persist in the following year. Similarly, if a country runs a deficit in one year, these deficits persist the following year.

After checking the robustness of our models, we check whether our models are able to explain the configuration of the current account using the example of a few countries. We then select the variables with the strongest predictions and calculate the contributions of the different variables in explaining the current account configuration.

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5	(6) Model 6
<i>L.CA_GDP</i>	0.773*** (0.0688)	0.741*** (0.0616)	0.743*** (0.0617)	0.742*** (0.0616)	0.738*** (0.0604)	0.741*** (0.0603)
<i>Fiscal balance</i>	0.155** (0.0747)	0.166** (0.0780)	0.161** (0.0772)	0.158** (0.0767)	0.158** (0.0788)	0.155* (0.0785)
<i>LagNFA_GDP</i>	-0.146 (0.306)	0.111 (0.286)	0.135 (0.280)	0.150 (0.279)	0.121 (0.292)	0.134 (0.287)
<i>logGDPpercapita</i>	0.915 (0.554)	1.065* (0.572)	1.079* (0.571)	1.081* (0.573)	1.066* (0.602)	1.059* (0.599)
<i>GDPgrowth</i>	-0.0859 (0.0780)	-0.0740 (0.0794)	-0.0729 (0.0787)	-0.0714 (0.0788)	-0.0746 (0.0791)	-0.0751 (0.0787)
<i>Youth ratio</i>	0.00762 (0.0147)	0.0151 (0.0136)	0.0142 (0.0135)	0.0145 (0.0138)	0.0206 (0.0143)	0.0194 (0.0141)
<i>Elderly ratio</i>	0.0101 (0.0254)	0.0197 (0.0246)	0.0226 (0.0246)	0.0207 (0.0243)	0.0238 (0.0257)	0.0259 (0.0251)
<i>Exchange rate</i>	-0.00322 (0.00770)	-0.00105 (0.00618)	-0.00142 (0.00622)	-0.00205 (0.00622)	-0.00282 (0.00631)	-0.00295 (0.00632)
<i>Trade openness</i>	-0.0105* (0.00573)	-0.00703 (0.00523)	-0.00601 (0.00514)	-0.00617 (0.00514)	-0.00790 (0.00511)	-0.00709 (0.00505)
<i>Financial Openness</i>	-0.474 (0.688)	-0.392 (0.620)	-0.359 (0.618)	-0.407 (0.631)	-0.417 (0.631)	-0.351 (0.630)
<i>Financial_Crises</i>	0.275 (0.651)	-0.0131 (0.571)	0.00221 (0.560)	0.0136 (0.549)	-0.0723 (0.555)	-0.0733 (0.549)
<i>CrisesxOpenness</i>	0.00242 (0.00981)	0.00272 (0.00878)	0.00269 (0.00864)	0.00264 (0.00854)	0.00364 (0.00852)	0.00377 (0.00842)
<i>Productivity</i>	-2.803 (1.947)	-4.882*** (1.476)	-4.815*** (1.442)	-4.841*** (1.432)	-4.929*** (1.475)	-4.786*** (1.447)
<i>Financial development</i>	-0.582 (0.925)	0.179 (0.870)	0.0473 (0.869)	0.0670 (0.872)	-0.0251 (0.901)	-0.260 (0.903)
<i>Currency misalignment</i>	-1.573* (0.866)	-1.592* (0.821)	-1.527* (0.797)	-1.561* (0.801)	-1.670* (0.869)	-1.580* (0.839)
<i>Investment profile</i>		-0.256*** (0.0720)	-0.212*** (0.0726)	-0.205*** (0.0761)	-0.251*** (0.0755)	-0.220*** (0.0735)
<i>Government stability</i>				-0.0521 (0.0699)	-0.0789 (0.0733)	-0.0539 (0.0714)
<i>Socioeconomic conditions</i>					0.117 (0.115)	0.131 (0.115)
<i>Corruption</i>					-0.171 (0.147)	-0.171 (0.145)
<i>Law and order</i>					0.0356 (0.126)	0.0647 (0.131)
<i>Internal conflict</i>			-0.148* (0.0854)	-0.129 (0.0836)		-0.143* (0.0853)
Constant	-4.599 (5.253)	-2.945 (4.926)	-2.195 (4.829)	-1.911 (4.783)	-2.682 (5.007)	-2.056 (4.953)
Observations	1,260	1,188	1,188	1,188	1,188	1,188
Number of idcoun	67	63	63	63	63	63

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 1.4: GMM model results

## 1.7 Model uncertainty and assessment of current account equilibrium levels for selected economies

Before analyzing the contributions of the different variables to the current account dynamics, we test the overall consistency of the various models presented above. The different models estimated allow us to make predictions of the current account or estimates of its equilibrium level, i.e. the current account that would be determined by the various fundamental variables considered. Since the models include different combinations of variables, this section provides a summary of these predictions for selected countries. These predictions allow us to check whether the actual current accounts are in line, or not with their fundamentals and give us an account of model uncertainty around these predictions.

The method is based on our current account equilibrium prediction derived from our 9 different models<sup>8</sup>. Since the predictions are different, we want to see how close the results are. So we compute the mean prediction as well as the deviations around that mean<sup>9</sup>. We then obtain the following graphs. These graphs are useful to illustrate the extent of model uncertainty around our predictions. Hence, the tighter the range around the prediction, the lower the model uncertainty. Model uncertainty is low in the case of Germany, USA and Japan (Graphs in [Figure 1.3](#)).

For Germany, the predictions point to structural surpluses in the current account of about two to four percent of GDP. This result shows that the current level of the German current account is above the predictions. In fact, it is above the upper bound of our uncertainty range, suggesting an excessive surplus compared to fundamentals. For China, our models suggest a current account close to balance or in slight deficit. Thus, the large current account surpluses registered before the GFC appear as clear external imbalances. The recent decline in surpluses is therefore in line with fundamentals as predicted by our models.

For France and Japan, our models indicate structural current account surpluses av-

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<sup>8</sup>We have not included robustness models as this would be redundant

<sup>9</sup>We chose to remove the extreme predictions, i.e. the first and last decile of the distribution



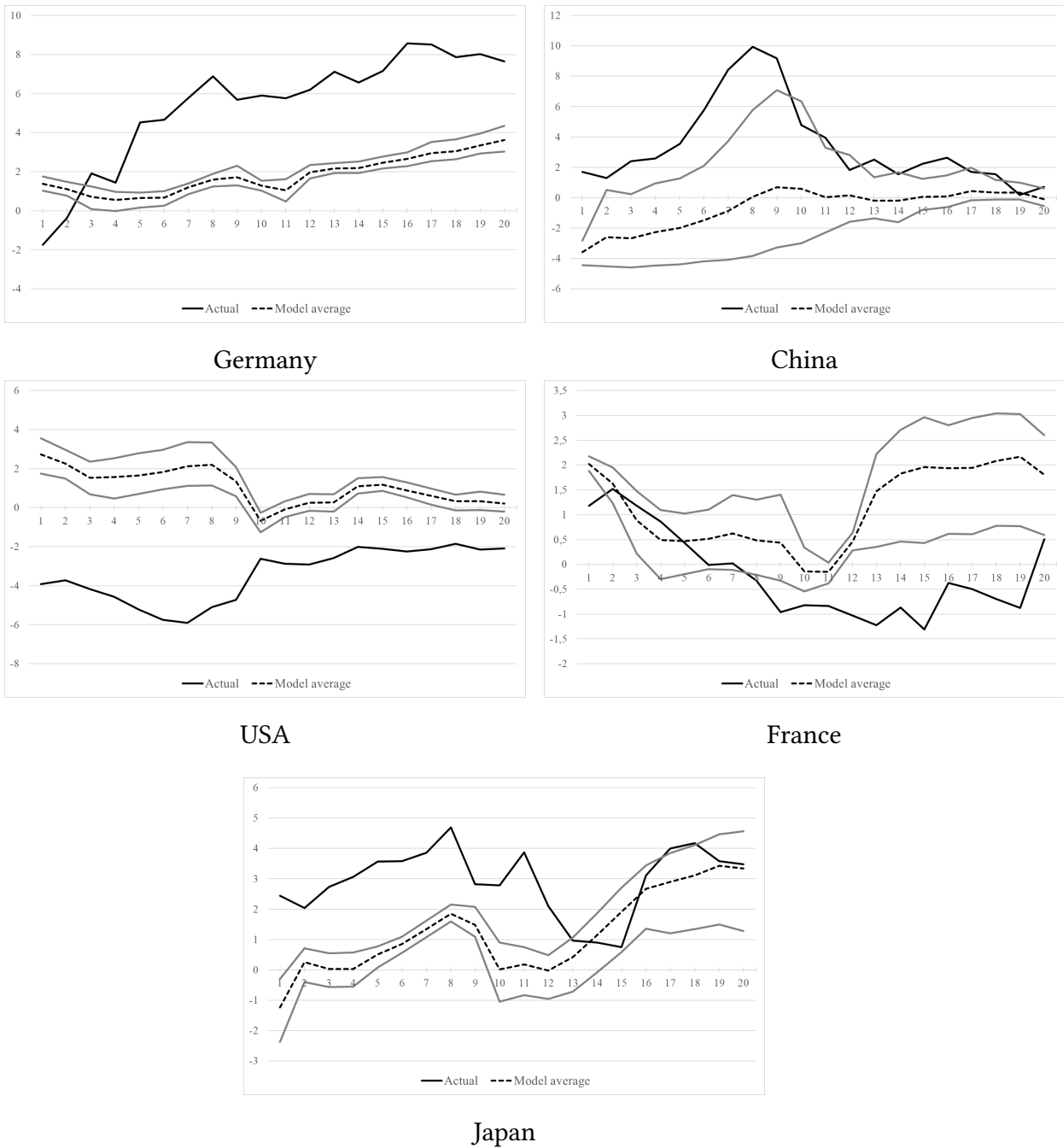
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eraging around 1.2<sup>10</sup> percent of GDP over the period studied (2000-2019). Both the French and the Japanese accounts are currently in this range.

Finally, for the U.S., the predictions point to structural surpluses in the current account of approximately zero to three percent of GDP. The mean is approximately one, and the predictions of our models range from surpluses of approximately 0.5 to 2 percent of GDP. The actual level of the U.S. current account appears below the lower bound of our wide range, suggesting that a current account deficit of more than two percent can be considered excessive.

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<sup>10</sup>calculations based on the data used to draw the graphs



**Figure 1.3: Estimates of current account equilibrium levels and model uncertainty**  
**Note:** Numbers 1 to 20 correspond to the years 2000 to 2019. The term "actual" refers to the actual reported current account and the term "model average" refers to the current account predicted by our models (the current accounts that would be determined by the different fundamental variables taken into account).

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## 1.8 Decomposition of model predictions

Our dataset takes into account current account determinants based on theoretical models and empirical approaches. In addition to the variables suggested by the literature, we use a Bayesian Model Averaging (BMA) approach to select the current account determinants that have real predictive power. Following [De Luca and Magnus \(2011\)](#), we retain auxiliary regressors that are robust. An auxiliary regressor is considered to have a robust correlation with the result if the ratio  $t$  on its coefficient is greater than one in absolute value or, equivalently, if the margin of error of a corresponding norm does not include zero (see [Table 15](#)). The robustness of auxiliary regressors can also be judged by their posterior inclusion probabilities. In fact, a posterior inclusion probability of 0.5 corresponds approximately to a  $t$ -ratio of one in absolute value ([Masanjala and Papageorgiou, 2008](#); [De Luca and Magnus, 2011](#)). The results are presented in the [Table 16](#). Based on variables with real predictive power according to our methodology. The results are presented for the general model and the subsample before and after the GFC.

Based on the results presented in [Table 16](#) (first column), we calculate the predicted current accounts and compare them with the observed current accounts. Both variables are represented as lines in our graphs. We also derive our estimates from the contribution of each explanatory variable by multiplying its estimated coefficient by its observations. In our graphs, the contributions of our explanatory variables are represented as bars. The openness variable combines trade openness and financial openness. The institutional variables include the country's investment profile and internal conflicts. The other variables are fiscal balance, net foreign assets, GDP per capita, the youth dependency ratio and the productivity variable. The variable labeled "other" in our graphs is calculated by subtracting the predicted current account balance (obtained after the regressions). We have presented three sets of graphs. The first shows the results of the general model. The one that considers all the years. The second concerns the years before the GFC and the last the years after the GFC crisis (see above [Figure 1.4](#), [Figure 1.5](#) and [Figure 1.6](#)).

### 1.8.1 What are the main current account balance drivers ?

Figure 1.4, which represents the general pattern of results in Table 16, shows that total factor productivity, openness variables, GDP per capita and institutional factors are the main drivers of current account positions in the selected countries. Therefore, we can say that savings and investment factors are the main drivers of current account prediction. As far as savings are concerned, we have used the age ratios as a proxy for private savings and the fiscal balance as an indicator of public savings. Only the contribution of the public savings factor appears in some of the selected countries. This contribution remains lower than that of investment factors. As mentioned in the definition of variables above, investment factors include GDP per capita, real total factor productivity, openness variables and institutional factors. The Figure 1.4 simply shows that between savings and investment factors, investment factors are the most important in the current account forecast. The "other" component is almost insignificant in the predictions. This also shows that the selected variables have real predictive power and that the regressions take into account country-specific characteristics.

In all selected countries, the productivity factor appears to be one of the positive drivers of current account balances. The share of this variable is higher in China than in the other countries. Since Germany's surpluses have been a challenge for the global economy in recent years, we provide an overview of the reasons for this country's persistent current account situation. In the literature, ethics, vocational training and consumer behavior, as well as the specificity of the euro area, are mentioned as part of the process that leads to current account surpluses in some countries like Germany (Coricelli et al., 2013; Weber, 1904; Rodriguez-Palenzuela and Dees, 2016). Ethics have been mentioned by sociologists and economists to have a significant impact in Protestant countries. They argue that Protestantism is one of the key factors contributing to the economic prosperity of these countries (Weber, 1904; Arruñada Benito, 2010; Becker and Woessmann, 2009; Cantoni et al., 2017). This factor leads to a culture of responsibility among policy makers and risk aversion among households and entrepreneurs (Weber, 1904; Arruñada Benito, 2010; Becker and Woessmann, 2009; Cantoni et al., 2017). Households prefer to save rather than spend to cope

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with potential uncertainties. Similarly, some entrepreneurs or multinational companies prefer to invest more abroad through foreign direct investment rather than invest heavily in their home country. As a result, investment in the country of origin becomes less important. Other important factors relate to the specific nature of the industrial sector. The German manufacturing sector is a key driver of surpluses, thanks to the high quality of its workforce and the reputation of "Made in Germany" products. This development would not be possible without certain changes in the education system, such as the vocational training program. Thanks to this program, the manufacturing sector has continuously produced a cheaper, more skilled workforce. As a result, the non-price competitiveness of German exports has also steadily increased, contributing to the current account position. Moreover, when considering the monetary policy of the euro area, Germany's current account surplus may to some extent reflect the peculiarities of the functioning of EMU (European Monetary Union). The original design of EMU ignored current account imbalances. This mechanism was only implemented in the post-crisis context in 2011. In this context, the monetary policy of the ECB (European Central Bank) may appear too accommodative for countries such as Germany compared to other countries with different characteristics, such as Spain or Italy. These factors contribute to the higher current account position in Germany than in France, both of which are members of the EMU. In this context, it could be useful to address these issues by implementing a policy mix that takes into account this heterogeneity within euro area members. Furthermore, it is important to point out that in our empirical exercise, after selecting the most predictive variables, exchange rate-related factors (including measures of misalignment) were not retained. These need to be verified in subsequent studies.



Figure 1.4: Contributions of fundamental variables to current account predictions (Model 1 of Table 1)

### 1.8.1.1 Before versus after the GFC

In addition to the general analysis of the contribution graphs, we carried out the same analysis before and after the GFC (Figure 1.5 and Figure 1.6). Real total factor productivity, GDP per capita, institutional components and openness are the variables that contribute most to

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the prediction of the current account balance in the selected countries prior to the crisis. The first two variables contribute positively, while the last ones contribute negatively (Figure 1.5). Turning to the post-GFC results (Figure 1.6), in addition to the variables listed in the pre-GFC results, the fiscal balance, net foreign assets and the youth age ratio are the other variables whose contribution becomes important in predicting the current account. However, here the variables that contribute positively to the prediction are real total factor productivity, openness and GDP per capita. Institutions, fiscal balance and youth dependency ratio contribute negatively. The impact of net foreign assets is mixed across countries.

The key finding in these analyses is the magnitude and sign of the contribution of some of these variables before and after the crisis. The contribution of real factor productivity is lower in the prediction of the current account after the GFC than before. GDP per capita and institutional variables remain the largest contributors to the current account prediction. Contrary to the general and pre-GFC results, the role of net foreign assets is important after the GFC. Its effect is positive for countries with traditional current account surpluses (China, Germany and Japan) and negative for countries with current account deficits. The impact of the net external position on the current account is therefore significant after the GFC. This can be seen in the current account trends of the countries mentioned (see the trend of the actual current account in the figure). The fiscal balance is also one of the variables that make a significant contribution to the outcome. Its impact is greater after the GFC than before, particularly in France, Japan and the United States.

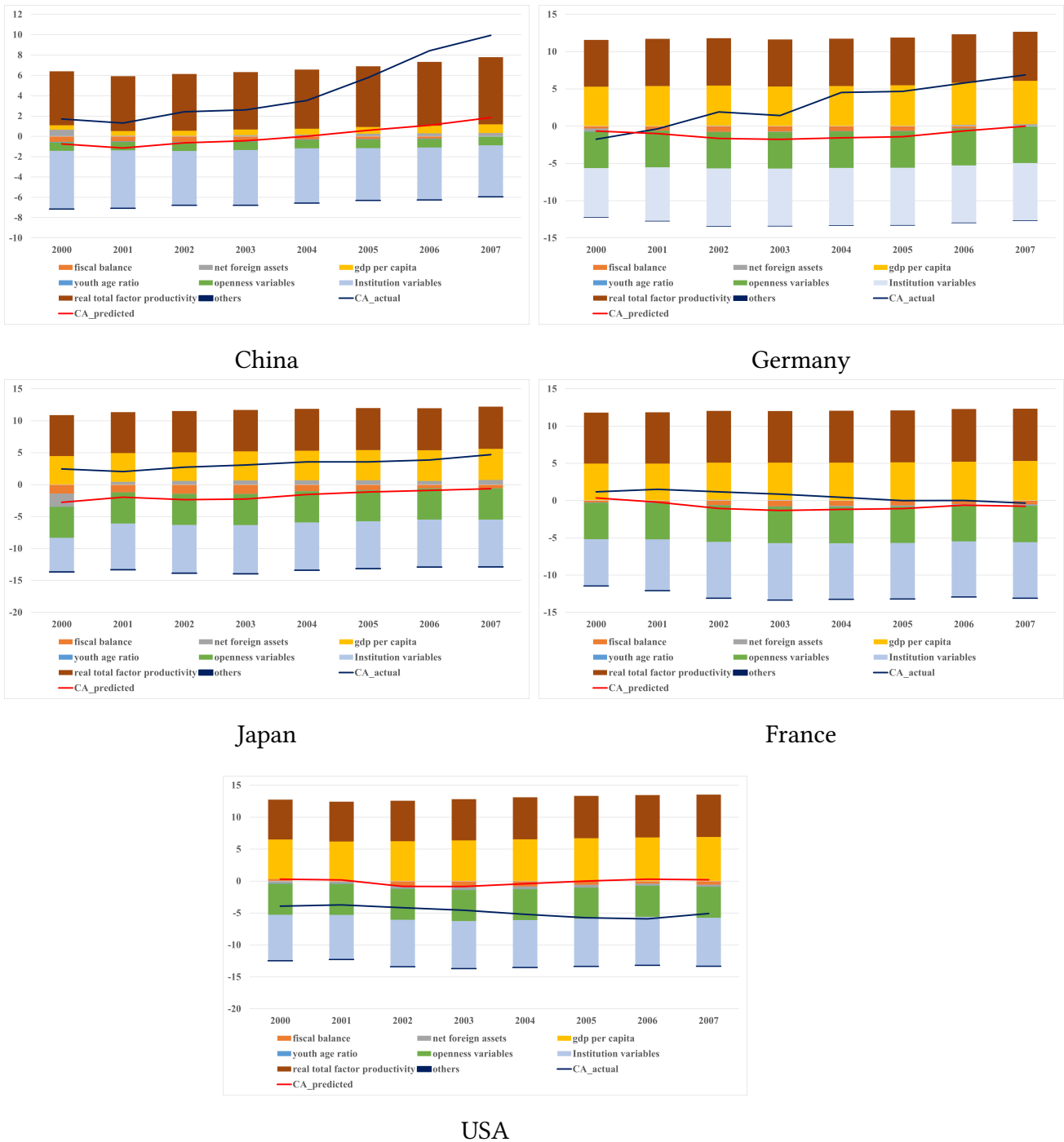


Figure 1.5: Contributions of fundamental variables to current account predictions (Before the GFC)



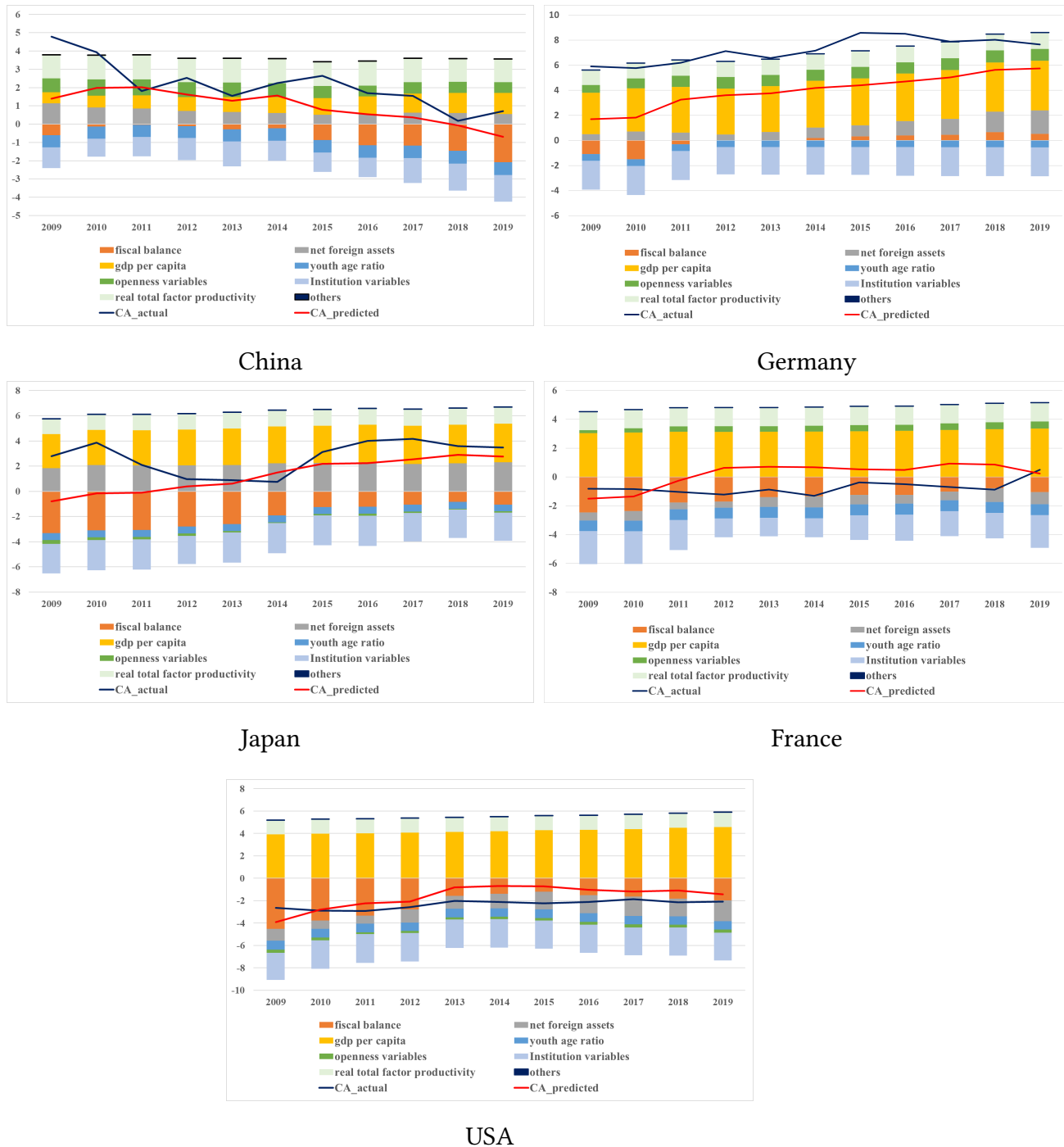


Figure 1.6: Contributions of fundamental variables to current account predictions (After the GFC)

## 1.9 Climate change and current account

In an era where the impacts of climate change are becoming increasingly evident, both public policies and economic strategies are evolving. More countries are embracing greener

economies, which involves investing in environmental transition to counteract global warming. The primary means of initiating these changes is through the implementation of environmental regulations, which can affect domestic investment patterns. Overall, there is mixed evidence regarding the impact of the green transition on fossil fuel investment. While the IMF (IMF, 2022a) has reported a substantial impact on investments made by oil and gas companies, the IEA (IEA, 2022) suggests that net zero commitments thus far have not been associated with fuel spending. These policies, along with increased public awareness, could result in a decrease in both imports and exports of fossil fuel-based products. Consequently, there may be a decrease in investment in the production of goods reliant on fossil fuels. Conversely, this could also lead to an increase in investment in green products. With this in mind, this section is built upon the relationship between the current account and savings and investment, as described above (see 1.3.3). It aims to offer a more thorough examination of how the environmental transition affects the current account. Our analysis will focus solely on variables related to climate change. It's worth noting that the interpretation of other variables remains consistent with previous discussions, as their impact remains unchanged in terms of sign. To gauge climate change and environmental transition, we utilize two variables: the climate change indicator from the Environmental Performance Index of the Yale Center for environmental Law, and the environmentally related tax revenue.

This section draws on chapter 2 of the IMF's External Sector Report (International Monetary Fund, 2022), on climate policies and external adjustment. It contributes to the assessment of the economic impact of climate policies on current account balances. The report examines the impact of five climate change mitigation measures. The first is a credible and globally coordinated carbon tax. The second concerns globally coordinated supply-side policies, such as green subsidies for renewable energy and infrastructure investment. The third is a globally coordinated set of mitigation policies. The fourth tests partial implementation of mitigation policies, and the last tests the impact of increased burden-sharing in emissions reduction<sup>11</sup>. The report shows that current account movements depend on investment responses. The report's conclusions are based on a macroeconomic model developed in the

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<sup>11</sup>consistent with the proposed internationally coordinated carbon price floor

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IMF's World Economic Outlook 2020. It shows that climate change mitigation policy choices could have substantially different medium-term effects on the current account. The impact is felt in savings and investment decisions.

With regard to the first policy, the implementation of a credible, globally-coordinated carbon tax results in a decrease in the current account in the greenest advanced countries. Conversely, the same policy leads to an increase in the current account of fossil fuel-dependent developing economies. This is due to the fact that the implemented tax reduces carbon-intensive investments. At global level, investment is expected to decrease, particularly in countries reliant on fossil fuels<sup>12</sup>. One of the consequences of the decline in global investment is the fall in the global interest rate. Since the latter is linked to global savings, savings will also fall. As for the second policy, a globally coordinated supply-side policy, such as green subsidies for investment in renewable energy and infrastructure, its implementation increases investment and savings as well as the global interest rate. However, this measure has a limited impact on the external sector. The current accounts remains largely unchanged. For the third policy, a set of climate change mitigation policies implemented globally, the global current account is reduced by 25 percent by 2027, while capital flows shift towards the direction of the greener advanced countries ([International Monetary Fund, 2022](#)). As for the penultimate policy, a partial implementation of mitigation policies, its effects depend on the type of policy implemented by the country. For instance, a unilateral carbon tax in Europe increases Europe's current account balance. The increase in the current account comes from a reduction in domestic investment. The tax leads to a movement of capital abroad. In contrast to the current account impact of a unilateral carbon tax, a unilateral green subsidy in Europe increases the response of the external sector by reducing the current account. Finally, increased burden-sharing of emissions reductions, in line with the proposed internationally coordinated carbon price floor<sup>13</sup>, could reduce the size of climate-policy-induced adjustment induced by climate policy between advanced and developing countries by a third.

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<sup>12</sup>In the 2022 WEO this fall in investment in gas and oil sectors is around 40 percent between 2014-2019

<sup>13</sup>October 2022 Fiscal Monitor

### 1.9.1 Climate Change indicator (CCH) from the Yale Center for Environmental Law

The first indicator is the Yale Center for Environmental Law & Policy's Environmental Performance Index (EPI). The EPI ("Environmental Performance Index") provides a data-driven summary of the state of sustainability around the world (Wendling et al., 2020). Using 32 performance indicators across 11 issue categories, the EPI ranks 180 countries in terms of environmental health and ecosystem vitality. These indicators provide a gauge at a national scale of how close countries are to established environmental policy goals. Among the issue-category indicators, the Climate Change (CCH) indicator presented in the Figure 1.7 is particularly relevant for our study as it combines growth rates and intensity of the main greenhouse gas emissions. Figure 1.7 show us that, over the period, it is the countries of the global North that have performed better in terms of meeting environmental policy goals. In our empirical exercise, this index is a weighted sum of seven climate change variables (Assogbavi and Dees, 2023) :  $CO_2$  Growth Rate (CDA),  $CH_4$  Growth Rate (CHA), F-gas Growth Rate (FGA),  $N_2O$  Growth Rate(NDA), Black Carbon Growth Rate (BCA), Greenhouse Gas Intensity Trend (GIB), Greenhouse Gas per Capita (GHP)<sup>14</sup>.

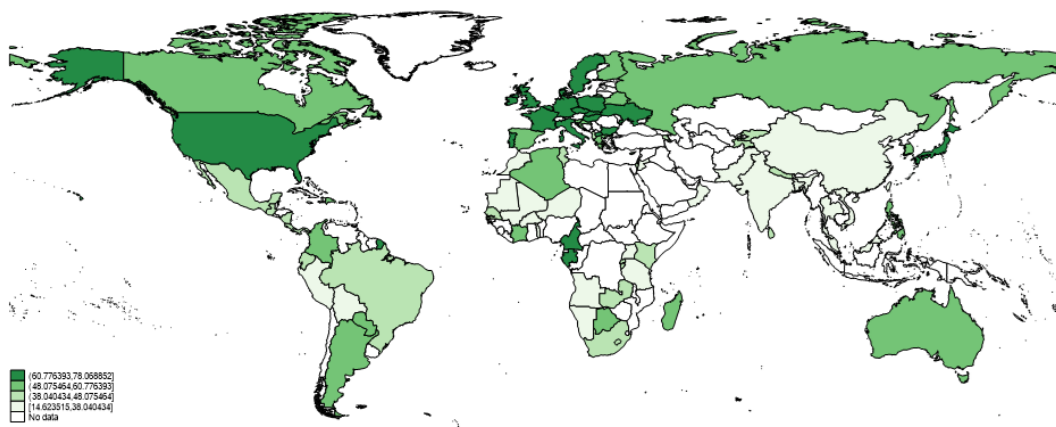


Figure 1.7: CCH, climate change, indicator distribution among countries (The greener the color, the higher the country's environmental performance) source: by author

The graph 1.8 represents the relationship between current account averages and the

<sup>14</sup> $CCH = (CDA * 0.56375) + (CHA * 0.15375) + (FGA * 0.1025) + (NDA * 0.05125) + (BCA * 0.05125) + (GIB * 0.05125) + (GHP * 0.025625)$ . The weights are obtained following data on <https://epi.yale.edu/>.

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climate change variable over the period 2000-2019 for 85 countries. A higher level of climate change performance is associated with current account surpluses. The relationship between these variables is therefore merely descriptive. An econometric analysis is required to confirm or refute this observation. We use the same econometric specification as in all previous analyses, as described in the section 1.4. The results are presented in Table 1.5 below. As can be seen, the climate change (CCH) variable is positively associated with the current account balance. An increase in CCH performance of one unit results in an increase in the current account ranging between 0.05% and 0.08% points of GDP. One explanation could be that tighter environmental regulations lead to a reduction in imports. This reduction could mainly affect fossil fuels and all high-polluting products. It can also be interpreted as the result of a decrease in investment in the production of the high pollution goods (as described above about the implementation of a unilateral carbon tax scenarios in [International Monetary Fund \(2022\)](#) and the results of [Bogmans et al. \(2023\)](#)). The impacts are particularly significant in advanced and low income countries. Our results are consistent with those who suggest an improvement in the current account throughout an improvement of measures reducing dependence on fossil fuels and increasing competitiveness in clean technologies and products ([Ozturk, 2013](#); [Cole and Elliott, 2003](#)). The positive effect on the current account balance, can also be achieved by increasing investment. In the case of Sweden, for example, [Brännlund et al. \(2009\)](#) notes that increased investment in renewable energy contributes to the trade balance by reducing imports and improving the competitiveness of exports.

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Emerging Market	(5) Advanced Market	(6) LIC
Fiscal balance	0.334*** (0.0461)	0.337*** (0.0463)	0.338*** (0.0460)	0.799*** (0.0629)	-0.0446 (0.0614)	0.118*** (0.0365)
LagNFAgDP	1.558** (0.658)	1.650** (0.657)	1.645** (0.658)	2.418*** (0.715)	0.677 (0.587)	1.663* (0.871)
logGDPpercapita	3.076*** (1.002)	3.019*** (0.974)	3.027*** (0.971)	0.279 (0.979)	0.0535 (1.691)	0.566 (1.591)
GDPgrowth	0.000788 (0.0391)	0.00834 (0.0401)	0.00919 (0.0401)	-0.0864* (0.0522)	0.0358 (0.0525)	0.0210 (0.0585)
Youth ratio	0.00679 (0.0348)	0.00650 (0.0336)	0.00771 (0.0333)	0.0304 (0.0383)	0.244*** (0.0775)	-0.135*** (0.0497)
Elderly ratio	-0.138** (0.0635)	-0.131** (0.0611)	-0.127** (0.0606)	-0.0995 (0.0855)	0.282*** (0.0699)	0.124 (0.549)
Exchange rate	-0.0219** (0.0110)	-0.0202* (0.0110)	-0.0208* (0.0110)	-0.00770 (0.0106)	-0.0146 (0.0129)	-0.0287 (0.0222)
Trade openness	-0.0299*** (0.00947)	-0.0282*** (0.00934)	-0.0285*** (0.00933)	-0.00488 (0.00792)	-0.00175 (0.00803)	-0.133*** (0.0175)
Financial Openness	-2.053* (1.082)	-2.048* (1.057)	-2.071* (1.061)	-2.305** (1.140)	0.857 (2.473)	0.430 (1.763)
Financial_Crises		0.569* (0.326)	0.145 (0.650)	1.776** (0.768)	0.132 (0.873)	-2.902** (1.447)
CrisesXopenness			0.00559 (0.00928)	-0.0156 (0.0109)	-0.00520 (0.0104)	0.0660*** (0.0253)
<b>CCH</b>	<b>0.0583***</b> (0.0169)	<b>0.0596***</b> (0.0164)	<b>0.0597***</b> (0.0163)	<b>0.0361</b> (0.0227)	<b>0.0807**</b> (0.0314)	<b>0.0756***</b> (0.0200)
Constant	-24.90** (10.41)	-24.90** (10.13)	-24.99** (10.08)	0.223 (11.05)	-18.76 (16.08)	7.994 (15.60)
Observations	1,660	1,660	1,660	793	475	392
R-squared	0.173	0.180	0.180	0.345	0.163	0.462
Number of idcoun	84	84	84	40	24	20

Standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

**Notes:** Prais–Winsten regression, correlated panels corrected standard errors (PCSEs) estimations. Standard errors are reported in parentheses

Table 1.5: Climate change and current account balance

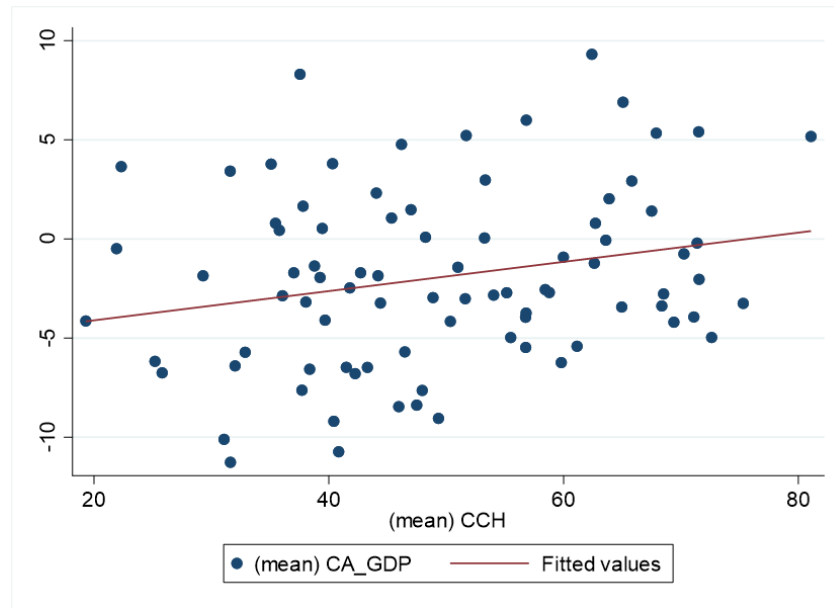


Figure 1.8: Relationship between current account balance (CA\_GDP) and Climate Change indicator (CCH)

## 1.9.2 Environmentally related tax revenue

In addition to the above CCH variable, and to test the robustness of the results we use another policy variable. The second indicator used is the variable of environmentally related tax revenue. It comes from the OECD (Organisation for Economic Co-operation and Development) database of Policy Instruments for the Environment (PINE) originally developed in co-operation with the European Environment Agency (EEA) <sup>15</sup>. The data of this indicator are decomposed into tax-base categories (energy, transport, pollution and resources) and environmental domain (Air pollution, biodiversity climate change and ocean). We use one of the sub-components, namely climate change taxes. This variable includes GHG taxes, fuel taxes, revenues from permits auctioned under GHG emissions trading schemes, energy taxes, road use taxes and forestry taxes. As indicated in the data documentation, environment-related taxes are an important instrument for governments to shape the relative prices of goods and services. It is therefore important to use them to analyze the impact of the ecological transition on the current account balance. Environmentally related tax revenue are therefore used

<sup>15</sup><https://www.oecd.org/environment/indicators-modelling-outlooks/policy-instruments-for-environment-database>

here as a proxy for environmental regulation. A higher level of environmentally related tax revenue translates into tighter environmental regulations.

As with the first indicator, we produce a graph 1.9 showing the relationship between the environmental variable and the current account balance. Although the slope of the adjusted value line is slightly lower than for the first variable, the trend remains the same. A high level of tax revenues is associated with a high level of the current account balance.

Again, we use the econometric specification described in the section 1.4. The results presented below are for advanced and low-income countries only. This is due to a significant lack of data for emerging economies. The econometric results are presented in Table 1.6 and clearly showing that an increase in taxes is positively associated with current account surpluses. A one percent increase in environment-related tax revenues results in an increase in the current account of between 0.875% and 1.979% points of GDP. Our results are consistent with the analysis in the IMF's External Sector Report on the current account impact of a unilateral carbon tax.

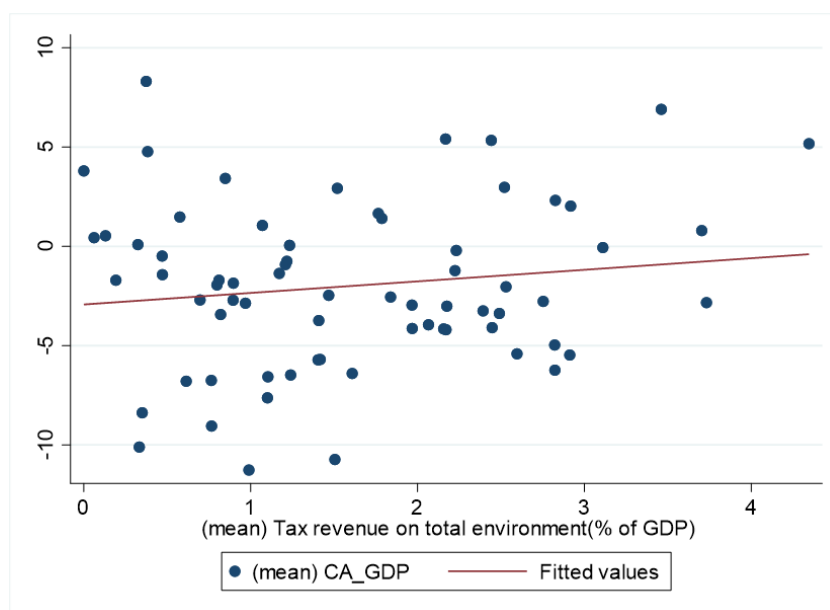


Figure 1.9: Environmentally related tax revenue and CA\_GDP



VARIABLES	(1) LIC and AM	(2) Advanced Market	(3) LIC
<i>Fiscal balance</i>	0.0309 (0.0339)	-0.0836 (0.0640)	0.0954** (0.0372)
<i>LagNFAGDP</i>	0.397 (0.553)	0.659 (0.587)	1.115 (1.113)
<i>logGDPpercapita</i>	1.625* (0.830)	1.619 (1.444)	0.731 (1.301)
<i>GDPgrowth</i>	0.0229 (0.0422)	0.0404 (0.0564)	0.00576 (0.0552)
<i>Youth ratio</i>	0.0234 (0.0351)	0.192*** (0.0611)	-0.149*** (0.0420)
<i>Elderly ratio</i>	0.153*** (0.0538)	0.325*** (0.0685)	-0.164 (0.529)
<i>Exchange rate</i>	-0.0189 (0.0131)	-0.00410 (0.0117)	-0.0613** (0.0271)
<i>Trade openness</i>	-0.0232** (0.00939)	-0.00255 (0.00772)	-0.118*** (0.0198)
<i>Financial Openness</i>	-0.622 (1.571)	-0.512 (2.331)	-0.715 (2.029)
<i>Financial_Crises</i>	0.310 (0.846)	0.259 (0.889)	-1.503 (1.865)
<i>CrisesXopenness</i>	-0.00392 (0.0115)	-0.00522 (0.0108)	0.0308 (0.0318)
<b><i>Environmentally related tax revenue_GDP</i></b>	<b>0.875*</b> (0.480)	<b>1.979***</b> (0.381)	<b>0.144</b> (0.553)
Constant	-18.84** (9.011)	-33.69** (14.10)	15.57 (12.47)
Observations	765	475	290
R-squared	0.253	0.213	0.312
Number of idcoun	39	24	15

Standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

**Notes:** Prais–Winsten regression, correlated panels corrected standard errors (PCSEs) estimations. Standard errors are reported in parentheses. Due to data availability problems for emerging countries with regard to the tax variable, regressions have only been carried out for advanced and low-income countries.

Table 1.6: Climate change related taxes and account balance

## 1.10 Conclusion

This chapter sheds light on variables explaining the persistence of current account imbalances with a special attention to the role of the GFC. Our results show that the more integrated a country is in global value chains, the more likely it is to run current account deficits. We find that financial crises acts as a stimulus to current account balances in general and especially in emerging countries. In the presence of financial crisis, foreign capital inflows logically decline, as does domestic investment. In low-income countries, financial crises combined with a high level of openness lead to current account surpluses, mainly due to a reduction in foreign capital, which also leads to a decline in domestic investment.

It helps us to better understand the role of crises, and the GFC in particular. Using different approaches to account for the GFC, we find that financial crises generally play an ambiguous role in assessing current account balances. In emerging countries, they play an important role. In emerging and advanced countries, they contribute to current account surpluses, while in low-income countries, they are negatively associated with current account balances. As 2008 was the year of the global financial crisis, we use the dummy year 2008 to assess the impact of this major event on the current account. The results suggest that the GFC was associated with the current account deficit. By decomposing our sample into pre- and post-GFC periods and using the dummy variable approach, we find that current account dynamics differ not only across countries but also across time. In assessing the presence of structural breaks from the GFC, we find evidence of the GFC as an important structural change in current account dynamics.

Including the role of financial development, currency misalignment, financial openness and institutional quality variables, we have found that these variables are significant factors impacting current accounts and that their impact passe through the changes in investment and saving behavior. In fact, specifying a full model, our results suggest that current account deficits are associated with financial development. We also find that currency overvaluation leads to current account deficits. As for the institutional variables, all of them<sup>16</sup>

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<sup>16</sup>with the exception of the government stability variable

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are negatively associated with current account deficits. Like the previous variables, current account deficits are associated with a high level of productivity in the country.

To check the robustness of our models we performed the same analyses using a more powerful estimator that takes into account possible endogeneity problems: the system-GMM. After this exercise, we then tested the ability of our models to explain the configuration of the current account using the example of a few countries. We assessed the degree of uncertainty between our models and found that our models are consistent with each other in most cases. Finally, we selected the variables with the strongest predictions and calculated the contributions of the different variables. Our predictions for the current account balance in selected countries underline the role of productivity, openness, GDP per capita and institution factors in the current account evolution. The decomposition before and after the GFC shows that the role of certain variables is more important before and after the GFC. Real total factor productivity, GDP per capita, institutional components and the contribution of openness are important in the pre-GFC results. In addition to pre-GFC variables, fiscal balance, net foreign assets and youth/age ratio also play important roles in post-GFC results.

In light of the IMF's ([International Monetary Fund, 2022](#)) recent external report, we assess the impact of climate change mitigation policies on the current account. We use two variables as policy indicators, a climate change indicator and environmental taxes. Our results suggest that a tightening of environmental policy or a high level of environmental taxes are associated with current account surpluses.

Overall, our results contribute to a better understanding of current account dynamics over time and across countries and show the importance of using factors that go beyond the traditional saving-investment determinants and account for more structural challenges. With respect to the results of the general model and the results for emerging, advanced and low-income countries, resolving global imbalances requires a coordinated international effort. In terms of policy recommendations, our results suggest the importance of international cooperation between countries. This should be encouraged through existing international organizations. This will avoid unilateral actions that could exacerbate imbalances. In addi-

tion, to ensure a sustainable economic environment, the coordination of fiscal and monetary policies should be encouraged. Such coordination can help manage inflation, interest rates and public spending. Moreover, monitoring and early warning mechanism should be set up to detect emerging imbalances at an early stage. Structural reforms should also be implemented to improve competitiveness, productivity and institutions, and reduce trade barriers.

Our results on the impact of climate change and energy transition confirm the fact that climate mitigation policies (implemented unilaterally) increase the current account balance in regions where they are implemented, rather than decreasing it when policies are coordinated. In terms of policy recommendations, international coordination of climate mitigation policies is necessary if policymakers are to achieve the desired effects.



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## ENVIRONMENTAL POLICY AND THE CO<sub>2</sub> EMISSIONS EMBODIED IN INTERNATIONAL TRADE

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*"We are the first generation to feel the impact of climate change and the last generation that can do something about it"*

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– Barack Obama, President of the United States (2008-2016)

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<sup>1</sup>This chapter is co-authored with Stéphane DEES and published in Environmental and Resource Economics. Link: <https://link.springer.com/article/10.1007/s10640-022-00734-6>

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## 2.1 Introduction

As the stringency of climate policies differs across countries, the production of carbon-intensive goods may shift from the most constrained countries to “pollution havens”, i.e. to countries with laxer policies. While data on emissions produced by the countries with most stringent policies point to some declines, they fail to take into account the emissions generated abroad and consumed domestically through imported goods. The emissions embodied in trade (around 8 billion tonnes in 2015) is very large, accounting for a quarter of total global emissions (approximately 32 billion tonnes), and advanced countries are generally net importers of CO<sub>2</sub> emissions, whereas emerging or commodity-producing countries are instead net exporters (Cezar and Polge, 2020). International climate commitments may contribute to this phenomenon as emissions targets differ by country, providing therefore an incentive to offshore highly polluting activities (Peters et al., 2011). This is usually referred to as “carbon leakage”.

The issue of carbon leakage has been discussed quite extensively in the debates related to climate change (IPCC, 2007). It is defined as the increase in emissions in a country A as a result of emission reductions in a country B which has implemented mitigation policies (Peters and Hertwich, 2008). Hence, introducing climate policy measures may increase the cost of regulatory compliance for country B’s firms, giving a comparative advantage to their competitors operating in less regulated economies. To satisfy the final demand of its consumers, country B therefore compensates the shifting of the polluted good production by importing these goods from abroad. The carbon leakage phenomenon reduces the environmental benefits of the policy at the global level while potentially damaging the competitiveness of the economy that commits to emission reductions. Despite the emergence of coordinated commitments of emission reduction at global level (Kyoto protocol or Paris agreement) or regional climate policies (e.g., in the European Union), growth in global CO<sub>2</sub> emissions has remained strong and some studies suggest that the stabilization of emissions in advanced countries was partially the results of growing imports from emerging and developing countries (Peters et al., 2011).

The evaluation of the extent of carbon leakage has given rise to an abundant literature (see an overview e.g., in [Branger and Quirion, 2014](#)). However, most studies concern *ex ante* evaluation with Computable General Equilibrium (CGE) models. They evaluate theoretically the percentage of production that shifts from one country to another in response to a mitigation policy implemented only in the former country. While these studies find the leakage to range between 0 and 130%, the results are highly dependent on the modeling assumptions ([IPCC, 2007](#); [Peters and Hertwich, 2008](#); [Branger and Quirion, 2014](#)). Although these theoretical studies correctly identify the channels and the mechanisms of production shifting and their impact on trade flows, there is little evidence empirically – i.e. *ex post* – that production actually shifts as a result of environmental legislation ([Cole et al., 2005](#); [Spatareanu, 2007](#)). On trade flows, the evidence is also mixed. For instance, [Aichele and Felbermayr \(2015\)](#) conduct an empirical *ex post* evaluation of the Kyoto protocol based on gravity models for the CO<sub>2</sub> content of trade. Based on panel data, they find evidence of carbon leakages, as binding commitments under Kyoto have increased committed countries' embodied carbon imports from non-committed countries by around 8%. Similarly, using data on U.S. regulations and trade with Canada and Mexico, ([Levinson and Taylor, 2008b](#)) find that 10% in net imports could be attributed to regulatory costs over a period from 1977 to 1986. More recently, however, in a study assessing whether the EU emissions trading system (ETS) causes carbon leakage in the European manufacturing sector, [Naegele and Zaklan \(2019\)](#) do not find any empirical evidence in evaluating the effect of four measures of environmental stringency on both net trade flows and bilateral trade flows.<sup>2</sup> Similarly, using a decomposition of U.S. manufacturing greenhouse gas emissions, [Brunel and Levinson \(2021\)](#) do not find any evidence of offshoring either to or from the United States since 1990.

In this chapter, we assess empirically the role of national climate-related legislation as a determinant to explain the bilateral trade in CO<sub>2</sub> emissions across countries. Following the literature on international trade flows, we rely on gravity models estimated on a large panel of countries. Our methodology is similar to [Aichele and Felbermayr \(2015\)](#) or [Duarte](#)

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<sup>2</sup>[Koch and Basse Mama \(2019\)](#), [aus dem Moore et al. \(2019\)](#) and [Dechezleprêtre et al. \(2019\)](#) also empirically reject claims of a substantial industrial relocation caused by the EU ETS that would manifest itself in the erosion of European assets and, consequentially, in emission leakage.



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et al. (2018) as we also base our analysis on gravity equations. However, compared to these previous contributions, our approach is different in three ways. First, we use the data on CO<sub>2</sub> emissions embodied in trade flows produced by the OECD (Yamano and Guilhoto, 2020) on a large set of countries over a more recent period (2005-2015). Second, we pay special attention to all the econometric shortcomings found in previous contributions following Egger and Pfaffermayr (2003) and follow the latest recommendations regarding the estimation of gravity equations. Finally, instead of focusing on the participation or not to the Kyoto protocol or to the implementation on a specific regulation (like EU ETS), we rely on various measures assessing the environmental policy stringency across countries at the world level. These measures allow us to extend previous analyses to a wider range of policy actions that may be more relevant in the present context. In this respect, although our database does not cover the post-Paris Agreement period, our approach could still be useful to assess possible regulatory leakages as our country-specific stringency index could be comparable to climate targets set in a bottom-up process by the Paris-Agreement parties – the so-called Nationally Determined Contributions (NDCs). This process differs from the Kyoto regime, where only the industrialised countries had fixed emission targets, while the vast majority of emerging countries had no obligations regarding their emissions. Hence, as each country individually formulated its NDC in line with its national circumstances, priorities and preferences, the differences in policy stringency may be more relevant. Our *de jure* environmental policy measures are also complemented with *de facto* measures based on environmental outcome, assessing the relative stringency of a country's policy in terms of *ex post* efficiency in reducing actual emissions.

Our results show no evidence of carbon leakage through international trade at the global level. On the contrary, a tightening in environmental policy leads to a reduction in CO<sub>2</sub> emissions embodied in trade. Such emissions are rather explained by usual trade determinants, such as shipping costs or other gravity forces. When breaking down the data by sectors, the effects of environment policy to lower emissions are even stronger for the most polluting sectors. Therefore, the apparent imbalances in CO<sub>2</sub> emissions embodied in trade do not seem to originate from differences in environmental policy but rather by usual

specialisation motives. At the same time, however, we do find evidence of carbon leakage for importing countries with more stringent policy, as the CO<sub>2</sub> of their imports tend to increase when their environmental policy is tightened. We also find that the impact of domestic environment policy measures is larger on exports of CO<sub>2</sub>-intensive goods than on imports, which shows that the virtuous countries from an environmental policy viewpoint tend to import the most from the least virtuous ones. Although our results are related to a pre-Paris agreement context, they are also relevant from a policy perspective. As differences in environmental regulation across countries tends to support trade in carbon-intensive goods, our results point to the importance of international coordination and cross-country harmonization in environmental policy in order to curb CO<sub>2</sub> emissions embodied in trade.

The chapter is organised as follows. Section 2.2 presents the theoretical background and the modelling approach followed in this chapter, sketching the gravity equations used in our empirical part. Section 3.3 presents then the data used in our analysis, detailing the OECD series of CO<sub>2</sub> emissions embodied in trade flows as well as the different measures of environmental policy stringency. Section 2.4 reports and discusses our empirical results. Section 3.6 concludes.

## **2.2 Modelling the CO<sub>2</sub> emissions embodied in trade with gravity equations**

In this section we first give an overview on how to introduce CO<sub>2</sub> emissions in standard gravity models before presenting thereafter its translation into our empirical exercise.

### **2.2.1 Introducing the carbon content of trade in gravity models**

Since the seminal paper of Tinbergen (1962), trade gravity models have been traditionally used to investigate the main determinants of bilateral trade flows. Gravity equations characterize bilateral trade flows in terms of the size of economies and the distance between them. It has been the workhorse model of international trade empirical analysis owing to

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its stability and performance in explaining bilateral trade flows. The empirical validations of the gravity equation (Evenett and Keller, 2002; Helpman, 1987; Hummels and Levinsohn, 1995) is in accordance with the main theoretical models of international trade, including the Heckscher–Ohlin models and the models of the New International Trade Theory (Helpman and Krugman, 1987 or Anderson and van Wincoop, 2003).

Based on assumptions that: (1) consumers follow constant elasticity of substitution preferences, (2) all goods are differentiated by place of origin, and (3) trade costs are borne by exporters, Anderson and van Wincoop (2003) derive a theoretically-based gravity equation as follows:

$$X_{ij} = \frac{Y_i Y_j}{Y} \left( \frac{D_{ij}}{\Pi_i \Pi_j} \right)^{1-\sigma} \quad (2.2.1)$$

where  $X_{ij}$  denotes exports from country  $i$  to country  $j$ ;  $Y$  represents world GDP, and  $Y_i$  and  $Y_j$  denote the GDP of countries  $i$  and  $j$ , respectively.  $D_{ij}$  denotes trade costs between countries  $i$  and  $j$ , and  $\Pi_i$  and  $\Pi_j$  represents respectively trade barriers for country  $i$  in exports and trade barriers for country  $j$  in imports.  $\sigma$  is the elasticity of substitution between all goods.

Using this theoretical model for trade flows, let us now see how to model emissions embodied in trade. CO<sub>2</sub> embodied in exports are calculated with the following equation:

$$C_{ij} = \mu_i \times X_{ij} \quad (2.2.2)$$

where  $C_{ij}$ , a vector of emissions embodied in exports from country  $i$  to country  $j$ . It is the product of a matrix of emissions multipliers ( $\mu_i$ ) and a matrix of trade flows with each element being a bilateral trade flow ( $X_{ij}$ ) between an  $ij$  pair of countries. Emissions multiplier is defined as  $\mu_i \equiv e_i(\mathbf{I} - \mathbf{A})^{-1}$ , i.e. by multiplying production-based emissions intensities,  $e_i$ , by the global Leontief inverse, with  $\mathbf{A}$  the matrix of input coefficients from the exporter's domestic input-output table.

Following [Aichele and Felbermayr \(2015\)](#), we substitute Eq. (2.2.1) into (2.2.2) to obtain a gravity equation for CO<sub>2</sub>. Environmental policy (measured by an indicator noted  $T_i$  and  $T_j$ ) affects the carbon content of trade through the sector's embodied emission intensity  $\mu_i$ , importer's demand and exporter's supply, as well as intermediate consumption. Log-linearizing the resulting gravity equation gives an empirical specification for CO<sub>2</sub> embodied in exports as follows:

$$\ln C_{ij} = \ln Y_i + \ln Y_j + \alpha_1 \ln D_{ij} + \alpha_2 \ln T_i + \alpha_3 \ln T_j + \ln \Pi_i + \ln \Pi_j + \epsilon_{ij,t} \quad (2.2.3)$$

When country  $i$  (the exporter) tightens its environmental policy  $T_i$ , we expect the carbon content of export to decline, i.e.  $\alpha_2 < 0$ . Indeed, when climate policy aims at reducing the production of CO<sub>2</sub> in its economy, the country becomes less specialised in carbon-intensive goods, thus reducing the carbon content of its exports. By contrast, when country  $j$  (the importer) tightens its policy  $T_j$ , should carbon leakage materialize, the carbon export content of export is expected to increase, i.e.  $\alpha_3 > 0$ . To circumvent the environmental policy measures applied to its domestic production, firms (intermediate consumption) and consumers (final consumption) would in that case increase their purchases of carbon-intensive goods from abroad, leading to a higher carbon content of the country's imports.

To account for the relative level of stringency in climate policy between exporters and importers, another specification of Eq. (2.2.3) is also envisaged, considering policy indicators in differences instead of being included separately:

$$\ln C_{ij} = \ln Y_i + \ln Y_j + \alpha_1 \ln D_{ij} + \alpha_4 \ln(T_{ij}) + \ln \Pi_i + \ln \Pi_j + \epsilon_{ij,t} \quad (2.2.4)$$

where  $T_{ij} = (T_i - T_j)/T_j$ , a relative policy indicator that could be interpreted as an index of dissimilarity in environmental policy. We expect  $\alpha_4 < 0$  as a country whose environmental policy is more stringent than its partner's is likely to export goods with a lower

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content in CO<sub>2</sub>. Taking this from the importer's side, it would also mean that environmental policy actions by country  $j$ , lowering  $T_{ij}$ , would imply higher CO<sub>2</sub> intensity of imported goods, supporting the carbon leakage hypothesis.

### **2.2.2 Empirical model for assessing the drivers of CO<sub>2</sub> emissions embodied in international trade**

The ordinary least-squares (OLS) estimator has been the most widely used technique to estimate various versions of the gravity equation. Although similar specifications have been used routinely in the trade literature, many of the gravity estimates are found to suffer from biases and inconsistency, violating gravity theory. As shown for instance by (Heid et al., 2021) or (Yotov et al., 2016), estimating the gravity model is subject to a number of modelling and econometric issues. This includes the facts that the trade barriers (or multilateral resistances) are not directly observable. To control for the multilateral resistances in the structural gravity model, it is recommended to use exporter-time and importer-time fixed effects in the equation. Other econometric issues are related to the presence of zero trade flows and heteroscedasticity in trade data, which makes the OLS estimates biased and inconsistent. To address these issues, an easy and convenient solution consists in applying the Poisson Pseudo Maximum Likelihood (PPML) estimator to estimate the gravity model, using it in multiplicative form instead of logarithmic form. The PPML regression finds its origin in spatial sciences where Davies and Guy (1987) recommended its use instead of the popular Poisson regression. In the international trade literature, the use of the PPML has been popularized by the paper of Silva and Tenreyro (2006), an approach which has been shown to produce less biased parameter estimates. In our empirical exercise, we use the algorithm proposed by Correia et al. (2020) that allows for fast estimation and check in a robust manner for the existence of (pseudo)maximum likelihood estimates. Finally, our environmental policy indicators, being exporter- and/or importer-specific, can be seen as non-discriminatory trade policies. However, in the estimation they will be absorbed respectively, by the exporter-time and by the importer-time fixed effects that need to be used in order to control for the multilateral resistances in the structural gravity model. To overcome this issue, Yotov et al. (2016)

recommend to include in the database intra-national trade in addition to international trade. As non-discriminatory trade policies are country-specific, they do not apply to intra-national trade and, as a result, the inclusion of intra-national trade implies that non-discriminatory variables become bilateral in nature, making their identification and estimation possible. Our empirical exercise will follow all these recommendations.

Based on the best practices and recommendations proposed in (Yotov et al., 2016), our empirical research is therefore based on the following version of the structural gravity model that we have adjusted to our research question:

$$C_{ij,t} = \exp[\gamma_{i,t} + \delta_{j,t} + \mu_{ij} + \alpha_1 D_{ij,t} + \alpha_2 T_{i,t} \times INTL_{ij} + \alpha_3 T_{j,t} \times INTL_{ij}] + \epsilon_{ij,t} \quad (2.2.5)$$

The variable  $C_{ij,t}$  denotes the carbon embodied in export flows, which now includes both international and intra-national trade. The terms  $\gamma_{i,t}$  and  $\delta_{j,t}$  denotes respectively the exporter-time and importer-time fixed effects, which control for any observable and unobservable country-specific factors that may influence bilateral trade (including multilateral resistances, countries' output shares and total expenditure). The term  $\mu_{ij}$  denotes the country-pair fixed effects, which measure all time-invariant gravity covariates as well as any other time-invariant bilateral determinants of CO<sub>2</sub> emissions embodied in trade that are not observable. The pair fixed effects also absorbs most of the linkages between the endogenous environmental policy variables and the error term  $\epsilon_{ij}$ , controlling therefore for potential endogeneity of the former. As, in principle, it is possible that the error term in gravity equations may carry some systematic information about trade costs, we keep the time-varying trade cost variable,  $D_{ij,t}$ , in our equation. The expressions  $T_{j,t} \times INTL_{ij}$  and  $T_{i,t} \times INTL_{ij}$  correspond to the product between our environmental policy indicators for both exporters and importers and the dummy  $INTL_{ij}$ , which takes a value of one for international trade between countries  $i$  and  $j$ , and zero otherwise. This interaction terms is necessary to identify the effects of any non-discriminatory policies, even in the presence of exporter- and importer-time fixed effects as required by gravity theory as explained in (Heid et al., 2021).

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Finally, whether the error term  $\epsilon_{ij,t}$  is introduced as additive or multiplicative does not matter for the PPML estimator ([Silva and Tenreyro, 2006](#)).

## 2.3 Data and variables

### 2.3.1 The OECD data on CO<sub>2</sub> emissions embodied in international trade

The methodology used by the OECD to estimate the origins of CO<sub>2</sub> emissions embodied in international trade and final demand (TECO2 database) is based on equations using vectors of production-based emissions and output multipliers from OECD's Inter-Country Input-Output (ICIO) tables. This accounts for the double counting issues associated with emissions embodied in intermediate trade flows (e.g., exported intermediate products could be used in domestic production processes). The computation follows Eq.(2.2.2). More details about the estimation of emissions embodied in a specific country pair's gross trade flow are available in [Yamano and Guilhoto \(2020\)](#). Compared to other available datasets of CO<sub>2</sub>, the TECO2 data are based on novel approaches that produces improved results. For database construction, the new approaches are mainly related to the allocation of emissions to industries, and to residents and non-residents. In particular, as regards the CO<sub>2</sub> emissions, the OECD has used more detailed information to better allocate emissions to road transportation and fill gaps to estimate territorial emissions. The production-based emissions are therefore fully compatible with the National Accounts framework (SEEA) by adjusting non-resident households and nonresident transportation operators (road, aviation and marine). The resulting allocation of emissions to a more detailed set of industries and countries were then aggregated to match the 36 industries and 65 economies considered in the ICIO system, which was then used to estimate CO<sub>2</sub> emissions, from fuel combustion, embodied in final demand and international gross trade. The updated set of indicators based on gross exports and final demand now include bilateral and industrial dimensions. Another advantage of the TECO2 database is that the embodied emissions also include international bunker fuels. This feature has been by and large ignored in previous studies of the carbon content of trade in the context of carbon

leakage, while it provides an important contribution to the CO<sub>2</sub> footprint of international trade.

The indicators provided by the TECO2 database provides insights about the role played by international trade in the allocation of emissions between consumer and producer countries, revealing the degree to which they are outsourcing the production from their most polluting industries to countries which are less stringent in terms of emission-related regulation. Overall, world CO<sub>2</sub> emissions from fuel combustion increased by about 19% between 2005 and 2015, from 27.1 to 32.3 Gigatonnes (Gt) i.e., an annual growth rate of 1.8%. Among the main exporters of CO<sub>2</sub>, China accounts for 24% of total trade-embodied emissions in 2015 compared with 20% in 2005 and is followed the United States (7%), India (5%), Russia (5%) and Germany (4%). The largest importers are the world's major economies, with the United States and China absorbing together a quarter of trade CO<sub>2</sub> in 2015 ([Cezar and Polge, 2020](#)).

Large advanced economies are generally large importers of CO<sub>2</sub> as they consume more CO<sub>2</sub> than they produce. Conversely, emerging and commodity producing economies are net exporters of CO<sub>2</sub>. Over the period 2005-2015, there was a reduction in net imports of CO<sub>2</sub> emissions by OECD countries from non-OECD economies from 2.1 to 1.6 Gt. However, CO<sub>2</sub> embodied in gross exports increased in most countries and regions with stronger increases in non-OECD countries. The increases in CO<sub>2</sub> embodied in exports in emerging economies are mainly explained by their development process and they remain net CO<sub>2</sub> exporters owing to the expansion of their manufacturing base to meet the consumption needs of more developed economies. The purpose of our empirical exercise will be to assess to what extent environment policy explains part of this worldwide configuration of CO<sub>2</sub> emissions embodied in trade.

As pointed out above, to identify our gravity equations and to avoid environmental policy effects to be absorbed by the exporter-time and by the importer-time fixed effects, we have also added to our database the carbon embodied in intra-national trade. To compute such data, we use OECD data on CO<sub>2</sub> based on production and compute the intra-national



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carbon content of trade by taking the difference with emissions embodied in exports<sup>3</sup>. Finally, as detailed in Section 2.2.2, trade costs are also included in our regressions. Data on trade costs are from ESCAP-World Bank Trade Cost Database. This trade cost measure, based on [Novy \(2013\)](#), is a comprehensive all-inclusive measure based on micro-theory and calculated using macro-economic data. More details on data sources are reported in Appendix A1.

### 2.3.2 Measuring environmental policy stringency

There are several approaches to the measurement of environmental policy stringency ([Botta and Kózluk, 2014](#)). The first category refers to *de jure* indicators reflecting either the signing of international agreements (single policy event) or aggregating data on national legislation regarding diverse policy instruments in order to define a measure of the overall environmental policy stance of a country. The second approach refers to *de facto* indicators reflecting mainly environmental performance or the outcomes of environmental policies.

In our empirical exercise, we will use both approaches. The *de jure* indicator will be the Environmental Policy Stringency (EPS) Index computed by the OECD and the *de facto* indicator will be the Environmental Performance Index (EPI) from the Yale Center for Environmental Law & Policy.

The OECD Environmental Policy Stringency Index (EPS) is a country-specific and internationally-comparable measure of the stringency of environmental policy. Stringency is defined as the degree to which environmental policies put an explicit or implicit price on polluting or environmentally harmful behavior ([Botta and Kózluk, 2014](#)). The index ranges from 0 (not stringent) to 6 (highest degree of stringency). The index covers 28 OECD and 6 BRICS countries for the period 1990-2015. The index is based on the degree of stringency of 14 environmental policy instruments, primarily related to climate and air pollution. The index aggregates information on stringency across selected environmental policy instruments using simple scoring and weighting (see [Figure 2.1](#)). It includes several individual policy in-

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<sup>3</sup>At sectoral level, intra-national trade is computed by multiplying the total production of CO<sub>2</sub> by the weight of each sector (using sector-specific weighting coefficients derived from their carbon content at world level).

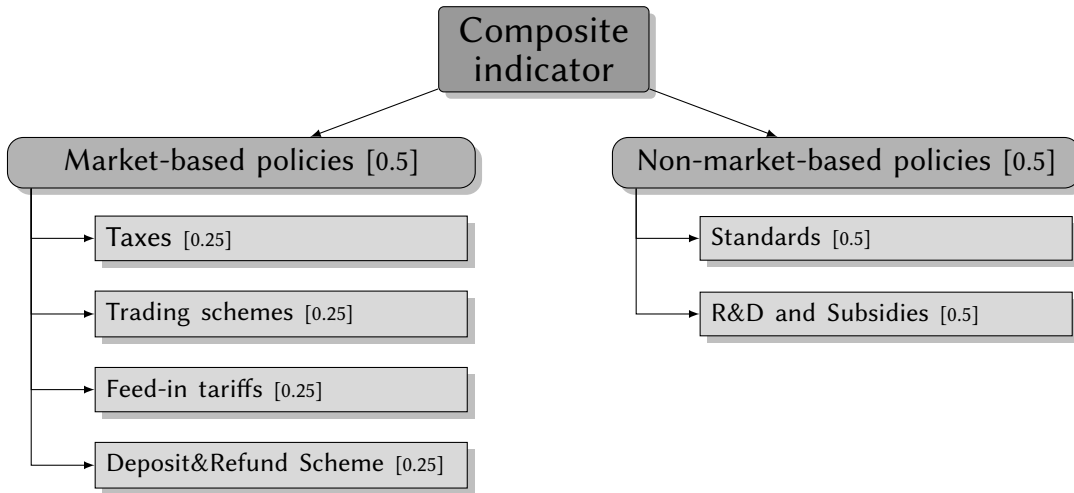


Figure 2.1: Aggregation structure of the composite index of EPS

struments (like taxes on pollutants), subsidizing instruments (such as feed-in tariffs or subsidies to R&D) and regulation (standards). The composite indicator of environmental policy stringency (EPS) is made of two sub-indices, one reflecting market-based policies – taxes, trading schemes, feed-in tariffs – (thereafter  $EPS^M$ ) and one reflecting non-market based policies – standards and R&D subsidies – (thereafter  $EPS^{NM}$ ). In our empirical evidence we will make use of both sub-indices as well as the composite one ( $EPS$ ).

The Environmental Performance Index (EPI) provides a data-driven summary of the state of sustainability around the world (Wendling et al., 2020). Using 32 performance indicators across 11 issue categories, the EPI ranks 180 countries on environmental health and ecosystem vitality. These indicators provide a gauge at a national scale of how close countries are to established environmental policy targets. As the index covers a wider range of countries than the OECD EPS, including many emerging and commodity-exporting countries, it will be of particular relevance to assess the role of environmental policy in the emissions embodied in trade between net exporters and net importers of  $CO_2$ . Among the issue-category indicators, the Climate Change indicator (CCH) is particularly relevant for our study as it combines growth rates and intensity of the main greenhouse gas emissions. In our empirical exercise, this index is a weighted sum of seven climate change variables:  $CO_2$  Growth Rate (CDA),  $CH_4$  Growth Rate (CHA), F-gas Growth Rate (FGA),  $N_2O$  Growth Rate (NDA), Black Carbon Growth Rate (BCA), Greenhouse Gas Intensity Trend (GIB), Greenhouse Gas

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per Capita (GHP)<sup>4</sup>.

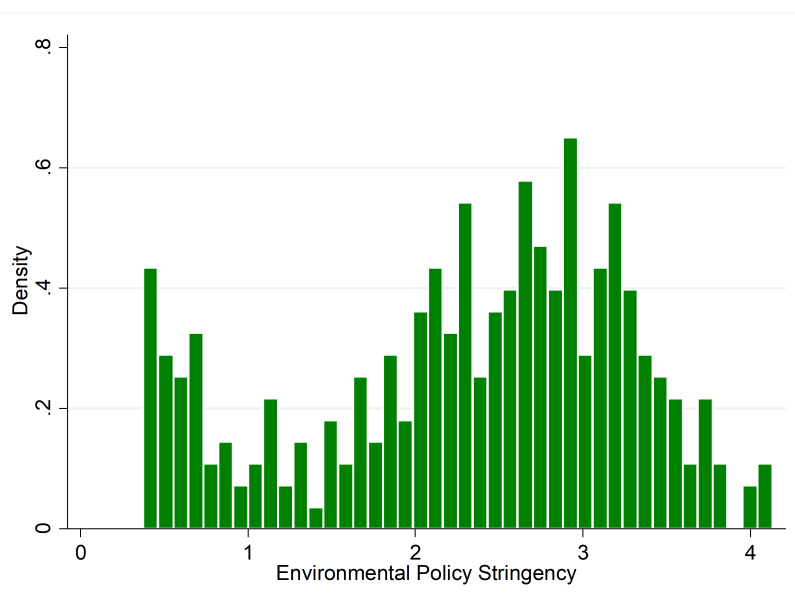
Figures 2.2 and 2.3 gives an overview of the distribution of our environmental indicators mixing all countries and all years. The EPS indicator ranges between 0.375 and 4.133 with a mean at 2.317. The distribution is not normal as the mode is around 3 but another peak can be noted at the lowest value, i.e. for countries that are the least stringent. The CCH indicator ranges from 18.1 to 94.5 and has a mean at 58.9. It has a skewed left distribution with fewer countries with very positive environmental outcomes. To assess the evolution of stringency indices over time, Figure 2.4 shows the EPS and CCH indicators for three large countries: the U.S., Germany and China. Concerning the EPS indicator, the German index was already at a high level at the beginning of our sample and stayed at this level at the end of the horizon, recovering from some decline in 2007-8. The U.S. index started from much lower levels but increased sharply between 2005 and 2009, reaching a peak in 2012 (slightly above Germany) before receding somehow from 2013 onwards. Finally, the Chinese index increased gradually up to 2012 and remained at this plateau until the end of the horizon. Concerning the CCH indicator, the German and the U.S. indices were at relatively high levels over 2005-2015, the German one being slightly above over the whole period, although the gap with the U.S. index being lower as of 2013. The Chinese index remained at much lower levels, despite some noticeable improvement from 2011 onwards.

As a first experiment about the relationships between emissions embodied in trade and our two environmental policy indicators, Figure 2.5 reports an overview of correlations between our variables of interest. We have also computed pair-wise cross-section correlations. Although the correlations are not high, a few observations can be noted. First, there is a negative relationship between the exports of CO<sub>2</sub>-intensive goods and the environmental policy of the exporting countries (pair-wise correlation of  $-0.09$  with EPS and  $-0.16$  for CCH). By contrast, such a relationship becomes positive when considering the policy index of the importing countries ( $+0.09$  for EPS and  $+0.02$ ). In other words, a more stringent environmental policy is associated with higher imports of CO<sub>2</sub>-intensive goods, illustrating

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<sup>4</sup>CCH=(CDA\*0.56375) + (CHA\*0.15375) + (FGA\*0.1025) + (NDA\*0.05125) + (BCA\*0.05125) + (GIB\*0.05125) + (GHP\*0.025625). The weights are obtained following data on <https://epi.yale.edu/>.

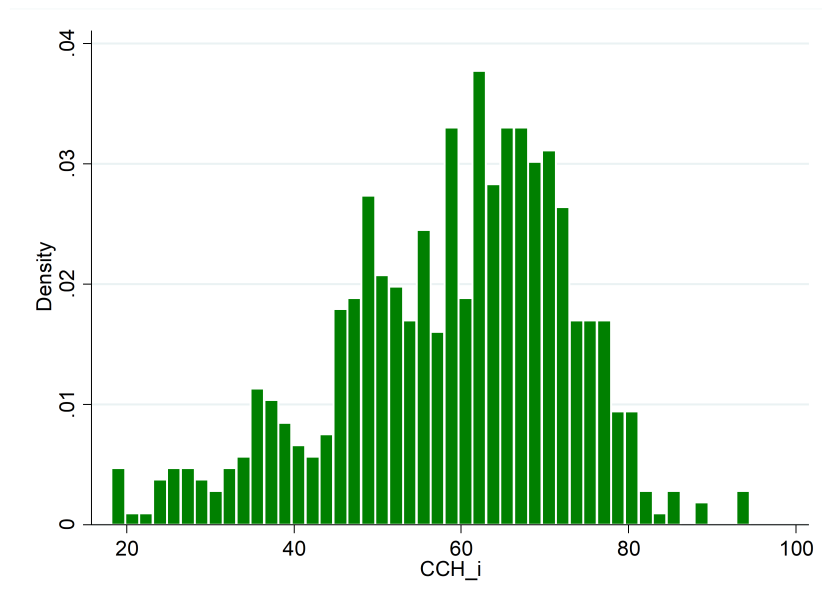
Figure 2.2: Distribution of the OECD EPS indicator



Source: OECD

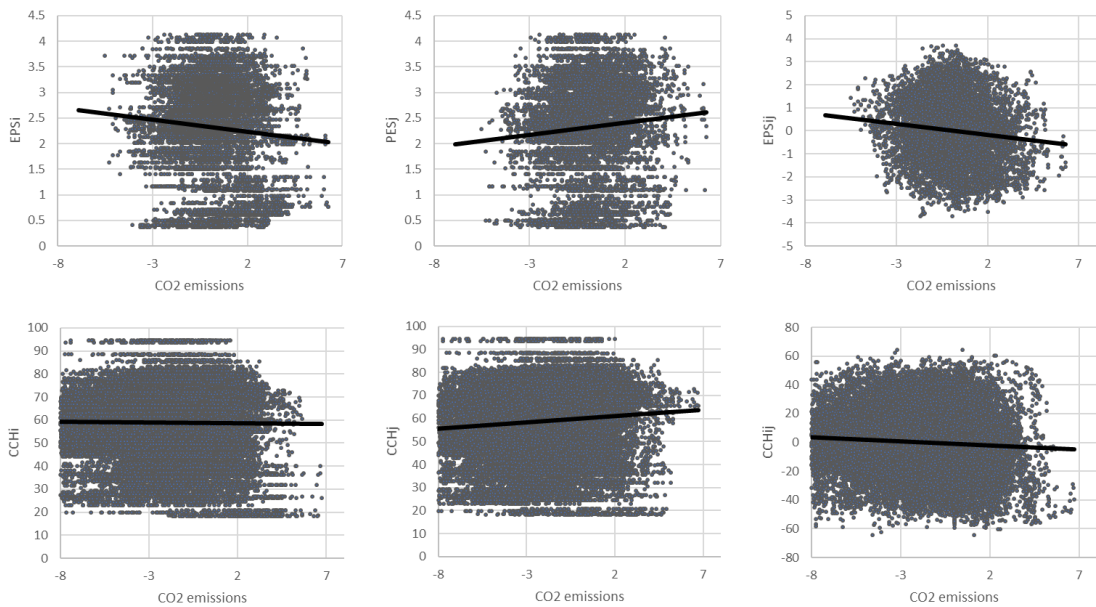
a possible carbon leakage of environmental policy through international trade. Finally, the more stringent the policy of the importer compared to the exporter (implying lower  $EPS_{ijt}$  and  $CCH_{ijt}$ ), the higher is the correlation with  $\text{CO}_2$  emissions embodied in trade, illustrating again a possible phenomenon of carbon leakage. The negative pair-wise correlations are in this case  $-0.12$  for both EPS and CCH. We will see therefore the importance of conducting a proper econometric analysis to verify whether these simple correlations imply or not a genuine relationship once controlled for usual trade determinants.

Figure 2.3: Distribution of the CCH indicator



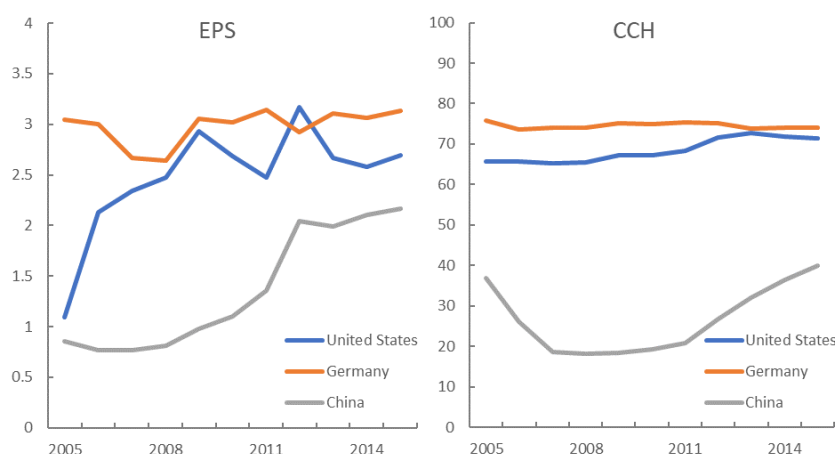
Source: Yale Center for Environmental Law & Policy

Figure 2.5: Scatter plot and correlations between CO<sub>2</sub> emissions embodied in trade and environmental policy indicators



Source: OECD, Yale Center for Environmental Law & Policy and authors' calculation. The black lines corresponds to the linear trend line.

Figure 2.4: Evolution of EPS and CCH in selected countries



Source: OECD and Yale Center for Environmental Law & Policy

## 2.4 Empirical results

We estimate our models using panels covering between 33 and 56 countries over the period 2005-2015. As our various exercises include variables whose country coverage is different, we report in Appendix A2 the list of countries corresponding to each exercise. To gauge the robustness of our results we have also estimated our gravity equations with two other estimation methods. These methods concern the standard Ordinary Least Square (OLS) and the fixed-effects estimator (FE). The results of these alternative methods are reported in [Assogbavi and Dees \(2021\)](#) and show the robustness of our results to estimation methods (see in appendix [subsection .2.1](#)). We have also considered another issue pointed in the literature surveyed by [Yotov et al. \(2016\)](#). This concerns the possibility that changes in trade flows (and therefore their carbon content) will not instantaneously respond to changes in policy measures. Therefore, estimations applied to data pooled over consecutive years may be unable to account for the fact that dependent and independent variables cannot fully adjust in a single year's time. To account for this issue, we have considered our policy variables with a one-year lag. As a robustness check, we have also tried to re-estimate our equations with panel data with 2 or 3-year intervals. However, our dataset is not sufficiently large and estimating on time interval data faces estimation efficiency issues, making such robustness check inap-

Table 2.1: Main results: Gravity equations for CO<sub>2</sub> emissions embodied in exports

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$D_{ij,t}$	-0.003***	-1e-05	-0.003***	-7e-05	-0.003***	2e-05	-0.001***	-5e-05
$EPS_{i,t} \times INTL_{ij}$	-0.373***							
$EPS_{j,t} \times INTL_{ij}$	-0.076***							
$EPS_{ij,t} \times INTL_{ij}$		-0.002						
$EPS_{i,t}^M \times INTL_{ij}$			-0.496***					
$EPS_{j,t}^M \times INTL_{ij}$			-0.080***					
$EPS_{ij,t}^M \times INTL_{ij}$				-0.001				
$EPS_{i,t}^{NM} \times INTL_{ij}$					-0.284***			
$EPS_{j,t}^{NM} \times INTL_{ij}$					-0.055***			
$EPS_{ij,t}^{NM} \times INTL_{ij}$						-0.001		
$CCH_{i,t} \times INTL_{ij}$							-0.022***	
$CCH_{j,t} \times INTL_{ij}$							-0.004***	
$CCH_{ij,t} \times INTL_{ij}$								0.008
Constant	1.378***	0.082***	1.322***	0.087***	1.348***	0.075***	1.466***	-0.116***
Observations	8,113	7,976	8,113	7,737	8,301	8,164	28,978	28,505
$R^2$	0.344	0.318	0.343	0.318	0.345	0.320	0.354	0.343

**Notes:** This table reports estimation results from a series of econometric models that study the impact of environmental policy on CO<sub>2</sub> emissions embodied in exports. All estimates are obtained with exporter-time and importer-time fixed effects as well as country-pair fixed effects (estimates of the fixed effects are omitted for brevity) and include trade costs ( $D_{ij,t}$ ). Column (1) reports estimates that are obtained with a PPML estimator and *de jure* policy indicators ( $EPS_{i,t}$  and  $EPS_{j,t}$ ). Column (2) replicates the specification from column (1) but using the policy indicators in relative terms ( $EPS_{ij,t}$ ). Columns (3)-(4) and (5)-(6) replicates the specification for columns (1)-(2) but using respectively the market (*M*) and non-market (*NM*) sub-indices. Columns (7) and (8) replicate the specification of columns (1) and (2) with *de facto* indicators ( $CCH_{i,t}$ ,  $CCH_{j,t}$  and  $CCH_{ij,t}$ ). All policy indicators are included as interactions with a dummy for international trade  $INTL_{ij}$ . \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

plicable. Another completely different approach, relying on long diff-in-diff estimators has also been tried and confirm the main results reported here<sup>5</sup>.

### 2.4.1 Results at aggregate level

We present first results related to the *de jure* measures of environment policy and present thereafter those related to *de facto* indicators. These results are complemented by additional estimations that explore further the evidence of carbon leakage from importers with more stringent environmental policy.

<sup>5</sup>Results available in Appendix A3

### 2.4.1.1 Results using *de jure* policy indicators

The results, reported in Table 2.1, show that both  $EPS_i$  and  $EPS_j$  appear with negative and significant coefficients (Column (1)). The more stringent a country is (both for exporters and importers), the less trade flows are intensive in  $CO_2$ . As expected, on the exporter side, environmental policy restricts the production of  $CO_2$  and therefore the country becomes less specialised in carbon-intensive goods. More surprisingly, on the import side, when domestic policy becomes more restrictive, we do not find any evidence of carbon leakage, as the carbon content of imports declines too. This could mean that domestic demand is also influenced by environment policy, discouraging consumers to buy goods or services that are rich in  $CO_2$ . Trade costs enter significantly with a negative sign, as expected.

Looking at our results in more detail, we notice that the size of the coefficients of the policy variables is larger in absolute terms for the exporter's policy indicator than for the importer one. The coefficient related to  $EPS_i$  is equal to  $-0.37$ , while it is only  $-0.08$  for  $EPS_j$ . To give an idea of the size of such coefficients, we have computed that, for an exporting country, an improvement in its EPS by one point (say from 1 to 2, while the importer stay at the average at 2.3), emissions embodied in its exports to the average importer would decline by 31 %, which is quite substantial. On the importer side, however, an improvement in EPS by one point (say from 2 to 3) from a non-stringent country (with EPS at 1) would reduce the emissions embodied in its imports from this exporter by 7% only. Although this result points to the fact that environmental policy actions may have less impact in relative terms on imports than on production (and therefore exports), showing that the virtuous countries from an environmental policy viewpoint tend to import the most from the least virtuous ones, the negative sign remains counterintuitive since it invalidates the assumption of carbon leakage when the importing country tightens its climate policy. We will investigate this aspect in more detail below.

To account for the relative level of stringency in environmental policy between exporters and importers, we replace the country-specific policy index by their difference ( $EPS_i - EPS_j$ ), scaled with the importer index (Column (2)). Such an index of dissimilarity



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in policy appears with a negative sign, meaning that a country whose environmental policy is more stringent than its partner's will export goods with a lower content in CO<sub>2</sub>. Taking this results from the importer's side, it means that environmental policy actions have significantly less impact in relative terms on CO<sub>2</sub> intensity of imported goods. Such effect is nevertheless not significant in our estimation results.

To go deeper into the analysis of the role of *de jure* policy in the CO<sub>2</sub> content of trade, we decompose the policy indicators into market and non-market instruments. Table 2.1 shows, in Columns (3) and (5), the results of specifications including such a decomposition. The results found with the aggregate index are verified when breaking it down into its market and non-market components. Interestingly, the sensitivity of CO<sub>2</sub> embodied in exports tends to be higher for market-related measures (−0.496 for exporters and −0.080 for importers) compared with non-market ones (−0.284 for exporters and −0.055 for importers). Market measures (i.e. carbon tax) contribute therefore more to avoid trade-related carbon leakage compared to non-market ones (regulatory measures or support to low-carbon technology). Moreover, when using bilateral measures (Columns (4) and (6)), while the coefficient related to  $EPS_{ijt}^{NM}$  is slightly larger (in absolute value) than the one related to  $EPS_{ijt}^M$ , both remain nonsignificant.

#### 2.4.1.2 Results using *de facto* environmental indicators

We then run estimations using similar specifications but replacing our *de jure* policy indicators (EPS) by *de facto* measures of environmental performance related to climate change (CCH). Table 2.1 - Column (7) gives the estimation results when including both indicators related to the exporter and the importer performance. The coefficients of  $CCH_i$  and  $CCH_j$  are both significant with a negative sign. The results found with our *de jure* policy indicator is therefore confirmed by the estimates including *de facto* measures. Comparing the size of the coefficient is not easy as the EPS is an indicator ranging from 0 to 6, while CCH is measured as a percentage. However, if we multiply the CCH-related coefficients by a factor of 100/6, we find values that are comparable (i.e. around −0.36 for country *i* indicator and −0.07 for

country  $j$  indicator). These results confirm therefore not only the sign but also the magnitude of the sensitivity of CO<sub>2</sub> embodied in trade to environmental indicators<sup>6</sup>. In the case of CCH, as the indicator covers more countries than EPS, this result is moreover satisfactory since doubling the size of the sample does not change the results. As it includes many more emerging and commodity-exporting countries, this sample also appears even more relevant to assess the presence of carbon leakage behaviours.

We also consider another set of estimations replacing the environmental indicators by a bilateral one, computed as for EPS as the difference between a country index and its partner's. Table 2.1 - Column (8) shows again that when environmental performance is dissimilar across partners, the more virtuous ones tend to import more carbon-intensive goods from less environmentally efficient partners. As for the case with *de jure* indicators, this result shows that a large heterogeneity in environmental performance is detrimental to the reduction in CO<sub>2</sub> emissions embodied in trade. The coefficient remains however nonsignificant.

#### 2.4.1.3 Exploring the evidence of carbon leakage for importing countries with more stringent environmental policy

The results found above do not provide evidence of carbon leakage and the negative and significant effect on the importer's stringency may seem puzzling at face value. To further explore this result, we follow (Beverelli et al., 2018) to include in our regressions the interaction of  $EPS_{j,t}$  with a dummy for countries with more stringent policies. We then repeat the same exercise with  $CCH_{j,t}$ . We define two dummies to select importing countries according to the stringency of their policy: first, considering countries whose policy indicator is above the median (noted  $SM_j$ ); second, selecting countries whose indicator is above the third quartile ( $SQ3_j$ ). When isolating the importing countries with more stringent policy, the result contrasts with those presented at global level. Indeed, Table 2.2 shows a large, positive and statistically significant estimate on both  $EPS_{j,t} \times SM_j$  and  $EPS_{j,t} \times SQ3_j$ ,

<sup>6</sup>The *de facto* indicator for climate policy being a weighted average of several greenhouse gas emission growth rates, there may be the risk of having reverse causality issues. The full consistency between our results, irrespective of the indicator used, shows that such a risk is limited

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which shows that importers with more stringent environmental policies tend to increase the CO<sub>2</sub> content of their imports when the policies are tightened. Such results therefore show some evidence of carbon leakage for this group of countries. Moreover, we note that while the estimates of the trade cost parameter and  $EPS_{i,t}$  are comparable to the corresponding estimates from Table 2.1, the estimates on  $EPS_{j,t}$  in Table 2.2 - Columns (1)-(2) are larger in absolute value as compared to the  $EPS_{j,t}$  estimate from Table 2.1 - Column (1). As also noted by (Beverelli et al., 2018), this is due to the fact that the estimate of the environmental policy effects from Table 2.1 combines the positive impact for importers with more stringent policies with the negative impact found for the other countries. Similar results are also found when considering de facto environmental indicators ( $CCH_{j,t} \times SM_j$  and  $CCH_{j,t} \times SQ3_j$ ) confirming therefore the evidence of carbon leakage when isolating countries with more stringent environmental policy.

This result could be explained by a loss in competitiveness in carbon-constrained sectors to the benefit of unconstrained competitors. It could also be explained by incentives for domestic firms to relocate capital to countries with less stringent environmental policies, leading subsequently to an increase in imports of parts and components or final goods from these countries. Although distinguishing between these two channels is beyond the scope of this chapter, our results support initiatives to protect domestic industries from carbon leakages by implementing for instance carbon border adjustment mechanisms.

## 2.4.2 Results at sectoral level

The results above are estimated at aggregate level and may hide significant heterogeneity at sectoral level. We then reestimate our models based on sector-level data. As we are interested in particular in activities that are the most emitting, we have disaggregated our dataset by focusing on the following sectors: agriculture, mining, electricity, chemicals and non-metallic products, transportation and storage, basic metals and fabricated metal products and, to be able to compare with results at aggregate level, other manufacturing and other services.

Figure 2.6 reports the values of the coefficients related to EPS and CCH, both for

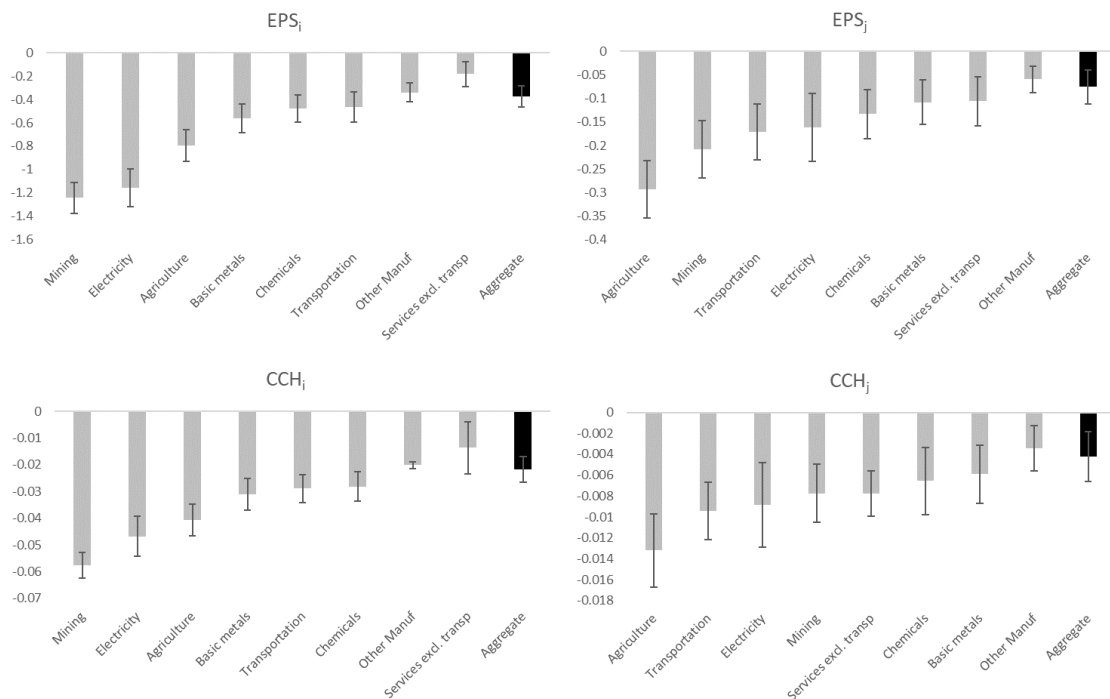
Table 2.2: Main results: Gravity equations for CO<sub>2</sub> emissions embodied in exports, including dummies for importers with more stringent environmental policy

	(1)	(2)	(3)	(4)
$D_{ij,t}$	-0.003***	-0.003***	-0.001***	-0.001***
$EPS_{i,t} \times INTL_{ij}$	-0.408***	-0.373***		
$EPS_{j,t} \times INTL_{ij}$	-0.170***	-0.110***		
$EPS_{j,t} \times SM_j$	0.163***			
$EPS_{j,t} \times SQ3_j$		0.083***		
$CCH_{i,t} \times INTL_{ij}$			-0.025***	-0.024***
$CCH_{j,t} \times INTL_{ij}$			-0.008***	-0.007***
$CCH_{j,t} \times SM_j$			0.011***	
$CCH_{j,t} \times SQ3_j$				0.011***
Constant	1.373***	1.357***	1.450***	1.479***
Observations	8,113	8,113	28,978	28,978
$R^2$	0.346	0.345	0.357	0.357

Notes: This table reports estimation results from a series of econometric models that study the impact of environmental policy on CO<sub>2</sub> emissions embodied in exports, including a dummy for importing countries with more stringent policy. All estimates are obtained with exporter and importer fixed effects (estimates of the fixed effects are omitted for brevity) and include trade costs ( $D_{ij,t}$ ). Column (1) reports estimates that are obtained with a PPML estimator and *de jure* policy indicators ( $EPS_{i,t}$  and  $EPS_{j,t}$ ) and the interaction between  $EPS_{j,t}$  and a dummy for countries whose index is above the median ( $SM_j$ ). Column (2) replicates the specification from Column (1) but using a dummy for countries whose index is above the third quartile ( $SQ3_j$ ). Columns (3) and (4) replicate the specification for Columns (1) and (2) with *de facto* indicators ( $CCH_{i,t}$ ,  $CCH_{j,t}$ ). All policy indicators are included as interactions with a dummy for international trade  $INTL_{ij}$ . \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

exporters (country  $i$ ) and importers (country  $j$ ). A few observations can be made about these results. First, some heterogeneity can be noticed. As expected, the most polluting activities are those that are the most sensitive to environmental policy. Both our *de jure* and *de facto* environmental indicators significantly affect the carbon content of trade at sectoral level. Second, the ranking in terms of sensitivity differs depending on whether we consider the exporter or the importer side. For exporters, mining and electricity are the most reacting sectors to a change in environmental policy, followed by agriculture and the manufacturing goods that are intensive in CO<sub>2</sub> (i.e. metals and chemicals). From the importer side, however, agriculture is the most sensitive sector, followed by mining, transportation and electricity. Third, the ranking is almost the same, whether we consider *de jure* or *de facto* environmental indicators, which shows that our results are robust whatever indicator considered. Finally, the estimates at aggregate level are consistent with those at sectoral level, considering that other manufacturing goods represent around 75% of total exports.

Figure 2.6: Estimates of coefficients related to EPS and CCH at sectoral level



Source: Authors' estimates. The black rectangles correspond to the estimates at aggregate level. 95% confidence intervals are reported as error bars.

### 2.4.3 Assessing the role of emissions related to international transportation

International trade generates CO<sub>2</sub> emissions from both the production of traded goods and from their transportation between trading partners. While the literature usually considers emissions associated with production to assess carbon leakages, emissions related to transportation contributes to around a third of the worldwide trade-related greenhouse gas emissions. For some categories of manufacturing products, transportation represents over 75 percent of emissions and including transport dramatically changes the ranking of countries by emissions per dollar of trade (Cristea et al., 2013). Disregarding this large portion of emissions attributed to international trade may therefore bias the aggregate results and is likely to underestimate the assessment of the sensitivity of emissions to environmental policy. The OECD data we use include emissions related to both goods and services, and, unlike previous studies, allocate fully CO<sub>2</sub> emissions from fuel combustion by non-residents, including the emissions from international bunkers.

To assess the bias that could be associated with omitting emissions related to international aviation and marine bunkers, we run, as an alternative exercise, our benchmark regressions by excluding them in the data of our dependent variable vector. Using sector-level data on international transportation-related emissions, we simply subtract the values related to aviation and marine bunkers from the aggregate data and estimate again Eq. 2.2.5. Table 2.3 reports these alternative results. The coefficients are generally higher (in absolute value) but very close to those reported with aggregate data including international transportation and the difference is not statistically significant. Therefore, our main results are robust whether or not we include emissions related to international bunker fuels and the bias due to their omission appears very limited.

Table 2.3: Alternative results: Gravity equations for CO<sub>2</sub> emissions embodied in exports (excluding transportation-related emissions)

	(1)	(2)	(3)	(4)	(5)	(6)
$D_{ij,t}$	-0.003***	-0.003***	-0.003***	-0.001***	-0.001***	-0.001***
$EPS_{i,t} \times INTL_{ij}$	-0.434***	-0.399***	-0.399***			
$EPS_{j,t} \times INTL_{ij}$	-0.077***	-0.172***	-0.108***			
$EPS_{ij,t} \times SM_j$		0.165***				
$EPS_{ij,t} \times SQ3_j$			0.077***			
$CCH_{i,t} \times INTL_{ij}$				-0.023***	-0.027***	-0.025***
$CCH_{j,t} \times INTL_{ij}$				-0.004***	-0.008***	-0.007***
$CCH_{ij,t} \times SM_j$					0.011***	
$CCH_{ij,t} \times SQ3_j$						0.011***
Constant	1.388***	1.382***	1.369***	1.482***	1.501***	1.492***
Observations	7,881	7,881	7,881	28,130	28,130	28,130
$R^2$	0.349	0.351	0.350	0.357	0.360	0.360

Notes: This table reports estimation results from a series of econometric models that study the impact of environmental policy on CO<sub>2</sub> emissions embodied in exports (excluding transportation-related emissions). All estimates are obtained with exporter and importer fixed effects (estimates of the fixed effects are omitted for brevity) and include trade costs ( $D_{ij,t}$ ). Column (1) reports estimates that are obtained with a PPML estimator and *de jure* policy indicators ( $EPS_{i,t}$  and  $EPS_{j,t}$ ). Columns (2) and (3) replicate the specification from Column (1), adding the interaction between  $EPS_{j,t}$  and a dummy for countries whose index is above the median ( $SM_j$ ) and the third quartile ( $SQ3_j$ ) respectively. Columns (4), (5) and (6) replicate the specifications of Columns (1), (2) and (3) with *de facto* indicators ( $CCH_{i,t}$ ,  $CCH_{j,t}$ ). All policy indicators are included as interactions with a dummy for international trade  $INTL_{ij}$ . \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

## 2.5 Concluding remarks

As policies to curb carbon emissions are not implemented similarly across countries, a so-called “carbon leakage” may offset domestic carbon reductions at the global level by redirecting CO<sub>2</sub>-intensive production to places with less stringent environmental regulation. Although the emissions embodied in international trade account for around a quarter of total global emissions, the evidence of carbon leakages coming from environmental policies has so far been scarce and rather mixed. This chapter uses a standard gravity model with panel data to assess what determines the CO<sub>2</sub> emissions embodied in gross trade flows. It pays particular attention to the inclusion, in addition to the traditional determinants of bilateral trade, of measures related to environmental regulation, both *de jure* (reflecting policy measures) and *de facto* (reflecting environmental performance). Our results show no evidence that environment regulation or performance would be bypassed by higher imports of CO<sub>2</sub>-intensive goods at the global level. On the contrary, the higher the environmental performance of a country, the lower the CO<sub>2</sub> emissions embodied in trade. This result holds true both for exporters and importers. When breaking down the data by sectors, the effects of environment policy to lower emissions are even stronger for the most polluting sectors. Therefore, the apparent imbalances in CO<sub>2</sub> emissions embodied in trade originate more from usual specialisation motives rather than from differences in environmental policy.

At the same time, when focusing on importing countries with more stringent policy, we do find some evidence of carbon leakages, as the CO<sub>2</sub> content of their import increases following a tightening in their environmental policy. We also find that the impact of domestic environment policy measures is larger on exports of CO<sub>2</sub>-intensive goods than on imports. This result also points to the fact that environmental policy actions may have less impact in relative terms on imports than on production (and therefore on exports), showing that the virtuous countries from an environmental policy viewpoint tend to import the most from the least virtuous ones. From a policy perspective, as differences in environmental regulation across countries tends to support trade in carbon-intensive goods, this result points to the importance of international coordination and cross-country harmonization in environmental



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policy in order to curb CO<sub>2</sub> emissions embodied in trade at global level.

## CHAPTER 3

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# BALANCE OF PAYMENTS AND NATURAL DISASTERS

*"The climate emergency is a race we are losing, but it is a race we can win".*

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– UN Secretary-General António Guterres (2017-present)

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## 3.1 Introduction

As the devastating impact of recent natural disasters, such as 2022 Pakistan floods, 2023 Panama's drought or 2023 Canadian wildfires indicate, mankind is vulnerable to extreme weather events even in advanced economies. Natural disasters can cause major injuries, deaths and economic losses. In terms of frequency, floods and storms are the main natural disasters reported (fig 3.1 ). A survey of 194 countries shows that at least 304 natural disaster was recorded in 2020.<sup>1</sup> In 2022, the largest loss-causing event was hurricane Ian and its damages has been estimated between USD 50-60 billions. It is the most costly catastrophe registered after hurricane Katrina (Swiss Re, 2022). Natural disasters, and climate change are inherently linked. Climatic and hydrological natural disasters, such as droughts or storms, are likely to occur more frequently as the global surface temperature increases. Higher temperatures lead to water evaporation. In the atmosphere, water vapor condenses and releases heat and helps fuel the occurrence of storms and their severity.<sup>2</sup>

Since the First IPCC Assessment Report in 1990, there has been growing evidence on the effects of natural disasters on human activities, including economic transactions. The macroeconomic consequences of natural disasters have been increasingly studied in the literature. For instance, natural disasters lead to a reduction in the affected countries' gross domestic product while the extent of the impacts depend on countries' characteristics, such as financial development or income level (Albala-Bertrand et al., 1993; Skidmore and Toya, 2002; Loayza et al., 2009; Chang and Zhang, 2020; Colacito et al., 2019). Furthermore, natural disasters such as heat waves increase food price inflation over time, especially in emerging countries (Faccia et al., 2021). However, to the best of our knowledge, no research has so far studied the impact of natural disasters on the balance of payments and its components. However, natural disasters are likely to leave imprints on trade balances, capital flows and current account stability. This chapter fills this research gap by examining the multifaceted impact of natural disasters on the balance of payments.

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<sup>1</sup>estimation based on a sample of 194 countries and Munich Re definition of large disasters

<sup>2</sup><https://www.pbslearningmedia.org/resource/nves.sci.earth.hurricane/water-vapor-fuels-hurricanes/>

The relationship between natural disasters and the balance of payments can be summarised as follows: death caused by natural disasters, destruction of physical capital, disruption in supply chains, and population displacement. To deal with these impacts, private sector agents in affected countries adapt their behaviours and governments implement economic policies to alleviate the negative consequences on the disasters. For instance, when demand is not met by domestic supply, which is disrupted by disruption of facilities, imports of goods increase for relief and recovery. In countries where the economy is based on exports, a natural disaster could also lead to a decrease in exports due to the destruction of capital or infrastructures. When the disaster leads to death, physical injuries or mass population migration, labor supply is also reduced, leading to an imbalance between labor supply and demand as well as movements in cross-border workers. In the medium to long-term, natural disasters could also lead to a drop in public investment and government's demands for goods and services. As a result of all these changes, the balance of payments in a disaster-stricken country could be significantly affected, driven therefore by higher imports, lower exports, change in capital flows, increase in migrant remittances and international assistance, new investments and inflation.

The primary contribution of this chapter is to assess the effects of natural disasters on the balance of payments and its various components. We use different measures of natural disasters and look for their differentiated effects according to geographical location and income levels. We assess empirically the impact of natural disasters on the balance of payments by applying the local projection (LP) method developed by [Jordà \(2005\)](#). Instead of assessing the average impact on our variables of interest, like in more standard econometric approaches, the LP methodology gives us the reactions of these variables on a number of horizons. This helps us to assess the dynamics over time of economic variables following the occurrence of a disaster. Our results show a decline in the deficit of the current account and the capital account a year after the disaster. It also shows that the impact of natural disasters varies according to the level of income and the geographical location of the country. This chapter also contributes to the literature on disasters' effects on the current account imbalances, trade in goods and services and income balances.

The remainder of the chapter is organized as follows: section 2 gives some basic definitions related to the accounting of the balance of payments and, provides a brief literature review. It also describes the effects of natural disasters and presents some stylized facts. Data and variables description is provided in section 3. Empirical strategy and the results are discussed in the section 4. Finally, section 5 concludes.

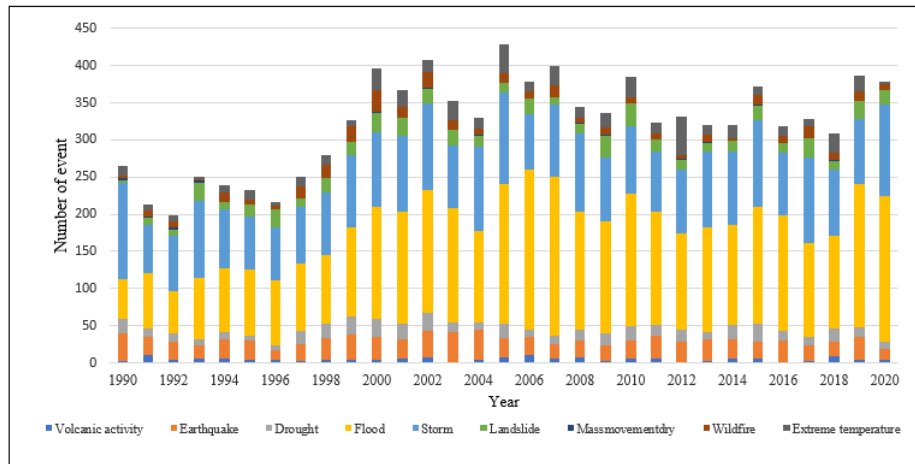


Figure 3.1: Natural catastrophes events since 1990

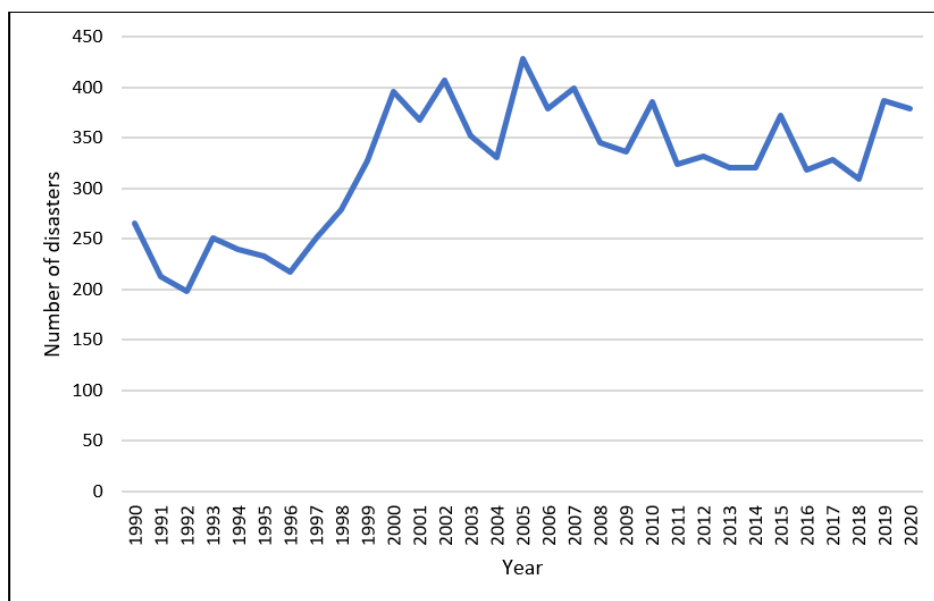


Figure 3.2: All Natural Disasters

## 3.2 Definitions and mechanisms

This section defines key concepts used in the paper and describes the mechanism through which natural disasters could affect the balance of payments. After describing the effects of natural disasters, we present some stylised facts and provide an overview of the literature review.

### 3.2.1 Balance of payments

The balance of payments is defined as *a statistical statement that summarizes economic transactions between residents and nonresidents during a specific time period*. It is composed of the goods and services accounts, the primary income account, the secondary income account, the capital account and the financial account. In this statistical statement transactions are recorded under the double-entry accounting system. Regrouping the first three components of the balance of payments in one component, it is composed of current account, capital

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account and financial account (BPM6).<sup>3</sup>

To give a short overview of each components we will define them as follows:

- The current account is composed of the balance of trade in goods and services, primary income and secondary income flows between residents and nonresidents.
- The capital account is used to record international transfers between the residents in one country and those in other countries. It contains credits and debit entries for non-produced nonfinancial assets and capital transfers between nonresidents and residents
- The financial account concerns net acquisition and disposal of financial assets and liabilities.

The sum of the balances on current and the capital account is equal to the net balance of the financial account. When it is positive, it represents the net lending by the home economy to the rest of the world. When it is negative, it represents the net borrowing of the home country to the rest of the world. We can then write down simple identities (to also introduce the notations used later):

$$BOP \equiv CA + KA + FA \equiv 0 \quad (3.2.1)$$

Where BOP represents the balance of payments, CA represents current account, KA capital account and FA represent financial account. By definition, the sum of accounts in the balance of payments is zero, implying that:

$$CA + KA \equiv -FA \quad (3.2.2)$$

The current account is also the sum of trade balance (TB), primary income balance (IB) and secondary income balance or transfers (SB). We can write:

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<sup>3</sup>Balance of Payments and International Investment Position Manual <https://www.imf.org/external/pubs/ft/bop/2007/pdf/bpm6.pdf>

$$CA = TB + IB + SB \quad (3.2.3)$$

These relationships guide our analysis of shocks. As indicated by the equation 3.2.2 between the current, capital and financial accounts, we will only present the results of the effects of natural disasters on the current account and its components, and then on the capital account.

### 3.2.2 Natural disasters impacts

The immediate damage that occurs in the aftermath of natural disasters often involves human casualties and capital destruction. The disasters destroy infrastructures, including roads and ports, as well as farms and plants and access to energy is reduced. Natural disasters are also a source of deaths and injuries. As shown in Figure 3, natural disasters have killed at least 1.6 million people since the early 90's, with 2010 being the most devastating year in terms of lives lost.

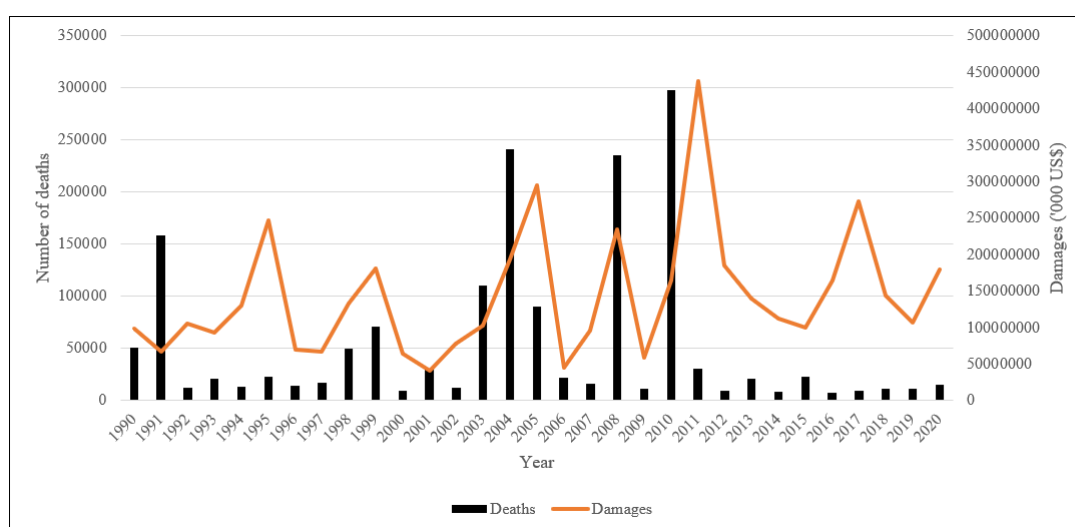


Figure 3.3: Death and Damages

As a consequence of the immediate effects listed above, domestic production may decrease followed by a decrease in income and tax revenues. A fall in production and a reduction of income reduce private spending and investment. Tax revenues may decline



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too, leading to, either a fall in public spending or, more likely, an increase in public debt, as reconstruction in public infrastructures requires government spending.

On trade, natural disasters can often substantially decrease exports and most empirical evidence confirms such a negative relationship (Gassebner et al., 2010; Da Silva and Cernat, 2012; Xu and Kouwoaye, 2019). Its impact on imports remains however ambiguous. On the one side, in the aftermath of the disasters, producers and exporters are not able to satisfy demand as disasters disrupt supply chains. The destruction of infrastructures, after the disasters, also leads to an increase in the cost of trade, as roads could be diverted or port activities curtailed. In addition to higher transportation costs, insurance premium may also rise, weighing on corporate profits and investment expenditures. As far as households are concerned, property damage can lead to a drop in consumption, which could be crowded out by expenditure on repairs.

On the other side, the loss of production capacity in countries affected by natural disasters increases the demand for goods from partner countries. The implementation of aid programs and the opening of trade will also lead to the entry of new trading partners into the market of the affected countries, which in turn will see their imports from these partner countries increase. The reconstruction process is another factor that could increase imports, given the need for raw materials in the construction sector. The international aid will also provide foreign currency to the governments to support reconstruction effort and will therefore foster import expenditures (Auffret, 2003).

The literature also shows that the impact of natural disasters differ across countries. Countries with large population, large land area and size in terms of GDP are able to endure larger losses in assets.<sup>4</sup> Pelling et al. (2002) and Rasmussen (2004) emphasize these types of geographic factors as it is shown by these studies that geographically, small countries are more vulnerable to disasters. However the level of development of some countries is another key factor in terms of disaster-related shocks absorption (Auffret, 2003).

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<sup>4</sup>WTO report on Natural Disasters and Trade, Study I : [https://www.wto.org/english/tratop\\_e/devel\\_e/study1\\_exec\\_summary\\_sympnaturaldisaster29112019\\_e.pdf](https://www.wto.org/english/tratop_e/devel_e/study1_exec_summary_sympnaturaldisaster29112019_e.pdf)

Figure 3.4 below underlines some important changes in balance of payments variables for selected countries following natural disasters. The graphs depict the development of five balance of payments variables - current account balance, trade balance, services trade balance, primary income balance and secondary income balance - in Peru, Indonesia, Haiti and Japan. These countries were all hit by major natural disasters. The grey bar indicates the time period when a large natural disaster occurred in the country. It is important to mention that the evolution of balance of payments variables are not entirely driven by natural disasters events and may be affected by underlying macroeconomic variables (that will be controlled for in the empirical part). However, these disasters have in some cases worsened some components of the balance of payments. In Indonesia, during the years 2012 and 2013, the country was hit by at least 17 episodes of floods and 5 episodes of earthquake leading to losses of 36 billion US dollar. During the same period the current account deficit increased. We observe similar trends in Peru, after the earthquake, extreme temperature events and floods that happened in 2007. These three disasters caused at least 784 million US dollar losses. It is also the case of Japan after the earthquake and Fukushima nuclear disaster in 2011. Finally, Haiti paid a heavy toll during the earthquake that occur in 2010. The exception within this example is the trend of transfers in the case of Haiti. The country's aid dependency was high before the disaster, reaching around 25 percent of GDP after the disaster. In the four cases, trade decreased and the current account deficit worsened.

Figure 3.4: Evolution of some balance of payments components and some major disasters (in percent of GDP)



**Note:** The gray bar indicate for each country the episode of large natural disasters in the selected year. In the same year countries can be hit by many disasters. It indicates an earthquake, floods and landslides for Indonesia; earthquake, floods and extreme temperature in Peru; an earthquake in Haiti; an earthquake and a tsunami in Japan.

### 3.2.3 Literature review

There is a growing interest in the impact of natural disaster on economic outcomes. Most of them focus on the economic growth effects of natural disasters. The impact of natural disaster on economic growth remains unclear. Some studies detect a negative impact (Cavallo et al., 2013; Felbermayr and Gröschl, 2014), contradicting other assessments (Skidmore and Toya, 2002). In any case, the literature shows that these impacts depend on several factors and some specific transmission channels. For instance, Loayza et al. (2009) find that the effects of natural disasters on growth depend on the type of disasters and the economic sectors affected. The intensity of the disasters matters too. Contrary to severe disasters that have a negative effect on growth, moderate disasters may even have a positive impact. Furthermore, Skidmore and Toya (2002) found that there is a correlation between higher frequencies of disaster events and higher rates of human capital accumulation, increases in total factor productivity, and economic growth. In developing economies, the economic growth is highly sensitive to natural disasters (Albala-Bertrand et al., 1993). In terms of a country's production capacity, the industrial sectors in developing countries appear more affected than the same sectors in developed countries (Loayza et al., 2009). Disaster impacts depend not only on the size of the countries but also on the level of institutions. In democratic countries the effect is identical either on import or exports while in countries with less democracy their impact remains negative but varies between imports and exports (Gassebner et al., 2010). Nations with higher-quality institutions and richest countries suffer less from natural disasters in terms of death losses (Khan and Knight, 1983).

Disasters lead to a loss in household and government revenues. Consumers and businesses see their income decrease in the aftermath of the natural event. The loss of income subsequently leads to a reduction in government revenues. Although governments try to implement some fiscal policies that help tackle the disasters consequences, a loss of revenue hampers the finance of fiscal policies in affected countries. The fiscal effects of natural disasters also depend on the country-specific macroeconomic dynamics that takes place to absorb the consequences of the natural disaster shocks (Noy and Nualsri, 2011). In devel-

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oped countries, for example, when a shock occurs, government spending often increases to counter the economic impact of the shock. By contrast, in developing countries, expenditure falls, and the shock could push the economy into recession. [Lis and Nickel \(2010\)](#) find a negative impact of extreme weather events on fiscal public budget as high as 1.1 % of GDP and the changes in budget balances after these extreme events are larger in developing countries. Using a panel VAR analysis, [Melecky and Raddatz \(2011\)](#) found an increase in government spending while there was no significant change in revenue during the occurrence of a climate shock. The increase in spending leads to a budget deficit deterioration in the aftermath of the natural disaster. One of the consequences of budgetary management in developing countries is that, in order to finance post-disaster expenditure, they divert the budget from the development loans they already granted ([Lal et al., 2012](#)).

[Ouattara and Strobl \(2013\)](#) constructed a hurricane index to study the fiscal implication of hurricanes in the Caribbean region. Using a panel VAR and impulse function they found that hurricanes lead to positive government spending and short-term deficits. For [Mallucci \(2022\)](#), natural disasters worsens the fiscal vulnerability of governments and cause sovereign defaults. He finds in seven Caribbean countries that a natural disasters risk (hurricane in this case) has the tendency to reduce governments potential to pay back their debts. He also observes that the natural disasters act as restrictions to governments access to financial market and thus have negative impacts on welfare.

Natural disasters also lead to large increases in foreign aid. [Yang \(2008\)](#) finds that in low-income countries, the natural disasters (hurricane) is accompanied by a rise in migrants' remittances. This result is in line with earlier empirical works that examine the reaction of remittances inflows after natural disasters (see [Clarke and Wallsten \(2003\)](#) in the case of Jamaica and [Ratha \(2006\)](#) for Bangladesh, the Dominican Republic, Haiti and Honduras.). Underlining this positive effect, [Ebeke and Combes \(2013\)](#) find that the effects of natural disasters disappear if the remittances to GDP ratio is between 7 percent and 17 percent of GDP. However, above 17 percent, the remittances inflows exacerbate the effect of natural disasters on macroeconomics instability.

In some emerging and developing countries, the responses put in place and the increases of financial flows can be effective if only the high quality of institutions is guaranteed. Institution quality as well as the level of country openness are also factors that exacerbate or mitigate the impact of natural disasters. The adverse effect of the natural disaster is reduced in a context of international openness and democratic institutions. Like institutions, the financial system also plays a similar role. Indeed, [Toya and Skidmore \(2007\)](#) reported that in countries where the financial system is developed the economic losses after natural disaster is low. In a presence of higher level of domestic credit – synonym of financial development – countries' resilience to shocks is improved ([Noy, 2009](#)). [Bos et al. \(2022\)](#) observes an increase of real estate lending of US commercial banks after the occurrence of natural disasters. They also notice that in order to finance the disaster-driven credit surge, the sale in government bonds tend to increase.

In summary, the literature review indicates that the impact of natural disasters on the balance of payments depends on the following factors: (1) the reaction of exports and imports, (2) governments' fiscal response, (3) private sector investment and saving behaviors, and (4) foreign aid and remittances.

### 3.3 Data and summary statistics

The data used in this study come from diverse sources. The main source of the natural disasters data is "Emergency Events Database" from the Center for Research on the Epidemiology of Disasters (CRED) at the Catholic University of Louvain, Belgium<sup>5</sup>. From the database we select natural disaster using climatological, hydrological, meteorological and geophysical events. These events include flood, storm, extreme temperature, drought, volcanic activity, earthquakes, landslides, wildfire, mass movements, fog and glacial lake outburst. For each event we count the number of its occurrence per year and per quarter. Using disasters relative to climate change we create a new variable that regroups flood, drought, extreme temperature, storm and wildfire. Following [Gassebner et al. \(2010\)](#); [Xu and Kouwoaye \(2019\)](#) we

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<sup>5</sup><http://www.emdat.be/>

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construct a large natural disaster variable according to the definition of [Munich Re \(2005\)](#) convention, whereby a natural disaster is a large one if it: (i) killed at least 1 000 persons; (ii) affected not less than 100 000 persons or (iii) injured at least 1000 persons or (iv) caused a monetary damage of 1 billion US dollar or more (in constant 2012 US dollars). Between 2000 and 2020, 1682 large natural disasters were recorded globally. Our control variables come from the IMF's International Financial Statistics (IFS) database and the World Bank's World Development Indicators database. They include: trade (openness variable)<sup>6</sup>, GDP, exchange rate<sup>7</sup>.

The [Table 3.1](#) below provides summary statistics on the main disasters and balance of payments variables used. A more complete table presents the descriptive statistic of all the variables in appendix ([Table 25](#) and [Table 26](#)). Over our study period, there are at least two large natural disasters and climate change disasters per year, with a total of 43 large natural disasters and 31 climate-change disasters. By climate change disasters, we mean disasters that are composed of floods, droughts, extreme temperature events, storms, and wildfires. As mentioned earlier, the disaster variables represent the number of occurrences of these disasters. The other variables are expressed as a percentage of GDP. As far as the current account is concerned, Saudi Arabia has the maximum surplus over our study period, with 27 percent of GDP, while the largest deficit is in Sierra Leone, with -65 percent of GDP.

Concerning the trade balance, the larger deficit is in Lesotho (-64.93 percent), while Gabon has the highest surplus at 46.65 percent, which is the maximum value observed over our study period. The maximum value for the services balance comes from Antigua and Barbuda, where it reaches 42.94 percent of GDP. Antigua and Barbuda are among the countries in the world that heavily depend on services in terms of revenue. Over the study period, Lesotho is the country that imports the most services, with services imports representing -29.39 percent of its GDP. Singapore and Luxembourg are respectively the countries that im-

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<sup>6</sup>an country's openness impacts its balance of payments through the current account. [Chinn and Prasad \(2003b\)](#) find that in developing countries, trade openness is negatively correlated with the current account balances. Trade openness plays an important role on the current account in the context of local currency depreciation

<sup>7</sup>Nominal Effective Exchange Rate (NEER), defined by the IMF as "a measure of the value of a currency against a weighted average of several foreign currencies"(IMF)

port and export the most goods and services. In Luxembourg, services exports reach 165.14 percent of GDP, and services imports reach 134.094 percent of GDP. In Singapore, services exports amount to 189.48 percent of GDP, and services imports reach 161.57 percent of GDP.

Table 3.1: Summary statistics

<b>VARIABLES</b>	<b>Obs</b>	<b>Mean</b>	<b>Std. dev.</b>	<b>Min</b>	<b>Max</b>
<i>Large natural disasters</i>	1,806	1.88	4.64	0	43
<i>Climate change disasters</i>	1,806	2.07	3.88	0	31
<i>Storm</i>	1,806	.76	2.17	0	19
<i>Flood</i>	1,806	.96	1.72	0	20
<i>Goods imports balance</i>	1,186	31.62	19.30	6.77	161.56
<i>Good exports balance</i>	1,186	29.89	23.79	1.79	189.48
<i>current account balance</i>	1,765	-1.39	7.82	-65.03	27.42
<i>capital balance</i>	1,713	1.05	3.79	-15.41	67.85
<i>Primary income balance</i>	1,682	-1.989	5.94	-35.73	54.72
<i>Secondary income balance</i>	1,682	2.83	5.99	-13.76	42.29
<i>Trade balance</i>	1,682	-4.61	14.29	-64.93	46.65
<i>Services balance</i>	1,682	2.25	8.139	-29.38	42.94
<i>Services exports balance</i>	1,696	14.12	19.08	.24	165.14
<i>Services imports balance</i>	1,696	11.88	14.21	.63	134.09



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### 3.4 Empirical specification

In order to estimate the dynamic response of the balance of payments variables to natural disasters, we follow the approach proposed by [Jordà \(2005\)](#). This method computes impulse responses without specifying or estimating the underlying multivariate dynamic system. The central idea consists in estimating local projections (LPs) at each period of interest rather than extrapolating into increasingly distant horizons from a given model, as it is done with vector auto-regressions (VAR). According to [Jordà \(2005\)](#), while the local projection method is an alternative method to VARs, they are more robust to mis-specification and to the problem of lag length, as they provide an easy, analytic joint inference for impulse response coefficients. The method is computationally easy to implement as the LPs can be estimated by single-equation OLS with standard regression packages. It can also be adapted to manage nonlinearities.

Our specification is inspired from the work of [Gupta and Jalles \(2022\)](#). It is similar to those used in [Colacito et al. \(2019\)](#), [Ramey \(2016\)](#) and [Faccia et al. \(2021\)](#). We include lagged values of dependent variable and independent variables up to the 2nd lag which makes our model a lag-augmented local projection. The lag-augmented local projection consists in using the lag of variables as control variables. [Montiel Olea and Plagborg-Møller \(2021\)](#) have shown that the lag-augmented local projections are asymptotically valid uniformly over both stationary and non-stationary data and over different response horizons. The empirical specification is as follows:

$$Y_{t+h,i} - Y_{t-1,i} = \alpha_i + \rho_i + \beta_h ND_{i,t} + \theta_h X_{i,t} + \epsilon_{c,t}^h \quad (3.4.1)$$

$Y$  is our dependent variable that represents the balance of payments variables.  $i$  denotes the cross-sectional unit, i.e. the country, and  $t$  the time index (year and quarters, respectively).  $ND$  represents the Natural Disaster dummy variable.  $X$  is a set of control variables including two lags of real GDP, real exchange rate, the disaster shocks and the balance of payments dependent variable.  $\beta_h$  represents the response (cumulative) of the natural disas-

ter in each  $t$  year after the disaster shock. We include in the specification the country effects,  $\alpha_i$  and time fixed effects  $\rho_i$ . Our results are reported as an impulse-response function, which describes the evolution of the variable of interest over time. We obtain them by plotting the estimate  $\beta_h$  for  $k= 0,1,\dots,6$  with 90 (and 68) percent confidence bands computed using the standard deviations associated with the estimated coefficients  $\beta_h$ . Robust standards errors are clustered at the country level. The computation of two confidence bands (90% and 68%) is quite standard in the literature ([Gupta and Jalles, 2022](#)).

## 3.5 Empirical results

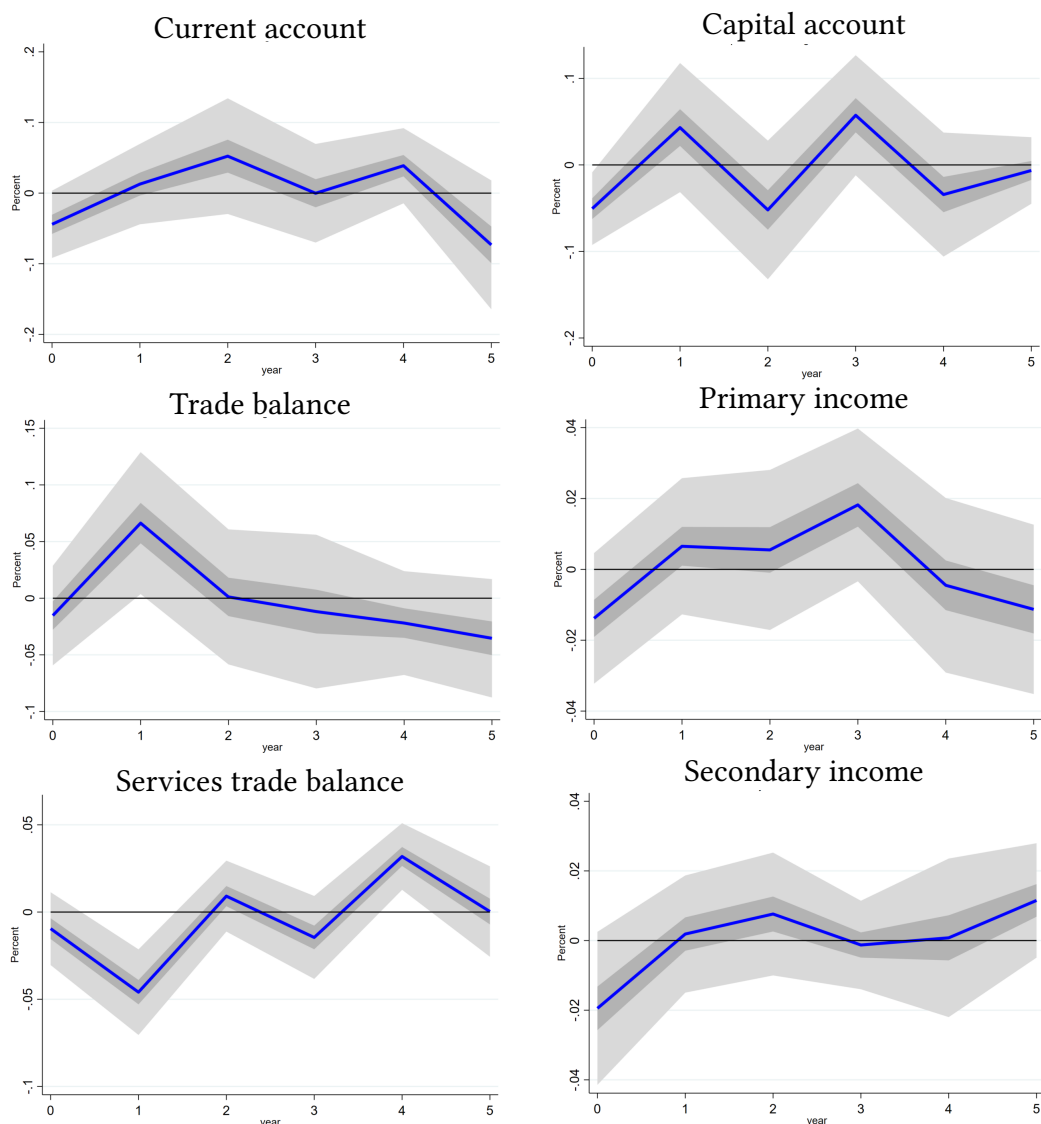
We begin our empirical analysis with annual data. Since there exists the risk of effects disappearing within a year, we conduct a second set of estimations to assess the effect at the quarterly data level.

### 3.5.1 Baseline results: annual data

#### 3.5.1.1 Balance of payment responses to large natural disasters

[Figure 3.5](#) shows the results of estimating equations for the various components of the balance of payments. These variables include the current account balance, the capital account balance, the goods balance, primary income and secondary income and the service balance. In addition to the median estimates, the figure also shows the 90 and 68 percent confidence bands. Our results show that the current account, capital account, and trade balance tend to decline after a major natural disaster. On the average, the negative impact of a shock lasts for about six months. After that, the effect tends to become positive again, albeit temporarily. In the case of the trade balance, it starts to decline after one year. We also observe that at the end of our horizon (year=5), both the current account and the trade balance tend to return to pre-disaster levels. The current account balance tends to reach equilibrium from the first year following the disasters until the fourth year within the specified horizon. As for the capital account, we can see that it is also negatively affected after disasters.

Figure 3.5: Balance of payments account responses to large natural disasters (in % GDP)



**Note:** x-axis in periods; t=0 is the year where the disasters shock. Solid blue lines denote the response to the natural disasters. The two gray bands denote the confidence bands. The largest denote 90 percent confidence bands and the smallest 68 percent bands, based on standards errors clustered at country level.

Both the primary and secondary income balances are negatively affected by the disasters. However, while the secondary income remains in surplus throughout the remaining years of our horizon, the primary income returns to its initial level (at year 0). In addition, we run different regressions taking into account the subcomponents (goods and incomes) of

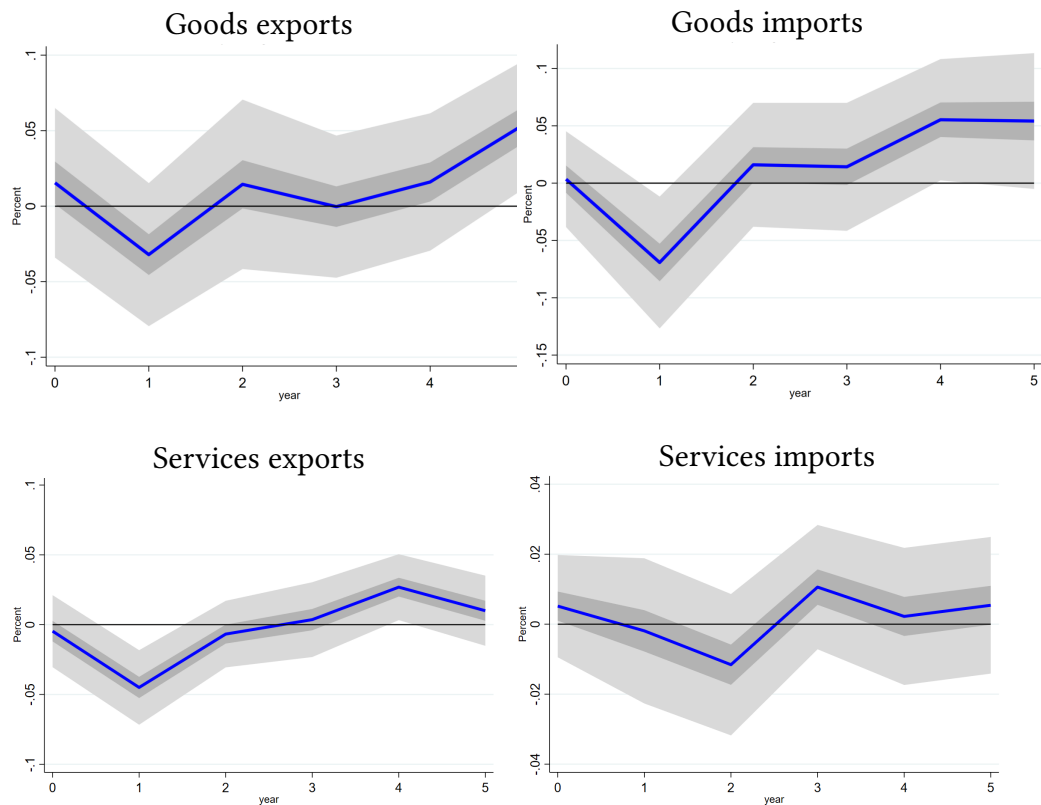
the main variables presented in the figure below. Since the trade component is an important part of the current account, we decide to look more closely at how trade in goods and invisible trade (services) respond to major disasters. We then run several regressions taking into account these components. The results are presented below and help to understand the trade balances above.

### 3.5.1.2 Trade response to the disasters shocks

In [Figure 3.5](#) the disasters immediately worsen trade flows. In the second year after a disaster, the trade balance runs a surplus. This effect can be interpreted in different ways. First, when exports and imports increase, the increase in exports could exceed the increase in imports. Second, when exports and imports decline, the decline in imports could be larger in absolute terms than the decline in exports. Third, in the absence of any change in exports or imports, imports could fall or exports could rise. To better understand what really drives the dynamics of the results above, we examine the trade responses to the shock, considering exports and imports separately. [Figure 3.6](#) presents the results of the estimation using only trade variables as dependent variables. Imports and exports of goods and services are used for the estimations. As an immediate effect, we observe that both imports and exports of goods decrease in the year following the disaster. The decrease is significant for both the 90 and 68 % confidence bands in the case of imports, while it is not significant for exports (for the 90% confidence bands). These effects of the disaster are intuitive and confirm what has been found in the literature ([Gassebner et al., 2010](#)). As mentioned above, disaster drives the destruction of countries' production capacity especially transportation infrastructures. The fact that imports and exports start to increase one year after the disaster may be due to the time it takes to repair infrastructure. Like goods, services also decline after a disaster. The services balance remains in deficit until the third year after the disaster. This result is consistent with [Xu and Kouwoaye \(2019\)](#) who find a decline in services exports. Tourism, for example, is one of the main service sectors that is highly exposed to disasters. [Ma et al. \(2020\)](#) shows that disasters tend to reduce the number of tourists in the affected countries. For example, in 2017, tourism in the Caribbean countries decreased after the hurricanes ([Council,](#)

2017). In addition, people’s perception of the risks, the extent of the damage and certain ethical reasons for traveling to the affected countries are all factors that contribute to the decline in tourism after disasters (Kozak et al., 2007; Sönmez et al., 1999; Rosselló et al., 2020). To fully understand the responses of the different components of trade to disasters at the global level, we then conduct an analysis that takes into account income levels. Economic structures, infrastructure resilience, financial resources and institutional capacities are some of the factors that lead to differences in the impact of disasters between advanced and emerging countries. The following section takes these factors into account by performing the same analyses as above, but taking into account countries’ income levels.

Figure 3.6: Trade variables to large natural disasters (in % GDP)



**Note:** x-axis in periods;  $t=0$  is the year where the disasters shock. Solid blue lines denote the response to the natural disasters. The two gray bands denote the confidence bands. The largest denote 90 percent confidence bands and the smallest 68 percent bands, based on standards errors clustered at country level

### 3.5.1.3 Emerging markets versus advanced markets

In this section we underline the responses of selected variables according to the level of income of countries. For the countries classification we follow the IMF recommendations. Our sample is composed of emerging and advanced countries. We create a dummy variable equal to one when the country is emerging and zero otherwise. We do the same for the advanced countries. Instead of running our regressions by dividing the sample into two categories, we chose to interact these variables with the occurrence of natural disasters. This approach avoids a reduction in the size of our sample (It is worth noting that this approach is the one used for the rest of sub-sample analysis). The aim of this decomposition is to see between the emerging countries and advanced countries which category of country drives the general trend of our variables and in particular to see how the balance of payments' components respond to the disasters. Figure 3.7 shows that the variables respond in the same way in the first period after the disasters. Taking the example of the current account in these two categories of countries, the deficit decreases in the first two years before it increases from year four in the both cases. For goods, the impact of the disasters is more pronounced in advanced countries than in emerging countries. All these countries record a trade surplus in the first year following the disaster, but this effect is greater in advanced than in emerging countries. In terms of services, emerging countries lose more in services than advanced countries. The deficit observed after the disaster is significant and greater than in advanced countries. Overall, the negative impact is greater in emerging economies than in advanced economies due to a number of factors. They often have less developed infrastructure. They are economically and socially vulnerable. They also have limited institutional capacity and weak governance structures. On the basis of the Regulatory Quality Index<sup>8</sup>, the majority of emerging markets are at the lower end of the scale. Although we lack specific data to directly test the role of institutions in our study, we can hypothesize that the level of institutions plays an important role in determining the magnitude and significance of the aforementioned effects.

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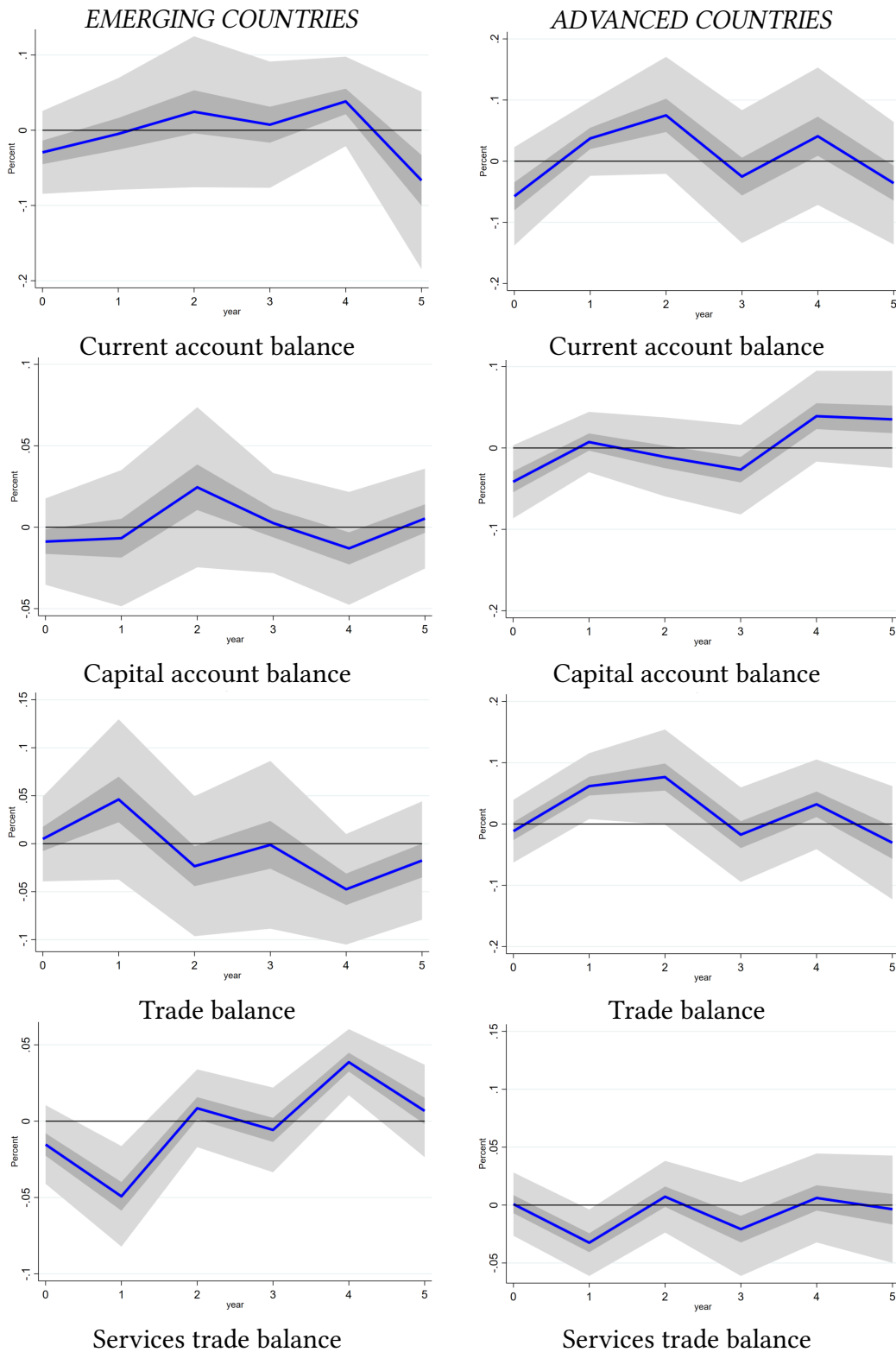
<sup>8</sup>[https://www.theglobaleconomy.com/rankings/wb\\_regulatory\\_quality/](https://www.theglobaleconomy.com/rankings/wb_regulatory_quality/)

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Finally, it should be noted that capital transfers also increase following a disaster. Post-disaster capital transfers play an important role in supporting post-disaster recovery. These include financial aid, investments and forms of support such as migrant remittances. Especially in the case of these emerging economies, migrant remittances are important as financial support to the population (Yang, 2008; Clarke and Wallsten, 2003; Ratha, 2006; Ebeke and Combes, 2013).

When analysing the impact of natural disasters, it is important to take into account not only income levels but also the geographical characteristics of countries. Indeed, certain categories of countries often appear to be more exposed to natural disasters than others. This is particularly true of tropical and island countries, which we analyse more closely in the next section.

Figure 3.7: Emerging countries versus advanced countries: responses functions to large natural disasters (in % GDP)



**Note:** x-axis in periods; t=0 is the year where the disasters shock. Solid blue lines denote the response to the natural disasters. The two gray bands denote the confidence bands. The largest denote 90 percent confidence bands and the smallest 68 percent bands, based on standards errors clustered at country level.



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### 3.5.1.4 Does geographical location play an important role?

To answer this question, we run a series of regressions taking into account the geographical characteristics of selected countries, namely island and tropical countries<sup>9</sup>. First, geographical location is an important determinant of physical vulnerability to natural disasters for some categories of countries. Furthermore, among natural disasters, tropical cyclones are listed as the natural hazard with the highest insured losses (Munich and re<sup>10</sup>). They are defined as a rotating, organised system of clouds and thunderstorms that originates over tropical or subtropical waters and has a closed low-level (NOAA<sup>11</sup>). It is then important to examine the impact on a sub-sample of tropical countries. In addition to the analysis of tropical countries, we add the category of island countries. Small island states, for example, are known to be particularly vulnerable to disasters IMF<sup>12</sup> (Coffman and Noy, 2012; Heger et al., 2008; Rasmussen, 2004). Most of these countries are tropical and have been studied in the literature on natural disasters.

#### 3.5.1.4.1 Tropical countries

Below we report the results for the current account and its main components. The current account seems to be balanced two years after the disasters before returning to its initial level. It appears that the disasters lead to a current account deficit, and the deficit is reduced after two years for tropical countries. Secondary income is negatively affected by disasters, but increases in the first year. An increase in secondary income could be driven by international aid and migrant remittances. The impact of disasters on services persists until the third year before declining, but to a lesser extent than the post-disaster response.

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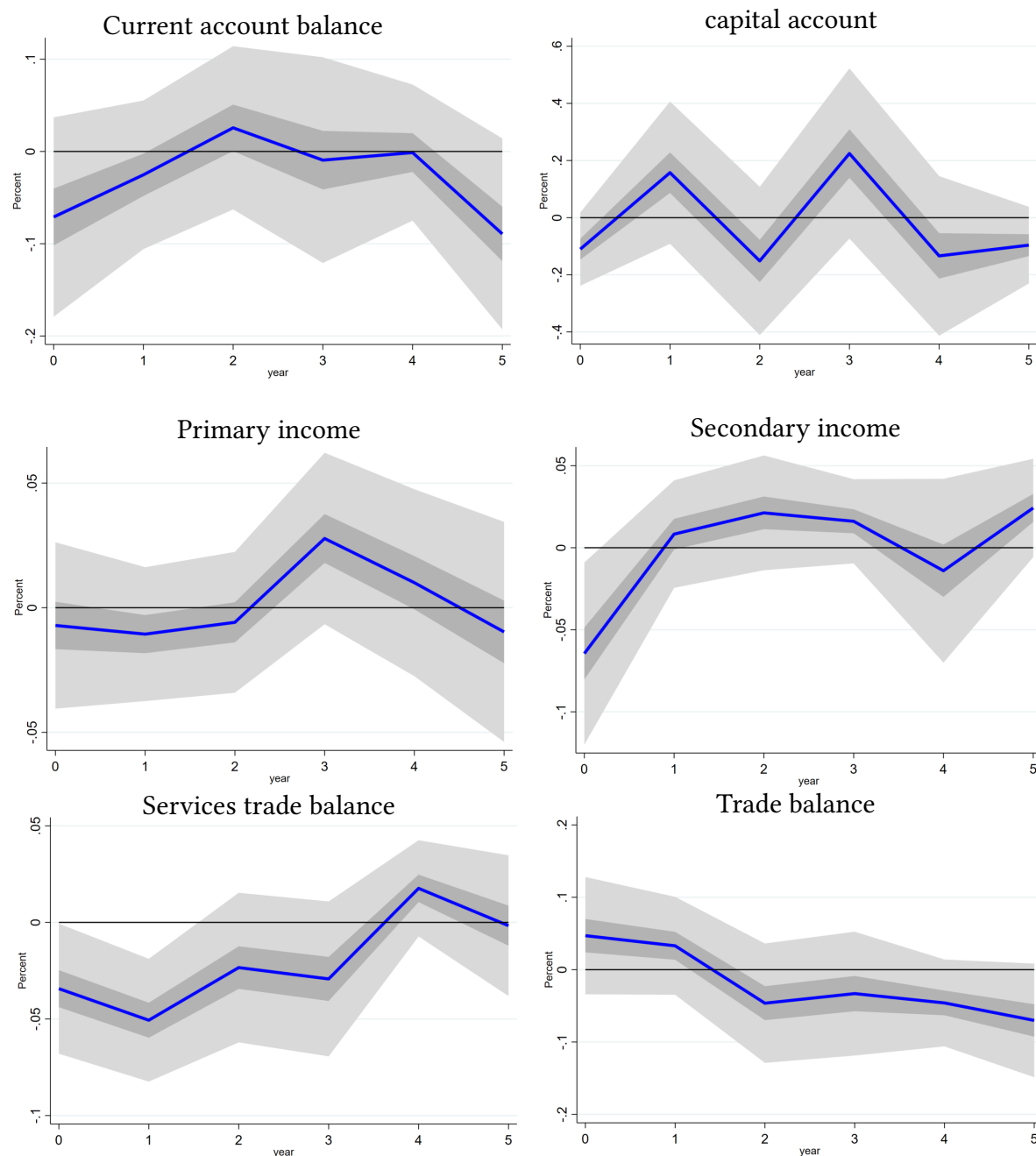
<sup>9</sup>We also conduct analyses for the sub-sample of coastal countries. However, we have not presented them here because the results are similar to the baseline results in terms of trends and magnitude as a percentage of GDP (see Figure 19 and Figure 20)

<sup>10</sup><https://www.munichre.com/en/risks/natural-disasters-losses-are-trending-upwards/hurricanes-typhoons-cyclones.html>

<sup>11</sup>National Oceanic and Atmospheric Administration:<https://www.nhc.noaa.gov/climo/>

<sup>12</sup>IMF:<https://www.imf.org/en/Publications/Policy-Papers/Issues/2019/06/24/Building-Resilience-in-Developing-Countries-Vulnerable-to-Large-Natural-Disasters-47020>

Figure 3.8: Variables responses to large natural disasters (in % GDP): tropical countries



**Note:** x-axis in periods;  $t=0$  is the year where the disasters shock. Solid blue lines denote the response to the natural disasters. The two gray bands denote the confidence bands. The largest denote 90 percent confidence bands and the smallest 68 percent bands, based on standards errors clustered at country level

In tropical countries, goods imports and exports react similarly to the overall results

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in the year two. After a decrease in the year following the disaster, exports and imports increase but the growth in imports is significant and exceeds the export growth. This explains the trend of the goods balances in Figure 3.8 and 18. Finally, after two years, the primary income does not seem to be affected, while the secondary income balance increases within the year after the disasters.

#### 3.5.1.4.2 Islands

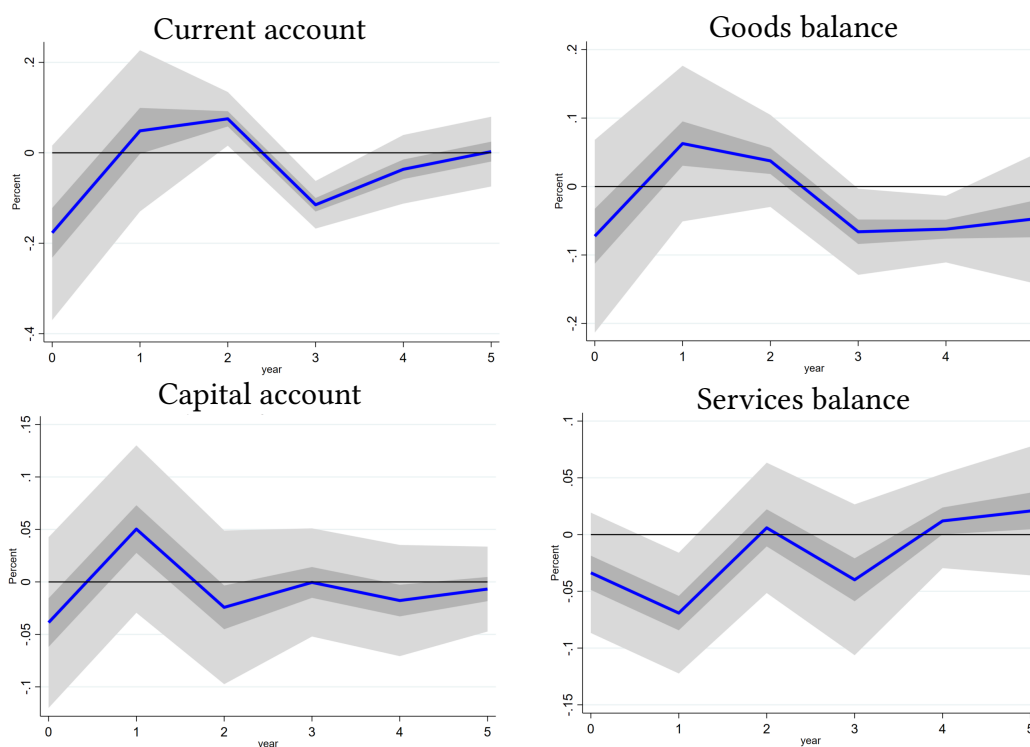
Islands in general are known to be highly vulnerable to natural disasters, especially small island states. Due to a lack of data, our sample includes a limited number of islands. Figure 3.9 below shows the impact of natural disasters on the current account, capital account, and goods and services taking into account islands.<sup>13</sup> The effects are more important than the overall sample results. The deficit in services is larger for the islands than for the sample as a whole. Similarly, the decline in the overall results by the third year is larger and more significant in the island countries. Trade in goods is in deficit overall, except for a surplus observed between the first year and second year after the disasters. This result can be explained by the trends in exports and imports, as shown in Figure 16. As mentioned above, the same explanations apply to the trade variables, and during the period between the first and second year after the disasters, there is a notable shift where imports do not exceed exports. Similarly, for services, the results show that exports are the main component of trade most affected by disasters, as shown in figure 16. A closer look at our sample reveals that the list of island countries includes some important countries in terms of level of development. Their presence in the sample could affect the results obtained. We have therefore decided to exclude these countries. Indeed, when we exclude the United Kingdom, Japan, Singapore and New Zealand (as large developed island countries) from our sample, the effects are similar to the overall result. Disasters immediately lead to deficits in the current account, trade, and services balances (see fig17). More interestingly, the negative impact on the goods and current account balances is slightly larger than for the sample as a whole. In addition, the

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<sup>13</sup>The island countries in our sample are: Antigua and Barbuda, The Bahamas, Bahrain, Cyprus, Dominica, Dominican Republic, Fiji, Iceland, Ireland, Malta, Philippines, Samoa, Solomon Islands, The UK, Japan, Singapore and the New Zealand

economies of these countries are often based on export industries that are highly sensitive to disasters such as tourism, agriculture and fisheries.

Figure 3.9: Variables responses to large natural disasters (in % GDP): Island countries



**Note:** x-axis in periods;  $t=0$  is the year where the disasters shock. Solid blue lines denote the response to the natural disasters. The two gray bands denote the confidence bands. The largest denote 90 percent confidence bands and the smallest 68 percent bands, based on standards errors clustered at country level.

So far, the disaster variable used in our analyses, as described above, takes into account all types of disasters, including non-climatic ones. These include floods, storms, extreme temperatures, droughts, volcanic activity, earthquakes, landslides, wildfires, mass movements, fog and glacial lake outburst. Of the world's major natural disasters, 90 percent are weather-related.<sup>14</sup> Based on this, we perform the same analysis as above but instead of an aggregate disaster variable as defined by Muniche and Re, we consider catastrophes such

<sup>14</sup><https://www.un.org/sustainabledevelopment/blog/2015/11/un-report-finds-90-per-cent-of-disasters-are-weather-related/>

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as floods, storms and climate change disasters as separate variables.

## **3.5.2 Different types of natural disasters**

### **3.5.2.1 Hydrological disasters impacts**

In this section, we focus on hydrological disasters such as floods and storms. As indicated by Figure 3.1, flood and storms are the most frequent types of natural disasters. The natural disasters effects on trade and services are similar to the effects of large natural disasters. As well as large disasters, floods lead to a decrease in goods and services, both imports and exports, in the first period after the disaster. We present also responses of the same variables in the case of storms in figure 15 in the appendix. The disasters lead to an increase in trade variables (imports and exports of goods and services) during the two years after the disaster. The results are similar when we take into account whether the countries have a coast or not. In fact, the sample is 81 percent composed of coastline countries (70 out of 86 countries).

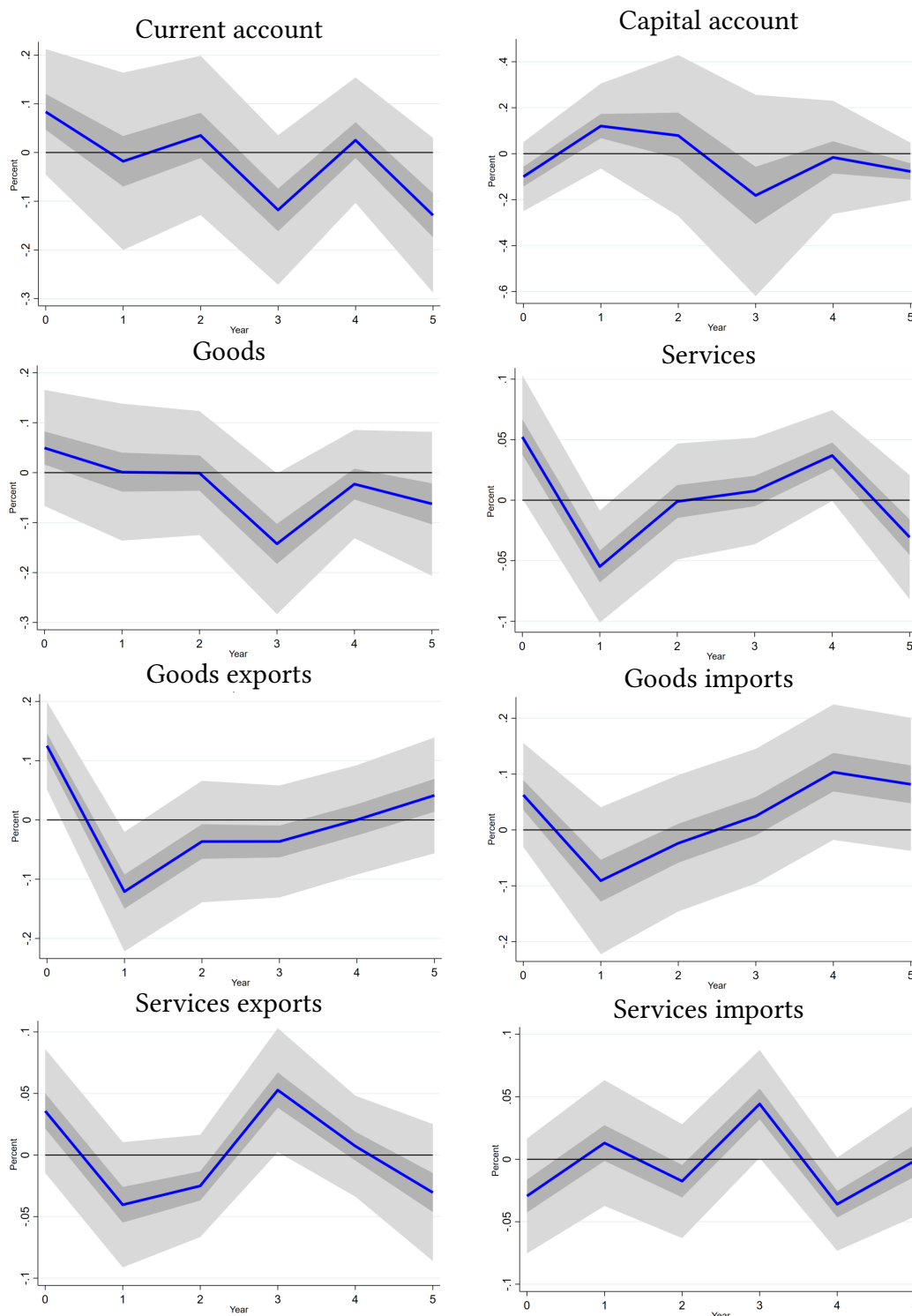
### **3.5.2.2 Climate change disasters**

As our natural disasters cover disasters that are not related to climate change consequence, we create a climate change disaster variable to assess the disasters impacts. These disasters are composed of flood, drought, extreme temperature events, storms and wildfires. The variable constructed is the sum of the cited disasters. The effects are in line with the baseline results specially concerning the trade components (imports and exports). After a climate change disasters the current account does not seem initially affected. The current account is balanced the first year after the disasters before increasing the following year. Nevertheless, the effect is not persistent. At horizon 5 the current account goes into deficit. The goods and services balance run a deficit after the disasters. As mention above the destruction of transport infrastructure leads to a decrease in trade and services variables in the first year after the disaster (see figure 3.11). We observe also an increase in the capital account <sup>15</sup> that

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<sup>15</sup>The use of the term “capital account” in this chapter is consistent with the definition in the Sixth Edition of the Balance of Payments and International Investment Position Manual-(BPM6), which distinguishes between

Figure 3.10: Variables responses to hydrological natural disasters: flood



**Note:** x-axis in periods; t=0 is the year where the disasters shock. Solid blue lines denote the response to the natural disasters. The two gray bands denote the confidence bands. The largest denote 90 percent confidence bands and the smallest 68 percent bands, based on standards errors clustered at country level.

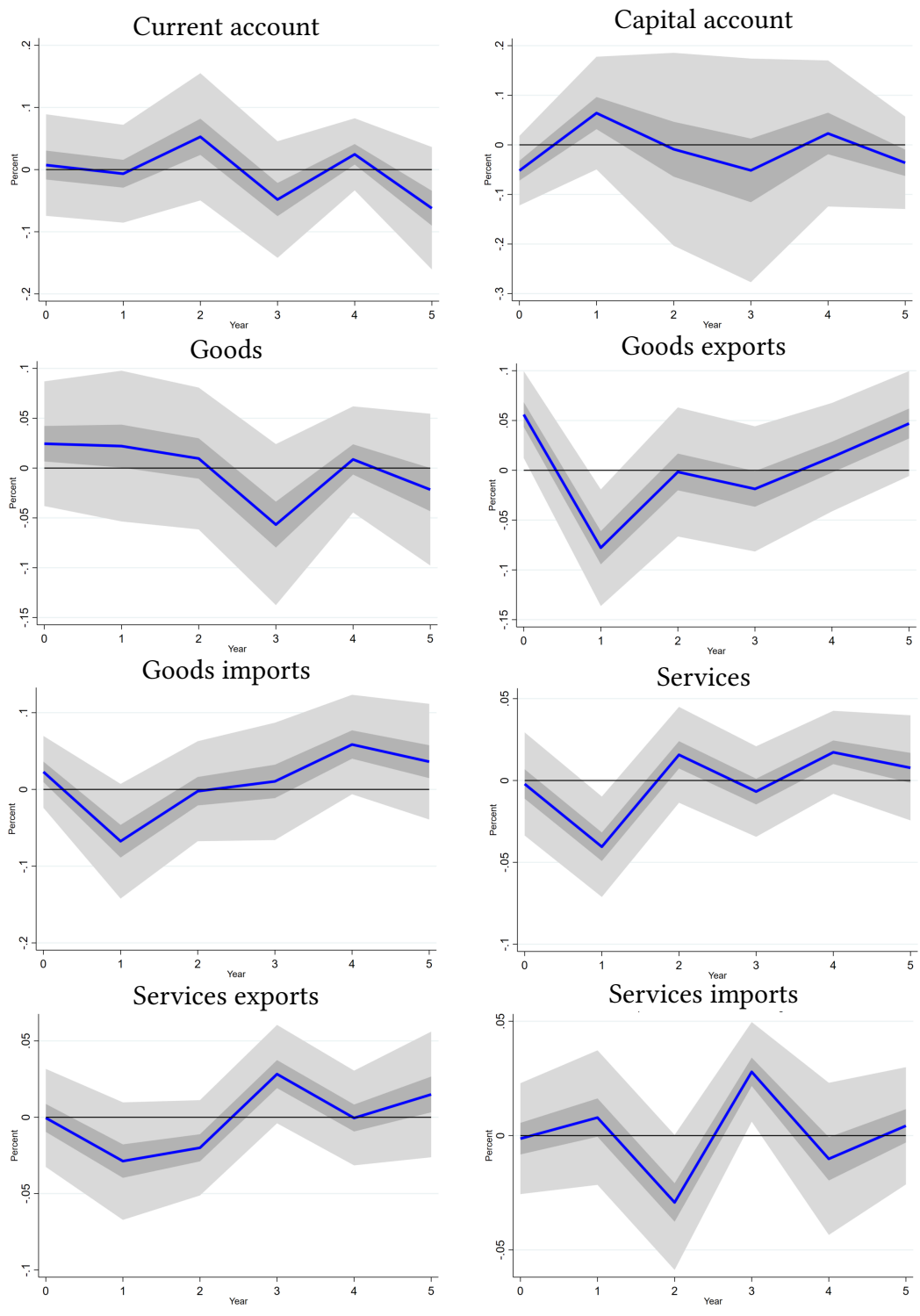
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results in a significant increase in capital transfers in the year following the natural disasters before returning to its initial situation after 5 years.

Our results help us understand global imbalances from the perspective of natural disasters. They complement what we have seen in previous chapters. Disasters are natural events that affect global imbalances through the main components of the balance of payments. Analyses at the annual level show how the balance of payments is affected by disasters. This is mainly through trade, one of the main components of the current account. Our main observation is that imbalances are exacerbated after major natural disasters.

Disasters lead to current account deficits. In fact, all components of trade decline after a major disaster. We also find that countries' income levels and geographical characteristics play a role in the intensity of the impact on the variables. In the following section, we verify these results at the quarterly level for the data available in the next section.

Figure 3.11: Responses to climate change natural disasters



**Note:** x-axis in periods; t=0 is the year where the disasters shock. Solid blue lines denote the response to the natural disasters. The two gray bands denote the confidence bands. The largest denote 90 percent confidence bands and the smallest 68 percent bands, based on standards errors clustered at country level.



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### 3.5.3 Quarterly data

#### 3.5.3.1 Baseline results

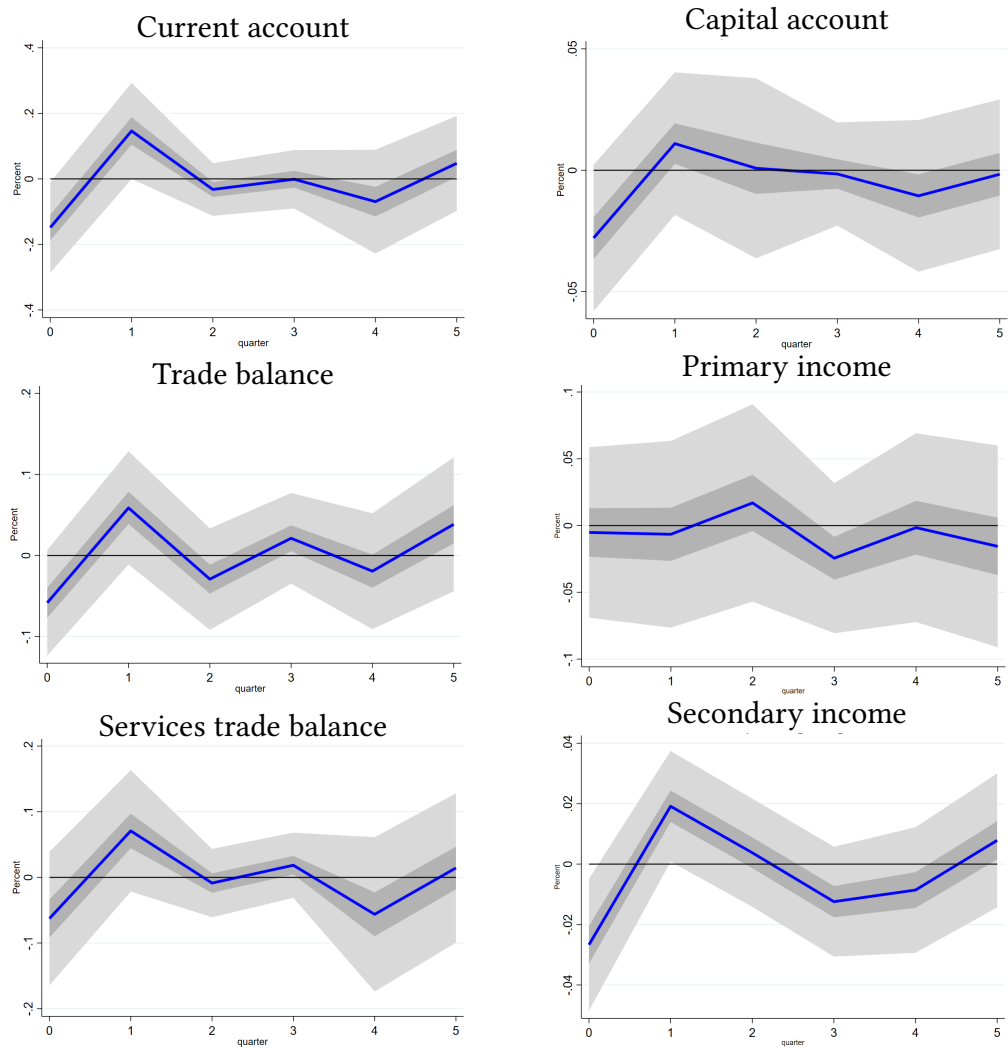
As mentioned above, because the impact of disasters can disappear within a year, we have carried out several robustness checks on the overall findings. The baseline results are presented below. The rest of the results are presented in the appendix. We run the same regressions as for the annual data at a quarterly frequency. Overall, the results are similar to the baseline results.

However, quarterly data provide more information on the evolution of our variables. Regarding the current account (CA), we observe that the negative effects on the CA diminish one year after the disaster. At the quarterly level, the results show that the effects are not linear. The negative effects disappear almost immediately after the natural event, but reappear from the second quarter to the fourth quarter. Looking at the dynamics, we can see that the negative effect exceeds the positive effects, which explains our overall results at the annual level. Moreover, the results at the quarterly level show that the impact as a percentage of GDP can be larger within the year than at the annual average level. The impact of disasters on the current account is three times larger at the annual level, amounting to 1.5 percent of GDP at the quarterly level and 0.5 percent at the annual level. It also appears that the current account results are mainly driven by the trade components. For example, the trade balance reaction remains the same at the annual level, but shows larger effects in terms of percentage of GDP. The post-disaster deficit is twice as large at the quarterly level than at the annual level (about 0.18 for the current account at the quarterly level against 0.05 at the annual level). After the disaster, we observe a decline in exports and imports of goods and services in the first quarter. Although the immediate impact on exports and imports is positive, the negative impact occurs in the first two months after the disasters. One quarter after the disasters, the negative impact begins to decline, while for exports it takes two quarters. For imports, we can explain this by the international aid received after disasters. This aid can be financial, but mostly consists of donations in kind and imports of materials needed to rebuild the affected countries. On the export side, logically, they can only resume once

the transport infrastructure has been rebuilt or temporary solutions have been found. The reconstruction process and the time needed to rebuild the infrastructure play a crucial role in determining when exports can effectively resume in the affected regions. For our sample, the results show that the time required for exports to resume is about two quarters, while for imports it is about one quarter. This suggests that exports take slightly longer to recover after disasters than imports.

For services, the results underline the fact that exports of services are more affected by disasters than imports of services. Looking at the results for trade in emerging and advanced economies, emerging economies are more affected than advanced economies for goods. At the same time, services react more in advanced economies than in emerging economies. As it is difficult to perform a subsample analysis from annual to quarterly data for countries such as those with coastlines or the Caribbean, our analysis remains less detailed.

Figure 3.12: Balance of payments accounts responses to large natural disasters (in % GDP): quarterly analysis



**Note:** x-axis in periods;  $t=0$  is the year where the disasters shock. Solid blue lines denote the response to the natural disasters. The two gray bands denote the confidence bands. The largest denote 90 percent confidence bands and the smallest 68 percent bands, based on standards errors clustered at country level.

## 3.6 Concluding remarks

There is a growing interest in the impact of natural disasters on key economic variables. When natural disasters occur, economic activity is disrupted as production facilities, transportation and communication infrastructure are affected. This destruction not only leads to immediate effects but can also leave scars on growth potential and economic behavior, implying delayed and long-lasting effects. This chapter has examined the impact of natural disasters on the components of the balance of payments. Given the multifaceted nature of the mechanisms through which natural disasters can affect an economy, the different balance of payments accounts provide an interesting and original lens through which we could approach the issue. Because it involves trade and financial transactions, the role of transport infrastructure, and repair expenditures that could crowd out other expenditures, assessing the impact of natural disasters on the balance of payments provides interesting insights. Additionally, it highlights the importance of public policies and international aid. In a broader context, it also shows how cross-border transactions and external imbalances face headwinds in an era of climate-related challenges.

This chapter uses the local projection method developed by [Jordà \(2005\)](#) to assess the impact of natural disasters on the balance of payments through its main components. Using the main components of the balance of payments, we find a decline in the current and capital account deficits following natural disasters. In terms of trade, natural disasters lead to a decline in imports and exports of goods and services in the two years following the disasters. Focusing on different definitions of disasters (climate change disasters, hydrological disasters), our baseline results are confirmed. We also ran our baseline regressions using different subsamples. We classify our countries according to their income level and geographical characteristics. On the income level, the impact of disasters on goods is larger in advanced countries than in emerging countries. We also find that the impact of disasters on services is larger in emerging countries than in advanced economies. In tropical countries, the main findings concern the response of secondary income to disasters. This sheds light on the role of remittances in the recovery process in these countries. Imports and exports de-

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cline as in the baseline results. In island countries, services are the most affected components compared to the sample as whole. This result was to be expected given the large share of tourism in the GDP of these countries. Indeed, it represents at least 9% in the island countries, which are among the top 10 countries with a highest share of international tourism receipts in GDP. The first three countries in this ranking are Aruba, Maldives and Macao, all island countries, where the revenues represent 41.26 %, 37.61 and 37.09 respectively. It reaches 41%<sup>16</sup>. Finally, our baseline results are confirmed when quarterly data are used instead of annual data.

In terms of policy recommendations, our results allow to assess the response horizon of variables after a major disaster. This can help policy makers to implement appropriate policies in response to natural disasters. The results can also help international organizations to better support countries according to the affected sector. In emerging economies where the results indicate a significant role for remittances, policymakers should consider implementing measures that facilitate the transfer of money from the rest of the world to these countries when disasters strike. This could include reducing transfer fees to promote easier and more accessible remittance flows. Furthermore, as natural disasters have a negative impact on all countries, international coordination is essential to help less well endowed countries develop appropriate infrastructure to mitigate the effects of such disasters. By providing assistance and resources, the international community can help minimize the impact of natural disasters on these vulnerable nations. Sustainable development must be promoted to reduce vulnerability to natural disasters.

Trade could help countries cope with the negative impacts of disasters. This means providing access to the resources needed to adapt to climate change. Policymakers must ensure that post-disaster trade can be facilitated by reducing trade barriers.

However in terms of areas for improvement, when we examined the impact of natural disasters controlling for institutional quality variables, we find a significant amount of missing data when we included institutional variables. Approximately 30% of the data was

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<sup>16</sup>source: World Tourism Organization and [www.theglobaleconomy.com](http://www.theglobaleconomy.com). The indicator used for this ranking is calculated on the basis of data available from 1995 to 2020.

missing, which prevented us from running the regressions. Consequently, further research is needed to verify the effects described in the existing literature by including institutional variables. The inclusion of geopolitical risk is also important to better capture the effect of disasters.



# GENERAL CONCLUSION

Since the 1990s, the world economy has experienced a significant increase in global current account imbalances. Despite a narrowing with the 2008 global financial crisis, these imbalances remained large and have persisted in the post-crisis period. This was exacerbated by the global COVID-19 pandemic (in 2020) and Russia's invasion of Ukraine (in 2022). These events show that economic and financial imbalances often lead to substantial adjustments in current account balances. Based on these recent developments on global imbalances, this thesis analyzes the new challenges ahead in terms of climate change and mitigation policies. This thesis aims to understand global imbalances and international trade in an era of climate change. The study sheds light on the factors that contribute to the persistence of global imbalances, how environmental policies affect the current account and how these policies could potentially lead to carbon leakage. It also examines the impact of natural disasters on the current account.

After a general introduction, [chapter 1](#) highlights the variables explaining the persistence of current account imbalances, paying particular attention to the role of the GFC. We find that financial crises modify current account balances in general. In emerging and advanced countries, they contribute to current account surpluses, while in low-income countries, they lead to current account balance deterioration. We assess the presence of structural breaks and we have find an evidence of the GFC as an important structural change in current the account dynamics. Through the decomposition of our sample between pre- and post-GFC, we find that current account dynamics differ not only across countries but also across time. In the presence of a financial crisis, foreign capital inflows logically decline, as does domestic investment. In low-income countries, financial crises combined with a high level of openness lead to current account surpluses, mainly due to a reduction in foreign capital, which also leads to a decline in domestic investment. Our results show that the more integrated a country is in global value chains, the more likely it is to run current account deficits. In addition to the first empirical results, we include other variables used in the literature to assess their role, including financial development, currency misalignment, financial



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openness and institution quality variables. We find that these variables are significant factors impacting current accounts and that their impact passes through the changes in investment and saving behaviors. Indeed, specifying a full model, our results suggest that current account deficits are associated with financial development. We also find that currency overvaluation leads to current account deficits. For the institutional variables, all of them<sup>17</sup> support an improvement in current accounts. Finally, current account deficits are associated with a high level of productivity in the country. We check the robustness of our models by carrying out the same analyses using the system-GMM, a more powerful estimator that takes into account possible endogeneity problems. After the robustness check, we examine whether our models are able to explain the configuration of the current account using the example of a few countries. We assess the degree of uncertainty between our models and find that in most cases our models are consistent with each other. In addition to the previous analysis, we select the variables with the strongest predictions and calculate the contributions of the different variables. Our predictions for the current account in selected countries highlight the role of productivity, openness, GDP per capita and institutional factors in the evolution of the current account. The decomposition before and after the GFC shows that the role of certain variables is more important before and after the GFC. Real total factor productivity, GDP per capita, institutional components and the contribution of openness are important in the pre-GFC results. In addition to the pre-GFC variables, the fiscal balance, net foreign assets and the youth/age ratio are found to be more important in the post-GFC results.

In this [chapter 1](#) we also consider another important dimension going forward: the role of the energy transition on global imbalances. The decline in demand for fossil fuels will affect both oil-exporting and oil-importing countries. At the same time, new players, such as exporters of transition critical minerals, may reshape the configuration of global current accounts. By redirecting trade flows and influencing savings-investment dynamics, the green transition is a key element to be incorporated into prospective current account analyses. In light of the IMF's ([International Monetary Fund, 2022](#)) recent external sector report, we assess the impact of climate change mitigation policies on the current account.

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<sup>17</sup>with the exception of the government stability variable

We use two variables as policy indicators: climate change and environmental taxes. The results suggest that a tightening of environmental policies or a high level of environmental taxes is associated with current account surpluses. Overall, our findings contribute to a better understanding of current account dynamics over time and across countries and show the importance of using factors that go beyond the traditional saving-investment determinants and take into account more structural factors. Our results on the impact of climate change are consistent with the scenario tested in the IMF's report ([International Monetary Fund, 2022](#)) on the implementation of climate change mitigation policies. They confirm the fact that climate change mitigation policies (implemented unilaterally) increase the current account in regions where they are implemented, rather than reducing them when policies are coordinated.

In the case of free mobility of factor of production across borders, [McGuire \(1982\)](#) suggests that the slightest regulatory difference between countries will completely relocate the regulated industry from the more regulated economy to the less regulated one. This relocation will certainly have an impact on international trade. It is against this backdrop that [chapter 2](#) analyzes the impact of environmental policy and CO<sub>2</sub> emissions embodied into international trade. It uses a standard gravity model with panel data to assess what determines the CO<sub>2</sub> emissions embodied in gross trade flows. It pays particular attention to the inclusion, in addition to the traditional determinants of bilateral trade, of measures related to environmental regulation, both *de jure* (reflecting policy measures) and *de facto* (reflecting environmental performance). Our results show no evidence that environment regulation or performance would be bypassed by higher imports of CO<sub>2</sub>-intensive goods at the global level. On the contrary, the higher the environmental performance of a country, the lower the CO<sub>2</sub> emissions embodied in trade. This results hold true both for exporters and importers. When breaking down the data by sectors, the effects of environment policy to lower emissions are even stronger for the most polluting sectors. Therefore, the apparent imbalances in CO<sub>2</sub> emissions embodied in trade originate more from usual specialisation motives rather than from differences in environmental policy. At the same time, when focusing on importing countries with more stringent policy, we do find some evidence of carbon leakages, as the

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CO<sub>2</sub> content of their import increases following a tightening in their environmental policy. We also find that the impact of domestic environment policy measures is larger on exports of CO<sub>2</sub>-intensive goods than on imports. This result also points to the fact that environmental policy actions may have less impact in relative terms on imports than on production (and therefore on exports), showing that the virtuous countries from an environmental policy viewpoint tend to import the most from the least virtuous ones.

The implementation of environmental policies aims at mitigating the consequences of climate change. When natural disasters occur, economic activity is affected by the destruction of production facilities and transport and communication infrastructures. This destruction not only has an immediate impact, but can also leave scars on growth potential and economic behaviour, with delayed and long-lasting effects. In this sense, [chapter 3](#) helps us to understand global imbalances from the perspective of natural disasters. It complements what we have seen in the previous chapters. First and foremost, we see that disasters are natural events that affect global imbalances through trade, primary income and secondary income. Natural disasters play a crucial role in understanding the evolution of the balance of payments. In our work, we analyse the impact of disasters on the balance of payments mainly through trade, one of the main components of the current account. Our main observation is that current account imbalances are exacerbated after major natural disasters. The impact of the disaster on the current account is negative, and this negative effect disappears within a year. Our results suggest that all components of trade decline after a disaster. Exports and imports of goods and services fall in the year following the disaster. Imports of services take the longest to recover. When we examine the impact of disasters according to countries' income levels, we find that the negative impact of disasters on the balance of payments is greater in emerging economies than in advanced countries. For example, the post-disaster trade deficit is larger in emerging economies than in advanced economies. We also find that capital transfers increase after disasters (under the form of foreign aid and remittances). Our results underline the important role of geographical characteristics. In tropical countries in particular, disasters lead to an increase in foreign aid and remittances. Similarly, imports and exports decrease after disasters. As expected, the impact of disasters is more severe than

in other groups of countries. Tourism and services exports are most affected by disasters, especially in island and coastal countries. As a robustness exercise, we assess the impact of different types of natural disasters. Hydrological and climatic disasters are the main ones tested. The results are in line with our findings. The results are also confirmed at the quarterly level and show that the responses of the variables are not linear.

In terms of policy recommendations, [chapter 1](#) suggests the importance of international cooperation between countries. This should be encouraged through existing international organizations and fora, like the G7 and the G20. It will avoid unilateral actions that could aggravate imbalances. In addition, to ensure a sustainable economic environment, the coordination of fiscal and monetary policies should be encouraged. Such coordination can help to manage inflation, interest rates and public spending. Moreover, comprehensive monitoring and early-warning mechanisms should be set up to detect emerging imbalances at an early stage. Structural reforms should also be implemented to improve competitiveness, productivity, institutions, reduce trade barriers and equitable growth. Examining the impact of environmental policies on global imbalances, the results show that environmental policies are positively associated with the current account balance. These results are very interesting in the context of emerging and developing countries, where there seems to be a conflict between economic development goals and environmental protection. We have explained them as a reduction in imports of fossil fuels, high-polluting products or an increase in investment in the green sector, which increases export competitiveness. For these countries, it is an opportunity to increase investment in the green sector while implementing environmental regulations. These policies will help reduce national emissions and encourage the adoption of low-carbon technologies. But for this to happen, these countries alone cannot finance this sector, which often requires large amounts of capital. This is the role that international organizations can play. Overall, the results suggest that international coordination of climate change mitigation policies is necessary if policymakers are to achieve the desired effects. This policy recommendation goes in the same direction as that suggested by the results in [chapter 2](#) concerning carbon emission embodied in international trade. Indeed, as differences in environmental regulation across countries tends to support trade in carbon-intensive goods,

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our result points to the importance of international coordination and cross-country harmonization in environmental policy in order to curb CO<sub>2</sub> emissions embodied in trade at global level. And finally about natural disasters, our results in [chapter 3](#) make it possible to assess the response horizon of variables after a major disaster. They can help policy-makers implement appropriate policies in response to natural disasters. The results can also help international organizations to better support countries according to the sector affected. In emerging markets where the results indicate a significant role for remittances, policymakers should consider implementing measures that facilitate the transfer of money from the rest of the world to these countries when disasters strike. This could involve reducing transfer fees to promote easier and more accessible remittance flows. Furthermore, given that natural disasters have a negative impact on all countries, international coordination is essential to help less well-endowed countries develop appropriate infrastructures to mitigate the effects of such disasters and become more resilient when these events occur. By providing support and resources, the international community can help minimize the impact of natural disasters on these vulnerable nations. Sustainable development and adaptation effort must be promoted to reduce their vulnerability to natural disasters. Trade should be also part of the solution, helping countries to combat the negative effects of disasters. Political decision-makers must ensure that, following a disaster, trade can be facilitated by reducing barriers to trade.

In terms of perspectives, our work has shown that there is still considerable uncertainty when it comes to assessing the effects of policies and behaviors on trade flows and current account imbalances. This uncertainty is linked to the models used, the magnitude and frequency of future shocks or the way in which structural changes will unfold. Taking this uncertainty into account is essential for political decision-makers when it comes to defining actions and tackling major challenges. Further research is therefore needed to properly integrate growing uncertainty into economic theories and policy tools. With regard to the impact of natural disasters on the balance of payments, further works taking into account the dimension of institutions would enable us to better understand the role that institutional quality plays in the resilience of countries affected by disasters. In addition,

the current geopolitical context calls for studies on the impact of geopolitical risks on global imbalances. This is also left for future research.

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# APPENDIXES

## .0.1 Appendix to general introduction

### .0.2 List of countries used for the figure 2

- **Emerging market and developing economies** : Afghanistan, Albania, Algeria, Angola, Antigua and Barbuda, Argentina, Armenia, Azerbaijan, Bahamas, The, Bahrain, Bangladesh, Barbados, Belarus, Belize, Benin, Bhutan, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, Brunei Darussalam, Bulgaria, Burkina Faso, Burundi, Cabo Verde, Cambodia, Cameroon, Central African Republic, Chad, Chile, China, People's Republic of, Colombia, Comoros, Congo, Dem. Rep. of the, Congo, Republic of, Costa Rica, Curacao, Côte d'Ivoire, Djibouti, Dominica, Dominican Republic, Ecuador, Egypt, El Salvador, Equatorial Guinea, Eritrea, Eswatini, Ethiopia, Fiji, Gabon, Gambia, The, Georgia, Ghana, Grenada, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, Hungary, India, Indonesia, Iran, Iraq, Jamaica, Jordan, Kazakhstan, Kenya, Kiribati, Kosovo, Kuwait, Kyrgyz Republic, Lao P.D.R., Lebanon, Lesotho, Liberia, Libya, Madagascar, Malawi, Malaysia, Maldives, Mali, Marshall Islands, Mauritania, Mauritius, Mexico, Micronesia, Fed. States of, Moldova, Mongolia, Montenegro, Morocco, Mozambique, Myanmar, Namibia, Nauru, Nepal, Nicaragua, Niger, Nigeria, North Macedonia, Oman, Pakistan, Palau, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Qatar, Romania, Russian Federation, Rwanda, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Samoa, Saudi Arabia, Senegal, Serbia, Seychelles, Sierra Leone, Sint Maarten, Solomon Islands, Somalia, South Africa, South Sudan, Republic of, Sri Lanka, Sudan, Suriname, Syria, São Tomé and Príncipe, Tajikistan, Tanzania, Thailand, Timor-Leste, Togo, Tonga, Trinidad and Tobago, Tunisia, Turkmenistan, Tuvalu, Türkiye, Republic of, Uganda, Ukraine, United Arab Emirates, Uruguay, Uzbekistan, Vanuatu, Venezuela, Vietnam, West Bank and Gaza, Yemen, Zambia, Zimbabwe
- **Advanced economies** : Andorra, Australia, Austria, Belgium, Canada, Croatia, Cyprus,



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Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hong Kong SAR, Iceland, Ireland, Israel, Italy, Japan, Korea, Republic of, Latvia, Lithuania, Luxembourg, Macao SAR, Malta, Netherlands, New Zealand, Norway, Portugal, Puerto Rico, San Marino, Singapore, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Taiwan Province of China, United Kingdom, United States

- **European Union** : Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain, Sweden

## .1 Appendix to chapter 1

### .1.1 Variables and their sources

VARIABLES	Sources
Current account balance	Milesi-Ferretti (2022)
GDP per capita	World Development Indicator
GDP growth	World Development Indicator
Net foreign assets	Milesi-Ferretti (2022)
Real exchange rates	(source: BRUEGEL, 2020)
Total factor productivity	Penn World Table
Financial openness	The Chinn-Ito index
Financial crises	(ICRG, 2020)
currency misalignment	(CEPII, 2017) <sup>18</sup>
Financial development	IMF's Financial Development Index database
Population variables	World Development Indicator
Climate Change indicator (CCH)	Yale Center for Environmental Law, Policy's Environmental Performance Index (EPI)
Environmentally related tax revenue	Policy Instruments for the Environment (PINE),(Organisation for Economic Co-operation and Development)
Institution variables	International Country Risk Guide

Table 2: Variables and their sources

### .1.2 Descriptive statistics General

VARIABLES	N	mean	sd	min	max
<i>Trade openness</i>	3,228	77.94	39.45	19.80	239.8
<i>Financial development</i>	3,230	0.378	0.253	0.0489	0.956
<i>Productivity</i>	2,736	0.976	0.0894	0.258	1.282
<i>Fiscal balance</i>	3,220	-2.523	3.542	-32.12	31.05
<i>CA_GDP</i>	3,228	-1.971	5.657	-32.16	24.71
<i>Exchange rate</i>	3,192	104.7	18.74	49.70	235.0
<i>Financial Openness</i>	3,230	0.591	0.372	0	1
<i>GDPgrowth</i>	3,230	3.491	3.072	-15.14	24.37
<i>Youth ratio</i>	3,230	45.93	23.21	17.18	106.9
<i>Elderly ratio</i>	3,230	14.52	9.527	3.089	49.92
<i>Government stability</i>	2,964	7.629	1.383	4.042	12
<i>Socioeconomic conditions</i>	2,964	6.025	2.258	0	11
<i>Investment profile</i>	2,964	8.757	1.832	2	12
<i>Internal conflict</i>	2,964	9.114	1.427	0.417	12
<i>Corruption</i>	2,964	2.819	1.146	0.500	6
<i>Law and order</i>	2,964	3.777	1.265	1	6
<i>Currency misalignment</i>	3,078	-0.0400	0.181	-0.885	0.656
<i>GDP per capita</i>	3,230	19,628	17,006	729.7	86,926
<i>Financial_Crises</i>	3,230	0.0161	0.317	-0.812	0.980
<i>CrisesxOpenness</i>	3,228	1.311	27.16	-92.37	152.6
<i>LagNFAGDP</i>	3,229	-0.368	0.460	-2.508	1.044

Table 3: Summary statistics General

### .1.3 Descriptive statistics Advanced Market

VARIABLES	N	mean	sd	min	max
<i>Trade openness</i>	912	89.72	46.29	19.80	239.8
<i>Financial development</i>	912	0.687	0.164	0.173	0.956
<i>Productivity</i>	912	0.983	0.0542	0.696	1.236
<i>Fiscal balance</i>	912	-2.171	3.586	-32.12	6.727
<i>CA_GDP</i>	912	0.0988	4.594	-14.41	10.83
<i>Exchange rate</i>	912	101.5	16.94	63.21	179.7
<i>Financial Openness</i>	912	0.947	0.129	0.164	1
<i>GDPgrowth</i>	912	2.251	2.580	-10.15	24.37
<i>Youth ratio</i>	912	25.90	5.437	17.18	47.03
<i>Elderly ratio</i>	912	25.55	6.520	9.925	49.92
<i>Government stability</i>	912	7.430	1.283	4.667	11.08
<i>Socioeconomic conditions</i>	912	8.415	1.242	4.083	11
<i>Investment profile</i>	912	10.48	1.446	6.250	12
<i>Internal conflict</i>	912	10.04	1.010	4.375	12
<i>Corruption</i>	912	4.126	1.019	2	6
<i>Law and order</i>	912	5.160	0.615	3	6
<i>Currency misalignment</i>	912	0.0246	0.110	-0.289	0.299
<i>GDP per capita</i>	912	42,903	9,979	15,667	86,926
<i>Financial_Crises</i>	912	0.00729	0.299	-0.319	0.975
<i>CrisesxOpenness</i>	912	0.215	31.91	-51.64	150.3
<i>LagNFAGDP</i>	912	-0.274	0.568	-1.968	0.865

Table 4: Summary statistics Advanced Market

**.1.4 Descriptive statistics Emerging Market**

VARIABLES	N	mean	sd	min	max
<i>Trade openness</i>	1,520	81.00	37.94	21.85	220.4
<i>Financial development</i>	1,520	0.328	0.154	0.0616	0.739
<i>Productivity</i>	1,254	0.983	0.0895	0.369	1.282
<i>Fiscal balance</i>	1,514	-2.697	3.588	-19.62	14.66
<i>CA_GDP</i>	1,520	-1.342	5.613	-25.76	24.71
<i>Exchange rate</i>	1,520	105.5	19.37	50.64	235.0
<i>Financial Openness</i>	1,520	0.487	0.335	0	1
<i>GDPgrowth</i>	1,520	3.621	3.108	-15.14	15.03
<i>Youth ratio</i>	1,520	41.97	15.86	19.69	90.83
<i>Elderly ratio</i>	1,520	12.59	6.924	3.293	34.30
<i>Government stability</i>	1,482	7.707	1.437	4.042	12
<i>Socioeconomic conditions</i>	1,482	5.629	1.443	2	10.29
<i>Investment profile</i>	1,482	8.265	1.420	2	12
<i>Internal conflict</i>	1,482	8.889	1.386	0.417	12
<i>Corruption</i>	1,482	2.326	0.559	1	5
<i>Law and order</i>	1,482	3.260	0.961	1	6
<i>Currency misalignment</i>	1,444	-0.0665	0.179	-0.885	0.504
<i>GDP per capita</i>	1,520	14,442	7,415	2,571	42,875
<i>Financial_Crises</i>	1,520	0.0128	0.268	-0.812	0.980
<i>CrisesxOpenness</i>	1,520	1.274	24.29	-92.37	143.2
<i>LagNEAGDP</i>	1,519	-0.354	0.387	-1.841	1.044

Table 5: Summary statistics Emerging Market

## .1.5 Descriptive statistics Low Income Market

VARIABLES	N	mean	sd	min	max
<i>Trade openness</i>	796	58.57	23.65	20.96	175.4
<i>Financial development</i>	798	0.120	0.0378	0.0489	0.248
<i>Productivity</i>	570	0.952	0.124	0.258	1.165
<i>Fiscal balance</i>	794	-2.596	3.377	-15.46	31.05
<i>CA_GDP</i>	796	-5.542	5.204	-32.16	10.34
<i>Exchange rate</i>	760	106.8	19.06	49.70	163.9
<i>Financial Openness</i>	798	0.381	0.343	0	1
<i>GDPgrowth</i>	798	4.662	3.009	-12.41	18.33
<i>Youth ratio</i>	798	76.35	15.91	41.13	106.9
<i>Elderly ratio</i>	798	5.603	1.330	3.089	9.447
<i>Government stability</i>	570	7.743	1.364	4.458	11.08
<i>Socioeconomic conditions</i>	570	3.230	1.126	0	7
<i>Investment profile</i>	570	7.278	1.137	2	10
<i>Internal conflict</i>	570	8.218	1.292	4.625	11
<i>Corruption</i>	570	2.009	0.584	0.500	4
<i>Law and order</i>	570	2.908	0.899	1.042	5
<i>Currency misalignment</i>	722	-0.0687	0.232	-0.820	0.656
<i>GDP per capita</i>	798	2,906	1,367	729.7	5,915
<i>Financial_Crises</i>	798	0.0326	0.411	-0.772	0.952
<i>CrisesxOpenness</i>	796	2.637	26.39	-73.04	152.6
<i>LagNFAGDP</i>	798	-0.500	0.416	-2.508	0.865

Table 6: Summary statistics Low Income Market

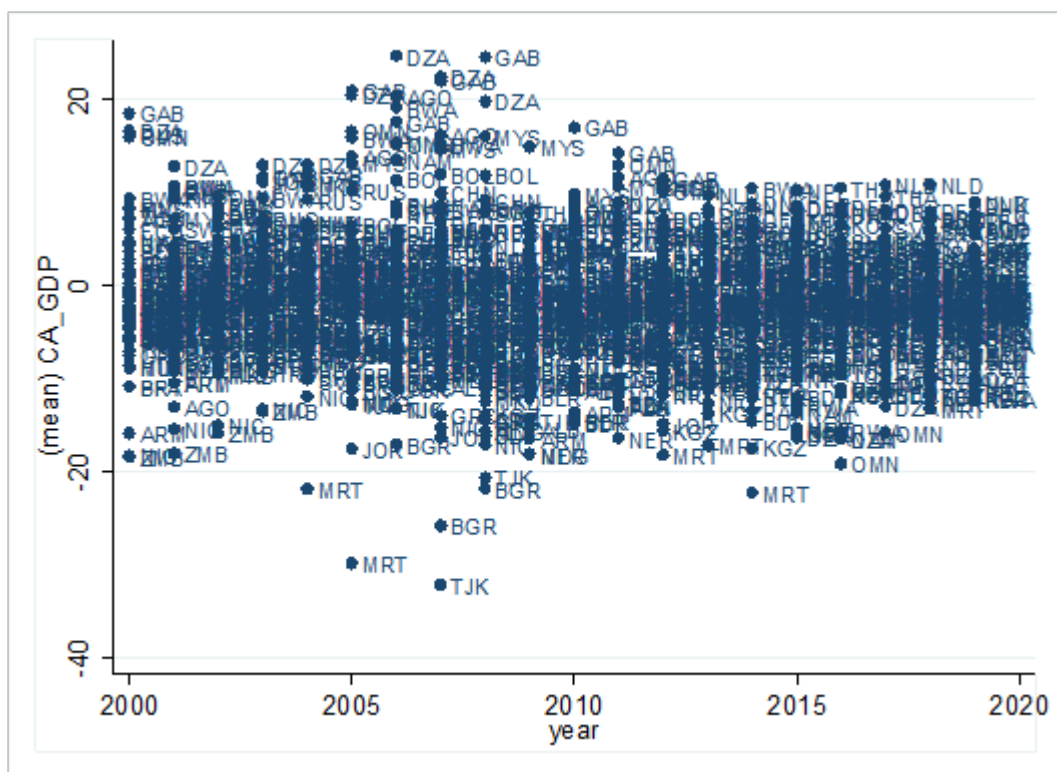


Figure 13: Current account: descriptive statistics per countries

## .1.6 Structural break tests

<i>CA_GDP</i>	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
<i>Fiscal balance</i>	0.319	0.044	7.30	0.000	0.234	0.405	***
<i>LagNFAGDP</i>	2.493	0.620	4.02	0.000	1.279	3.707	***
<i>logGDPpercapita</i>	3.457	0.971	3.56	0.000	1.554	5.360	***
<i>GDPgrowth</i>	0.129	0.059	2.19	0.029	0.014	0.245	**
<i>Youth ratio</i>	-0.010	0.037	-0.28	0.781	-0.082	0.061	
<i>Elderly ratio</i>	-0.261	0.077	-3.37	0.001	-0.413	-0.109	***
<i>Exchange rate</i>	-0.005	0.014	-0.38	0.703	-0.033	0.022	
<i>Trade openness</i>	-0.033	0.011	-2.84	0.004	-0.055	-0.010	***
<i>Financial Openness</i>	-2.158	1.302	-1.66	0.097	-4.709	0.393	*
<i>Financial_Crises</i>	0.283	0.967	0.29	0.769	-1.611	2.178	
<i>CrisesxOpenness</i>	0.015	0.016	0.97	0.334	-0.015	0.046	
<i>d2</i>	3.248	11.013	0.29	0.768	-18.338	24.833	
<i>id1</i>	5.530	1.462	3.78	0.000	2.665	8.395	***
<i>id2</i>	-4.816	1.579	-3.05	0.002	-7.912	-1.721	***
<i>id3</i>	-0.869	1.099	-0.79	0.429	-3.023	1.284	
<i>id4</i>	-0.229	0.074	-3.12	0.002	-0.373	-0.085	***
<i>id5</i>	0.010	0.039	0.24	0.809	-0.068	0.087	
<i>id6</i>	0.242	0.084	2.89	0.004	0.078	0.407	***
<i>id7</i>	-0.011	0.021	-0.55	0.581	-0.052	0.029	
<i>id8</i>	0.025	0.012	2.14	0.033	0.002	0.048	**
<i>id9</i>	1.062	1.558	0.68	0.495	-1.991	4.115	
<i>id10</i>	-1.675	1.324	-1.26	0.206	-4.269	0.919	
<i>id11</i>	-0.006	0.019	-0.31	0.757	-0.044	0.032	
<i>Constant</i>	-24.576	9.612	-2.56	0.011	-43.415	-5.737	**
<i>Mean dependent var</i>	-1.869						
<i>SD dependent var</i>	6.218						
<i>Number of obs</i>	1660.000						
<i>R-squared</i>	0.247						
<i>Chi-square</i>	421.100	Prob>chi2	0.000				
(1) <i>d2=0</i> , (2) <i>id1=0</i> , (3) <i>id2=0</i> , (4) <i>id3=0</i> , (5) <i>id4=0</i> , (6) <i>id5=0</i> (7) <i>id6=0</i> , (8) <i>id7=0</i> , (9) <i>id8=0</i> , (10) <i>id9=0</i> , (11) <i>id10=0</i> , (12) <i>id11=0</i> <i>chi2(12)=91.30, Prob&gt;chi2 = 0.0000</i>							

Prais–Winsten regression, correlated panels corrected standard errors (PCSEs)

\*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$

Table 7: Chow test

## .1.7 Hausman test

Variables	(b)	(B)	(b-B)	sqrt(diag(V_b-V_B))
	fixed	random	Difference	Std. err.
<i>Fiscal balance</i>	.4768098	.5006481	-.0238383	.0080998
<i>LagNFAGDP</i>	-.7647853	.5970375	-1.361823	.1732989
<i>logGDPpercapita</i>	-3.917331	1.221079	-5.13841	.7802928
<i>GDPgrowth</i>	-.0094763	-.0165	.0070237	.0069197
<i>Youth ratio</i>	.0287927	.046775	-.0179823	.0262861
<i>Elderly ratio</i>	.432998	.171357	.2616409	.046366
<i>Exchange rate</i>	.0054427	-.0008164	.0062591	.0030405
<i>Trade openness</i>	.0033911	.0081959	-.0048048	.0059034
<i>Financial Openness</i>	.3016918	-1.184965	1.486657	.6759163
<i>Financial_Crises</i>	.421054	.9146594	-.4936054	.1073199
<i>CrisesxOpenness</i>	.002867	.0040203	-.0011533	.0009556

*b* = Consistent under  $H_0$  and  $H_a$ ; obtained from xtreg.  
*B* = Inconsistent under  $H_a$ , efficient under  $H_0$ ; obtained from xtreg.  
 Test of  $H_0$ : Difference in coefficients not systematic  
 $chi2(11) = (b-B)'[(V_b-V_B)\hat{(-1)}](b-B) = 148.57, Prob > chi2 = 0.0000$

Table 8: Hausman test

## .1.8 Cross-Sectional dependence test

CA_GDP	Coef.	St.Err.	t-value	p-value	[95% Conf Interval]	Sig
<i>Fiscal balance</i>	0.477	0.032	14.74	0.000	0.413 0.540	***
<i>LagNFAGDP</i>	-0.765	0.395	-1.94	0.053	-1.539 0.010	*
<i>logGDPpercapita</i>	-3.917	0.884	-4.43	0.000	-5.651 -2.184	***
<i>GDPgrowth</i>	-0.009	0.037	-0.26	0.797	-0.082 0.063	
<i>Youth ratio</i>	0.029	0.032	0.89	0.372	-0.034 0.092	
<i>Elderly ratio</i>	0.433	0.060	7.19	0.000	0.315 0.551	***
<i>Exchange rate</i>	0.005	0.008	0.70	0.487	-0.010 0.021	
<i>Trade openness</i>	0.003	0.008	0.42	0.678	-0.013 0.019	
<i>Financial Openness</i>	0.302	0.974	0.31	0.757	-1.608 2.212	
<i>Financial_Crises</i>	0.421	0.663	0.64	0.525	-0.879 1.721	
<i>CrisesxOpenness</i>	0.003	0.008	0.38	0.703	-0.012 0.018	
<b>Constant</b>	27.202	8.778	3.10	0.002	9.984 44.419	***
Mean dependent var	-1.869	F-test	32.607			
SD dependent var	6.218	R-squared	0.186			
Number of obs	1660.000					
Bayesian crit. (BIC)	9294.123	Prob > F	0.000			
Akaike crit. (AIC)	9229.149					

*Pesaran's test of cross-sectional independence = 10.951, Pr = 0.0000*  
*Average absolute value of the off-diagonal elements = 0.321*

\*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$

Table 9: Cross-Sectional Dependence



## .1.9 Autocorrelation test

<i>CA_GDP</i>	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
<i>Fiscal balance</i>	0.278	0.029	9.68	0.000	0.222	0.334	***
<i>LagNFAGDP</i>	-0.962	0.518	-1.85	0.064	-1.979	0.055	*
<i>logGDPpercapita</i>	-1.126	1.359	-0.83	0.407	-3.791	1.539	
<i>GDPgrowth</i>	0.040	0.026	1.51	0.132	-0.012	0.092	
<i>Youth ratio</i>	0.085	0.071	1.19	0.233	-0.054	0.224	
<i>Elderly ratio</i>	0.541	0.130	4.17	0.000	0.286	0.795	***
<i>Exchange rate</i>	-0.065	0.012	-5.47	0.000	-0.088	-0.042	***
<i>Trade openness</i>	-0.096	0.012	-7.83	0.000	-0.120	-0.072	***
<i>Financial Openness</i>	-0.691	1.290	-0.54	0.592	-3.222	1.840	
<i>Financial_Crises</i>	-0.189	0.654	-0.29	0.773	-1.472	1.095	
<i>CrisesxOpenness</i>	0.005	0.008	0.65	0.517	-0.010	0.020	
<b>Constant</b>	11.940	3.799	3.14	0.002	4.488	19.391	***
<b>Mean dependent var</b>	-1.869	SD dependent var	6.218				
<b>Overall r-squared</b>	0.001	Number of obs	1576.000				
<b>F-test</b>	17.459	Prob > F	0.000				
<b>Akaike crit. (AIC)</b>	7871.631	Bayesian crit. (BIC)	7935.983				
*** p<0.01, ** p<0.05, * p<0.1							
<i>F test that all u_i=0: F(83,1481) = 3.10 Prob &gt; F = 0.0000, Baltagi-Wu LBI = .85737736</i>							
<i>modified Bhargava et al. Durbin-Watson = .74011475</i>							
*** p<0.01, ** p<0.05, * p<0.1							

Table 10: Autocorrelation test

### .1.10 Dummy before and after GFC variable approach (alternative method)

VARIABLES	(1)	(2)
	Before GFC	After GFC
<i>BeforeGFCxFiscalbalance</i>	0.204*** (0.0614)	
<i>AfterGFCxFiscalbalance</i>		0.375*** (0.0825)
<i>BeforeLagnfa</i>	1.468** (0.701)	
<i>AfterLagnfa</i>		-0.423 (1.573)
<i>BeforeGDP_per capita</i>	1.127*** (0.373)	
<i>AfterGDP_per capita</i>		0.349 (0.248)
<i>BeforeGDPgrowth</i>	0.133** (0.0643)	
<i>AfterGDPgrowth</i>		-0.0104 (0.0480)
<i>BeforeYouth ratio</i>	-0.0357* (0.0213)	
<i>AfterYouth ratio</i>		-0.0441** (0.0177)
<i>BeforeElderly ratio</i>	-0.194* (0.0998)	
<i>AfterElderly ratio</i>		0.0786 (0.0662)
<i>BeforeExchangeRate</i>	-0.0199 (0.0143)	
<i>AfterExchangeRate</i>		-0.00661 (0.0132)
<i>Beforeopenness</i>	-0.0286*** (0.0109)	
<i>Afteropenness</i>		-0.0102 (0.00965)
<i>BeforeFinancial Openness</i>	-0.799 (0.940)	
<i>AfterFinancial Openness</i>		0.993* (0.589)
<i>BeforewFinCris</i>	-0.0751 (0.969)	
<i>AfterwFinCris</i>		-0.677 (0.876)
<i>BeforeCrisesxOpenness</i>	0.0114 (0.0156)	
<i>AfterCrisesxOpenness</i>		0.0127 (0.0109)
Constant	-2.608*** (0.289)	-2.644*** (0.573)
Observations	1,660	1,660
R-squared	0.075	0.098
Number of idcoun	84	84

Standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 11: Estimations before and after the GFC(Dummy variable approach, alternative method))

**Note:** The results here are based on the interaction between the dummy variable created for before and after the global financial crisis. This approach differs from the first dummy variable approach, where only the year dummy variables are used.

### .1.11 Dummy variable approach (year dummy)

VARIABLES	(1) General	(2) General with Year2007	(3) General with Year2008	(4) General with All Year dummies
<i>Fiscal balance</i>	0.333*** (0.0455)	0.340*** (0.0454)	0.358*** (0.0468)	0.371*** (0.0533)
<i>LagNFAGDP</i>	1.526** (0.651)	1.574** (0.643)	1.611** (0.655)	1.798*** (0.681)
<i>logGDPpercapita</i>	3.116*** (0.945)	2.969*** (0.915)	3.170*** (0.907)	3.087*** (0.879)
<i>GDPgrowth</i>	0.00159 (0.0408)	0.00264 (0.0414)	0.0167 (0.0339)	0.0248 (0.0377)
<i>Youth ratio</i>	0.00839 (0.0322)	0.00208 (0.0316)	0.0129 (0.0304)	0.000453 (0.0288)
<i>Elderly ratio</i>	-0.0511 (0.0545)	-0.0577 (0.0468)	-0.0596 (0.0512)	-0.0626 (0.0590)
<i>Exchange rate</i>	-0.0229** (0.0108)	-0.0215** (0.0105)	-0.0148 (0.0104)	-0.00838 (0.0113)
<i>Trade openness</i>	-0.0265*** (0.00942)	-0.0232** (0.00918)	-0.0223** (0.00906)	-0.0207** (0.00923)
<i>Financial Openness</i>	-2.235** (1.061)	-2.261** (0.984)	-2.150** (1.035)	-2.043** (1.016)
<i>Financial_Crises</i>	0.160 (0.650)	0.146 (0.654)	0.208 (0.632)	0.105 (0.643)
<i>CrisesxOpenness</i>	0.00533 (0.00933)	0.00553 (0.00931)	0.00822 (0.00903)	0.00759 (0.00904)
<i>2007.year</i>		-0.0896 (0.545)		
<i>2008.year</i>			-1.844*** (0.324)	
Constant	-23.84** (9.776)	-22.53** (9.585)	-25.59*** (9.165)	-24.20*** (8.811)
Observations	1,660	1,660	1,660	1,660
R-squared	0.165	0.175	0.189	0.216
Number of idcoun	84	84	84	84

Standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 12: Estimations before and after the GFC( years dummy variable approach)  
**Note:** Here, in the model 4, the regression take into account the dummies years, but we present only the results of the main variable

### .1.12 Results of the General model (before and after the GFC)

VARIABLES	(1) Model 1.a	(2) Model 1.b	(3) Model 2.a	(4) Model 2.b	(5) Model 3.a	(6) Model 3.b	(7) Model 4.a	(8) Model 4.b	(9) Model 5.a	(10) Model 5.b	(11) Model 6.a	(12) Model 6.b	
<i>Fiscal balance</i>	0.108** (0.0439)	0.318*** (0.0622)	0.117*** (0.0491)	0.352*** (0.0633)	0.121** (0.0498)	0.352*** (0.0606)	0.122** (0.0495)	0.352*** (0.0608)	0.125** (0.0534)	0.359*** (0.0626)	0.132** (0.0537)	0.355*** (0.0610)	
<i>LagNFAGDP</i>	0.596 (0.514)	3.714*** (0.710)	1.453** (0.580)	3.818*** (0.577)	1.368** (0.590)	3.815*** (0.546)	1.412** (0.591)	3.764*** (0.559)	1.433** (0.574)	3.758*** (0.563)	1.353** (0.586)	3.769*** (0.566)	
<i>logGDPpercapita</i>	5.285*** (1.556)	5.222*** (0.740)	5.783*** (1.515)	4.112*** (0.919)	5.848*** (1.497)	4.080*** (0.890)	5.867*** (1.481)	4.117*** (0.903)	6.431*** (1.618)	4.408*** (0.987)	6.384*** (1.521)	4.432*** (0.991)	
<i>GDPgrowth</i>	0.0959 (0.0714)	0.0510 (0.0393)	0.113 (0.0867)	0.0540 (0.0413)	0.112 (0.0886)	0.0461 (0.0416)	0.109 (0.0889)	0.0447 (0.0417)	0.0647 (0.0835)	0.0628 (0.0413)	0.0616 (0.0863)	0.0533 (0.0409)	
<i>Youth ratio</i>	0.0859** (0.0426)	0.0630 (0.0391)	0.0896** (0.0436)	0.0555 (0.0367)	0.0910** (0.0450)	0.0440 (0.0353)	0.0940** (0.0437)	0.0448 (0.0357)	0.0960** (0.0456)	0.0551 (0.0353)	0.0938** (0.0457)	0.0474 (0.0355)	
<i>Elderly ratio</i>	-0.112 (0.125)	0.0491 (0.0599)	-0.117 (0.0896)	0.0760 (0.0488)	-0.110 (0.0950)	0.0779 (0.0488)	-0.110 (0.0936)	0.0827 (0.0511)	-0.146 (0.0980)	0.0958** (0.0455)	-0.134 (0.102)	0.0937** (0.0475)	
<i>Exchange rate</i>	0.0236 (0.0246)	0.0211* (0.0108)	0.0207 (0.0316)	0.0156 (0.0132)	0.0183 (0.0313)	0.0155 (0.0131)	0.0188 (0.0309)	0.0161 (0.0131)	0.0165 (0.0301)	0.0149 (0.0129)	0.0149 (0.0293)	0.0158 (0.0130)	
<i>Trade openness</i>	-0.0290* (0.0168)	0.000691 (0.00844)	-0.0141 (0.0135)	0.00927 (0.00661)	-0.0144 (0.0136)	0.0124* (0.00662)	-0.0137 (0.0136)	0.0128* (0.00666)	-0.0178 (0.0132)	0.0148** (0.00687)	-0.0162 (0.0132)	0.0163** (0.00671)	
<i>Financial Openness</i>	-4.412** (1.799)	-4.012*** (0.848)	-4.699*** (1.407)	-3.366*** (1.057)	-4.584*** (1.396)	-3.569*** (1.051)	-4.632*** (1.374)	-3.561*** (1.042)	-4.632*** (1.492)	-3.591*** (1.061)	-4.464*** (1.443)	-3.564*** (1.051)	
<i>Financial Crises</i>	-0.482 (1.277)	-0.432 (1.006)	1.882* (1.026)	-0.547 (1.044)	1.972* (1.067)	-0.499 (0.999)	1.895* (1.068)	-0.536 (1.019)	1.387 (0.992)	-0.529 (1.044)	1.438 (1.014)	-0.478 (1.007)	
<i>CrisesxOpenness</i>	0.0202 (0.0213)	0.0146 (0.0126)	-0.0270 (0.0190)	0.0110 (0.0123)	-0.0287 (0.0197)	0.0105 (0.0117)	-0.0281 (0.0196)	0.0109 (0.0119)	-0.0223 (0.0186)	0.0123 (0.0123)	-0.0231 (0.0188)	0.0114 (0.0118)	
<i>Productivity</i>	-2.958 (4.390)	-10.33** (4.494)	-4.872 (4.795)	-17.15*** (4.114)	-4.257 (4.786)	-17.20*** (4.107)	-4.244 (4.713)	-17.34*** (4.079)	-3.965 (4.436)	-17.17*** (4.100)	-2.987 (4.286)	-16.98*** (4.116)	
<i>Financial development</i>	-2.178 (2.562)	-2.494 (1.700)	-1.766 (2.791)	-0.338 (1.551)	-1.844 (2.847)	-0.760 (1.566)	-1.729 (2.829)	-0.865 (1.606)	-1.099 (2.506)	2.131 (1.555)	-1.456 (2.653)	1.239 (1.501)	
<i>Currency misalignment</i>	-8.015*** (3.085)	-1.818 (1.316)	-7.655*** (2.655)	-1.449 (1.392)	-7.624*** (2.656)	-1.157 (1.432)	-7.784*** (2.679)	-1.120 (1.427)	-7.980*** (2.653)	-1.726 (1.413)	-7.947*** (2.666)	-1.330 (1.397)	
<i>Investment profile</i>			-0.347*** (0.123)	-0.380*** (0.112)	-0.312** (0.125)	-0.300** (0.118)	-0.334*** (0.125)	-0.311*** (0.116)	-0.359*** (0.112)	-0.314*** (0.119)	-0.331*** (0.117)	-0.275*** (0.121)	
<i>Government stability</i>							-0.124 (0.109)	0.0812 (0.116)	-0.0362	0.0472	-0.0108	0.0910	
<i>Socioeconomic conditions</i>									-0.245 (0.188)	-0.329* (0.194)	-0.242 (0.187)	-0.283 (0.199)	
<i>Corruption</i>									-0.870*** (0.216)	0.0195 (0.258)	-0.845*** (0.215)	0.0666 (0.279)	
<i>Law and order</i>									0.604** (0.275)	-0.515* (0.295)	0.661** (0.293)	-0.422 (0.301)	
<i>Internal conflict</i>					-0.185 (0.125)	-0.372* (0.195)	-0.161 (0.132)	-0.404** (0.199)				-0.203 (0.129)	-0.326 (0.223)
Constant	-47.30*** (13.56)	-41.33*** (9.790)	-48.36*** (10.71)	-21.77* (11.44)	-48.10*** (10.29)	-18.24 (11.47)	-47.45*** (10.22)	-18.88 (11.73)	-52.58*** (12.06)	-23.29* (12.04)	-51.89*** (11.15)	-21.68* (12.51)	
Observations	523	735	493	693	493	693	493	693	493	693	493	693	
R-squared	0.179	0.430	0.238	0.339	0.243	0.359	0.246	0.359	0.256	0.362	0.261	0.366	
Number of idcoun	67	67	63	63	63	63	63	63	63	63	63	63	

Standard errors in parentheses

\*\*\* p&lt;0.01, \*\* p&lt;0.05, \* p&lt;0.1

Table 13: General Models After and Before the GFC

**Note:** The letters "a" and "b" refers to the results before and after the GFC. For example 1.a refers to the results of the model 1 before the GFC and 1.b refers to the results after the GFC

## .1.13 Robustness models Before and After the GFC

VARIABLES	(1) Model 1.a	(2) Model 1.b	(3) Model 2.a	(4) Model 2.b	(5) Model 3.a	(6) Model 3.b	(7) Model 4.a	(8) Model 4.b	(9) Model 5.a	(10) Model 5.b	(11) Model 6.a	(12) Model 6.b
<i>L_CA_GDP</i>	1.058*** (0.131)	0.588*** (0.0928)	0.975*** (0.0925)	0.601*** (0.0990)	0.974*** (0.0925)	0.608*** (0.101)	0.967*** (0.0917)	0.607*** (0.101)	0.952*** (0.0901)	0.605*** (0.0989)	0.949*** (0.0899)	0.609*** (0.100)
<i>Fiscal balance</i>	0.00174 (0.0505)	0.349** (0.161)	0.0118 (0.0527)	0.315* (0.167)	0.00539 (0.0536)	0.300* (0.164)	-2.30e-05 (0.0510)	0.299* (0.166)	0.0121 (0.0482)	0.316* (0.177)	0.0144 (0.0478)	0.304* (0.174)
<i>LagNFAGDP</i>	-1.117 (0.820)	0.750* (0.423)	-0.794 (0.794)	0.740* (0.397)	-0.704 (0.799)	0.740* (0.394)	-0.662 (0.793)	0.751* (0.391)	-0.638 (0.797)	0.774* (0.409)	-0.500 (0.796)	0.756* (0.405)
<i>logGDPpercapita</i>	1.050 (0.942)	1.345** (0.646)	1.297 (0.875)	1.083 (0.708)	1.261 (0.857)	1.156 (0.727)	1.314 (0.848)	1.159 (0.735)	1.022 (0.857)	1.134 (0.775)	0.911 (0.821)	1.181 (0.791)
<i>GDPgrowth</i>	0.154 (0.166)	-0.154 (0.0957)	0.151 (0.181)	-0.146 (0.0969)	0.158 (0.177)	-0.147 (0.0955)	0.155 (0.177)	-0.147 (0.0961)	0.171 (0.188)	-0.144 (0.0979)	0.177 (0.183)	-0.147 (0.0971)
<i>Youth ratio</i>	0.0135 (0.0196)	0.00571 (0.0163)	0.0272 (0.0205)	0.00537 (0.0176)	0.0269 (0.0208)	0.00539 (0.0172)	0.0297 (0.0207)	0.00540 (0.0175)	0.0394* (0.0208)	0.00392 (0.0193)	0.0366* (0.0200)	0.00380 (0.0189)
<i>Elderly ratio</i>	-0.0159 (0.0305)	0.0162 (0.0288)	-0.0185 (0.0311)	0.0201 (0.0298)	-0.00422 (0.0331)	0.0231 (0.0297)	-0.00326 (0.0334)	0.0227 (0.0297)	0.0160 (0.0367)	0.0196 (0.0343)	0.0271 (0.0348)	0.0123 (0.0340)
<i>Exchange rate</i>	-0.0186 (0.0193)	0.00575 (0.00823)	-0.00504 (0.0206)	0.00346 (0.00774)	-0.00415 (0.0209)	0.00297 (0.00762)	-0.00351 (0.0207)	0.00285 (0.00784)	-0.0118 (0.0221)	0.00361 (0.00812)	-0.0135 (0.0218)	0.00333 (0.00805)
<i>Trade openness</i>	-0.0200* (0.0114)	-0.00442 (0.00486)	-0.0173 (0.0121)	-0.00294 (0.00469)	-0.0147 (0.0117)	-0.00191 (0.00447)	-0.0145 (0.0116)	-0.00196 (0.00450)	-0.0186 (0.0116)	-0.00246 (0.00476)	-0.0161 (0.0114)	-0.00153 (0.00463)
<i>Financial Openness</i>	0.432 (1.058)	-1.156 (0.777)	-0.286 (0.949)	-0.598 (0.768)	-0.327 (0.950)	-0.531 (0.763)	-0.475 (0.927)	-0.541 (0.755)	-0.970 (0.945)	-0.623 (0.753)	-0.839 (0.910)	-0.563 (0.748)
<i>Financial_Crises</i>	2.123 (1.526)	-0.499 (0.961)	2.522 (1.827)	-0.928 (0.738)	2.723 (1.896)	-0.964 (0.716)	2.664 (1.897)	-0.963 (0.716)	1.825 (1.737)	-0.901 (0.743)	1.954 (1.763)	-0.947 (0.729)
<i>CrisesxOpenness</i>	-0.0161 (0.0252)	0.0110 (0.0131)	-0.0309 (0.0287)	0.0130 (0.0106)	-0.0334 (0.0293)	0.0134 (0.0101)	-0.0328 (0.0294)	0.0133 (0.0101)	-0.0184 (0.0280)	0.0127 (0.0107)	-0.0197 (0.0280)	0.0132 (0.0103)
<i>Productivity</i>	-1.532 (2.971)	-5.649** (2.424)	-3.918** (1.906)	-7.043** (3.055)	-3.642* (1.853)	-6.885** (2.928)	-3.614* (1.859)	-6.901** (2.983)	-3.430* (1.879)	-7.032** (3.164)	-2.988 (1.825)	-6.904** (3.067)
<i>Financial development</i>	-0.644 (1.344)	-0.297 (1.329)	-0.802 (1.290)	0.419 (1.335)	-0.799 (1.294)	0.161 (1.315)	-0.660 (1.314)	0.162 (1.321)	-2.293 (1.556)	0.735 (1.506)	-2.845* (1.633)	0.400 (1.471)
<i>Currency misalignment</i>	-1.905 (2.676)	-0.761 (0.852)	-3.294 (2.887)	-0.781 (0.756)	-3.375 (2.908)	-0.670 (0.720)	-3.483 (2.895)	-0.680 (0.717)	-3.576 (2.998)	-0.843 (0.765)	-3.595 (2.982)	-0.714 (0.731)
<i>Investment profile</i>			0.110 (0.225)	-0.226** (0.107)	0.188 (0.235)	-0.181* (0.102)	0.171 (0.233)	-0.182 (0.111)	0.0313 (0.219)	-0.198* (0.103)	0.116 (0.229)	-0.170* (0.0979)
<i>Government stability</i>							-0.0611 (0.115)	-0.0128 (0.117)	-0.152 (0.123)	-0.0410 (0.114)	-0.0936 (0.127)	-0.0104 (0.118)
<i>Socioeconomic conditions</i>									0.527*** (0.189)	-0.0836 (0.174)	0.573*** (0.187)	-0.0644 (0.170)
<i>Corruption</i>									-0.0250 (0.204)	0.0119 (0.221)	-0.0513 (0.201)	0.0466 (0.225)
<i>Law and order</i>									-0.118 (0.208)	-0.0373 (0.206)	-0.00556 (0.227)	-0.0406 (0.199)
<i>Internal conflict</i>					-0.268 (0.167)	-0.194 (0.131)	-0.246 (0.173)	-0.187 (0.140)			-0.336* (0.185)	-0.181 (0.144)
Constant	-6.911 (7.918)	-6.131 (6.319)	-9.514 (8.356)	-0.878 (6.145)	-8.084 (8.031)	-0.403 (5.828)	-8.305 (8.001)	-0.361 (5.873)	-7.398 (8.468)	-0.801 (6.383)	-5.399 (8.040)	-0.414 (6.159)
Observations	458	735	432	693	432	693	432	693	432	693	432	693
Number of idcoun	67	67	63	63	63	63	63	63	63	63	63	63

Robust standard errors in parentheses  
\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 14: GMM Models After and Before the GFC

## .1.14 Bayesian average model test results

Model space: 262144 models						
Estimation						
.....	50%					
.....	100%					
BMA estimates Number of obs = 1249						
k1 = 1						
k2 = 18						
<i>CA_GDP</i>	Coef.	Std.Err.	t	pip	[1-Std.Err.	Bands]
<i>_cons</i>	-23.008	3.449	-6.670	1.000	-26.457	-19.560
<i>Fiscal balance</i>	0.441	0.036	12.420	1.000	0.406	0.477
<i>LagNFAGDP</i>	3.684	0.318	11.600	1.000	3.367	4.002
<i>logGDPpercapita</i>	4.385	0.354	12.390	1.000	4.031	4.739
<i>GDPgrowth</i>	0.001	0.011	0.120	0.040	-0.010	0.012
<i>Youth ratio</i>	0.066	0.013	4.930	1.000	0.053	0.079
<i>Elderly ratio</i>	0.014	0.028	0.500	0.240	-0.014	0.042
<i>Exchange rate</i>	0.000	0.003	0.160	0.050	-0.002	0.003
<i>Trade openness</i>	0.013	0.005	2.610	0.940	0.008	0.018
<i>Financial Openness</i>	-2.878	0.553	-5.200	1.000	-3.432	-2.325
<i>Currency misalignment</i>	-0.018	0.184	-0.100	0.030	-0.202	0.166
<i>Investment profile</i>	-0.737	0.103	-7.160	1.000	-0.840	-0.634
<i>Government stability</i>	0.033	0.083	0.400	0.170	-0.050	0.115
<i>Socioeconomic conditions</i>	0.001	0.020	0.040	0.030	-0.019	0.021
<i>Corruption</i>	-0.045	0.127	-0.360	0.150	-0.172	0.081
<i>Law and order</i>	0.005	0.041	0.120	0.040	-0.036	0.046
<i>Internal conflict</i>	-0.338	0.158	-2.140	0.890	-0.496	-0.180
<i>Productivity</i>	-11.040	1.534	-7.200	1.000	-12.574	-9.506
<i>Financial development</i>	0.029	0.241	0.120	0.040	-0.212	0.270

Table 15: Bayesian average model

**.1.15 Results of variables with higher predictive power(after the Bayesian Model Average**

VARIABLES	(1) General	(2) Before GFC	(3) After GFC
<i>Fiscal balance</i>	0.228*** (0.0424)	0.193*** (0.0618)	0.342*** (0.0667)
<i>LagNFAGDP</i>	1.594*** (0.524)	1.885*** (0.563)	3.760*** (0.724)
<i>GDP per capita</i>	9.41e-05*** (3.31e-05)	0.000123*** (3.70e-05)	7.33e-05** (3.29e-05)
<i>Youth ratio</i>	-0.00850 (0.0192)	-0.00156 (0.0279)	-0.0262 (0.0220)
<i>Trade openness</i>	-0.000996 (0.00744)	-0.000795 (0.0147)	0.0198** (0.00893)
<i>Financial Openness</i>	-1.614* (0.923)	-4.841*** (0.775)	-0.788 (1.051)
<i>Investment profile</i>	-0.472*** (0.130)	-0.521*** (0.128)	-0.297** (0.132)
<i>Internal conflict</i>	-0.0354 (0.116)	-0.134 (0.122)	0.102 (0.192)
<i>Productivity</i>	3.824** (1.654)	6.867*** (1.887)	1.303 (2.228)
Observations	1,329	525	737
R-squared	0.124	0.207	0.209
Number of idcoun	67	67	67

Standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 16: Results of variables with real predictive power according to the BMA selection

## AppendixA2: List of countries

- **Basic estimation, the general model result (84 countries)** : Albania, Algeria, Angola, Argentina, Armenia, Australia, Bangladesh, Belarus, Belgium, Bolivia, Botswana, Brazil, Bulgaria, Burkina Faso, Burundi, Cameroon, Canada, China, Colombia, Costa Rica, Cote d'Ivoire, Croatia, Cyprus, Czech Republic, Denmark, Dominican Republic, Ecuador, Finland, France, Gabon, Germany, Greece, Guatemala, Haiti, Hungary, India, Ireland, Israel, Italy, Japan, Jordan, Kenya; Korea, Rep.; Kyrgyz Republic, Macedonia FYR, Madagascar, Malaysia, Mali, Mauritania, Mexico, Morocco, Namibia, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Oman, Pakistan, Panama, Paraguay, Peru, Philippines, Poland, Portugal, Russian Federation, Rwanda, Senegal, Slovak Republic, Slovenia, South Africa, Spain, Sri Lanka, Sweden, Tajikistan, Tanzania, Thailand, Togo, Tunisia, Uganda, Ukraine, United Kingdom, United States, Vietnam
- **Basic estimation, emerging market (40 countries)** : Albania, Algeria, Angola, Argentina, Armenia, Belarus, Bolivia, Botswana, Brazil, Bulgaria, China, Colombia, Costa Rica, Croatia, Dominican Republic, Ecuador, Gabon, Guatemala, Hungary, India, Jordan, Macedonia FYR, Malaysia, Mexico, Morocco, Namibia, Oman, Pakistan, Panama, Paraguay, Peru, Philippines, Poland, Russian Federation, South Africa, Sri Lanka, Thailand, Tunisia, Ukraine, Vietnam
- **Basic estimation, advanced market (24 countries)** : Australia, Belgium, Canada, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Greece, Ireland, Israel, Italy, Japan, Korea Rep., Netherlands, New Zealand, Portugal, Slovak Republic, Slovenia, Spain, Sweden, United Kingdom, United States
- **Basic estimation, low income countries (20 countries)** : Bangladesh, Burkina Faso, Burundi, Cameroon, Cote d'Ivoire, Haiti, Kenya, Kyrgyz Republic, Madagascar, Mali, Mauritania, Nepal, Nicaragua, Niger, Rwanda, Senegal, Tajikistan, Tanzania, Togo, Uganda



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## .2 Appendix to chapter 2

### AppendixA1: Data sources

Table 17: Variables and their sources

Variables	Sources
Environmental Policy Stringency (EPI)	Organization for Economic Co-operation and Development (OECD)
Climate Change indicator (CCH)	Yale Center for Environmental Law
CO2 emissions embodied in international trade	Organization for Economic Co-operation and Development (OECD)
Trade cost	ESCAP-World Bank Trade Cost Database

### AppendixA2: List of countries

- **Panels based on de jure measures (EPS) as environmental policy variable (33 countries)** : Australia, Austria, Belgium, Brazil, Canada, China (P.R.), Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, India, Indonesia, Ireland, Italy, Japan, Korea, Netherlands, Norway, Poland, Portugal, Russian Federation, Slovak Republic, Slovenia, South Africa, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States.
- **Panels based on de facto measures (CCH) as environmental policy variable (56 countries)** : Argentina, Australia, Austria, Belgium, Brazil, Brunei Darussalam, Bulgaria, Canada, Chile, China, Colombia, Costa Rica, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, India, Indonesia, Ireland, Israel, Italy, Japan, Kazakhstan, Korea, Latvia, Lithuania, Luxembourg, Malaysia, Malta, Mexico, Netherlands, New Zealand, Norway, Peru, Philippines, Poland, Portugal, Russian Federation, Saudi Arabia, Singapore, Slovak Republic, Slovenia, South Africa, Spain, Sweden, Switzerland, Thailand, Turkey, United Kingdom, United States.

### AppendixA3: Long difference-in-difference estimations

As an alternative to the PPML estimator, we have also run long diff-in-diff estimations. Following (Bertrand et al., 2004) and (Aichele and Felbermayr, 2011), we apply a fixed-effect es-

imator to a pre- and post-treatment averages, assuming that significant changes in climate policies have occurred between the beginning (2005-2007) and the end of our sample (2013-2015). This approach takes into account cross-country heterogeneity in adopting measures to reduce emissions. We use our policy indicators to split our sample into countries which have implemented more stringent policies (the countries exposed to the "treatment" are those whose policy indicators - *EPS* and *CCH* - have increased above their median value) from the rest of the countries, assigned to the control group. As in our main estimations, we also include bilateral trade costs as a control variable.

Table 18 shows the results of long diff-in-diff estimations. The estimates of tighter environmental policy's effect from the long diff-in-diff model are consistent with the ones found in the PPML models on yearly data both in terms of the estimates' sign and significance. From the exporter side, tighter policies reduce the CO<sub>2</sub> content of exports whatever policy indicator used. We obtain negative, significant estimates for *did* coefficients both with  $EPS_i$  (column 1) and  $CCH_i$  (column 3). From the importer side, however, the results are less conclusive since the degree of significance of the *did* coefficients does not meet the usual criteria in terms of confidence thresholds. Their sign is even positive, pointing to possible carbon leakages when more stringent policies are implemented in "treated" countries.

Table 18: Long diff-in-diff estimations for CO<sub>2</sub> emissions embodied in trade

	(1)	(2)	(3)	(4)
$did\_EPS_{i,t}$	-0.314***			
$did\_EPS_{j,t}$		0.024		
$did\_CCH_{i,t}$			-0.237***	
$did\_CCH_{j,t}$				0.106
Observations	6,734	6,734	6,734	6,734
$R^2$	0.378	0.427	0.120	0.068

Notes: This table reports estimation results from long diff-in-diff estimations. The pre-treatment period corresponds to the average of 2005-2007 and the post-treatment period corresponds to 2013-2015. The countries exposed to the "treatment" are those whose policy indicators -  $EPS$  and  $CCH$  - have increased above their median value. The other countries are assigned to the control group. The coefficients reported are the diff-in-diff coefficients ( $did$ ), i.e. the effect of tighter environmental policy on CO<sub>2</sub> emissions embodied in trade (difference in changes over time). Column (1) reports estimates obtained when selecting exporting countries based on the *de jure* policy indicators ( $EPS_{i,t}$ ). Column (2) reports estimates obtained when selecting importing countries based on  $EPS_{j,t}$ . Columns (3) and (4) replicate the specification for Columns (1) and (2) with *de facto* indicators ( $CCH_{i,t}$ ,  $CCH_{j,t}$ ). Bilateral trade costs are included as a control variable. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

## .2.1 Fixed Effects results

We present first results related to the *de jure* measures of environment policy and present thereafter those related to *de facto* indicators.

### .2.1.1 Results using *de jure* policy indicator

Following the literature of gravity models, we consider models including standard variables explaining bilateral trade between countries. These include GDP per capita, trade costs and other gravity variables like common languages or contiguity. To account for the fact that we are interested by the CO<sub>2</sub> content of exports we include in our models not only our environmental policy indicators but also variables that could reflect the energy content of goods produced in the exporting country, like energy use or electricity production. Overall, we consider 4 different models from the simplest where we consider only GDP per capita, trade costs and environmental policy indicators to the most comprehensive one that includes all variables. Table 19 shows the results when we consider separately the EPS indicator for both the exporting and importing countries.

Before looking at the environmental policy variables, a first point worth mentioning is related to the signs and significance of GDP per capita. Unlike gravity equations used to describe trade flows, our specification shows that the CO<sub>2</sub> content of exports is inversely proportional to the level of development of the exporter. The richer the exporter is, the less exports contain CO<sub>2</sub>. This result is not surprising and is related to the literature on the Environmental Kuznets Curve that predicts emissions to decline (or at least moderate) as per capital GDP increases beyond a certain threshold (see [Dees, 2020](#), for recent evidence). If production of high-income countries are less and less intensive in CO<sub>2</sub>, the same phenomenon should then apply to their exports as well. However, our results show that concerning imports, higher income also leads to higher imports of goods that are rich in CO<sub>2</sub>. This result shows what we may usually call a carbon leakage, high-income country consumer bypassing environmental regulation applied to domestic production by importing from lower-income countries. However, this result should not been taken at face value as it relates only to con-

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sumer preferences and not necessary to domestic regulation. The elasticity of CO<sub>2</sub> embodied in exports to environmental policy variables are therefore key to bring evidence to this issue.

The results show that both  $EPS_i$  and  $EPS_j$  appear with negative and significant coefficients. The more stringent a country is on environmental policy (both for exporters and importers), the less trade flows are intensive in CO<sub>2</sub>. On the exporter side, environmental policy restricts the production of CO<sub>2</sub> and therefore the country becomes less specialised in carbon-intensive goods. On the import side too, when domestic policy becomes more restrictive, we do not find any evidence of carbon leakage, as the carbon content of imports declines too.

The other variables have the expected sign and, interestingly, do not alter the results on the policy variables, showing the robustness of our findings. In all specifications, trade costs enter significantly with a negative sign, as expected. Adding energy-related variables shows that the CO<sub>2</sub> embodied in trade also depends positively on the energy use of the exporter as well as its electricity production.

Looking at our results into more details, we notice that the size of the coefficients of the policy variables is larger in absolute terms for the exporter's policy indicator than for the importer one. In Table 20 we replace our policy variables by a single one taking the difference in the degree of stringency between the exporting country and the importing one, giving an indication of the relative level of stringency in environmental policy between each country. Such an index of dissimilarity in policy appears with a negative sign, meaning that a country whose environmental policy is more stringent than its partner's will export goods with lower content in CO<sub>2</sub>. Taking this result from the importer's side, it means that environmental policy actions have significantly less impact in relative terms on CO<sub>2</sub> intensity of imported goods. Such effect is nevertheless not significant in our estimation results. Altogether, our results show that although we do not find evidence of carbon leakage (coefficient of  $EPS_{ij}$  negative in Table 20), the virtuous countries from an environmental policy viewpoint tend to import the most from the least virtuous ones. From a policy perspective, as differences in environmental regulation across countries tends to support trade in carbon-intensive goods,

this result points to the importance of international coordination and cross-country harmonization in environmental policy in order to curb CO<sub>2</sub> emissions embodied in trade.

To go deeper into the analysis of the role of *de jure* policy in the CO<sub>2</sub> content of trade, we decompose the policy indicators into market and non-market instruments. Table 21 shows the results of specifications including such a decomposition. The results found with the aggregate index are verified when breaking it down into its market and non-market components. Interestingly, the sensitivity of CO<sub>2</sub> embodied in exports tends to be lower for market-related measures (−0.05 for exporters and −0.03 for importers) compared with non-market ones (around −0.06). Non-market measures (regulatory measures or support to low-carbon technology) contribute therefore more to avoid trade-related carbon leakage compared to market ones (i.e. carbon tax). Moreover, when using bilateral measures, while the coefficient related to  $EPS_{ijt}^M$  is significantly negative (Model 5), the one related to  $EPS_{ijt}^{NM}$  is not significant, meaning that the difference between exporters and importers vanishes for non-market measures.

### **.2.1.2 Results using *de facto* environmental indicators**

We then run estimations using similar specifications but replacing our *de jure* policy indicators (EPS) by *de facto* measures of environmental performance related to climate change (CCH). Table 22 gives the estimation results when including both indicators related to the exporter and the importer performance. In all models both  $CCH_i$  and  $CCH_j$  appear significant with a negative sign. The results found with our *de jure* policy indicator is therefore confirmed by the estimates including *de facto* measures. Comparing the size of the coefficient is not easy as the EPS is an indicator ranging from 0 to 6, while CCH is measured as a percentage. However, if we multiply the CCH-related coefficients by a factor of 100/6, we find values that are comparable (i.e. around −0.2 for country  $i$  indicator and −0.1 for country  $j$  indicator). These results confirm therefore not only the sign but also the magnitude of the sensitivity of CO<sub>2</sub> embodied in trade to environmental indicators. In the case of CCH, as the indicator cover more countries than EPS, this result is moreover satisfactory since doubling

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the size of the sample do not change the results. As it includes many more emerging and commodity-exporting countries, this sample also appears even more relevant to assess the presence of carbon leakage behaviours.

We also consider another set of estimations replacing the environmental indicators by a bilateral one, computed as for EPS as the difference between a country index and its partner's. Table 23 shows again that when environmental performance is dissimilar across partners, the more virtuous ones tend to import more carbon-intensive goods from less environmentally efficient partners. As for the case with *de jure* indicators, this result shows that a large heterogeneity in environmental performance is detrimental to the reduction in CO<sub>2</sub> emissions embodied in trade.

## .2.2 Similarity in the production structure

In the following specifications, we complement the above variables with an indicator measuring the similarity in the production structure between the exporting and importing countries. This variable, noted  $S_{ij}$ , is an index computed as follow.

$$S_{ij} = \sum_n^N |s_{ni} - s_{nj}| \quad (.2.1)$$

Where  $s_{ni}$  and  $s_{nj}$  are respectively sector  $n$ 's share in total value added in country  $i$  and country  $j$ .  $N$  represents the total number of sectors<sup>19</sup>. We used five sectors ( $N = 5$ ). When the origin country ( $i$ ) and the destination country ( $j$ ) are completely symmetric then  $S_{ij} = 0$  ; when they are completely asymmetric,  $S_{ij} = 2$ . In practice,  $S_{ij}$  ranges between 0 and 1.20, with the mass of the distribution spreading between 0.2 and 0.5 - see Figure 1 in Appendix).

The rationale behind this inclusion is the need to reflect the sectoral differences across countries that could justify the trade of carbon-intensive goods. In particular, these

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<sup>19</sup>These sectors are (1) Total services included construction, (2) Electricity, gas, water supply, sewerage and remediation service (3) Manufacturing , (4) Mining and quarrying, (5) Agriculture, forestry and fishing

emissions embodied in exports could correspond to intersectoral trade needed to provide raw materials or less sophisticated input from countries specialised in upstream sectors towards countries specialised in downstream sectors. Although our analysis remains at aggregate level, we account for the potential impact of such a sectoral dissimilarity on policy-related carbon leakage by multiplying the similarity indicator to the policy variable of the importing country. This will therefore measure whether stringent policy in importing countries could foster the import of carbon-intensive goods from country whose sectoral composition of production is different.

### **.2.2.1 Sectoral considerations**

Here we take into account the role of sectoral dissimilarity across trade partners. The rationale of this robustness check is to consider whether the above results would not be biased by the fact that CO<sub>2</sub> emissions embodied in trade may mainly reflect the fact that the structures of production differ between exporters and importers. The fact that CO<sub>2</sub> intensive goods are mainly exported from emerging countries or from countries with abundant natural resources to advanced economy might bias the impact estimates of *de jure/ de facto* environmental policy measures. Using the structural similarity index described in Eq. .2.1, we account for the role of structural differences by including an interaction variable between our environmental policy indicators of the importers' countries and this bilateral similarity index. The idea is to verify if an importing country with stringent policies tend to import CO<sub>2</sub>-intensive goods from countries whose production structure is very different. At maximum (theoretical) level of dissimilarity (when  $S_{i,j} = 2$ ), the coefficient associated with the interaction term should be half (in absolute value and of opposite sign) of the importer's policy indicator coefficient to point to any evidence of carbon leakage via trade with the most dissimilar countries. As seen above, the maximum value of  $S_{i,j}$  is around 1.20 and most of the distribution ranges between 0.2 and 0.5, so that the interaction term coefficient must be at least twice as large (in absolute value) as the corresponding coefficient to cancel the negative impact of policy stringency on CO<sub>2</sub> emissions embodied in trade.



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Table 24 report the results for both the *de jure* and the *de facto* indicators. For EPS, the interaction term does not appear as significant, indicating that the importing countries do not bypass the stringency of their domestic policy by importing from countries whose production structure is different. For CCH, however, the coefficient of  $CCH_j \times S_{ij}$  is significant and its absolute value is slightly higher than the coefficient of  $CCH_j$ . In the extreme case where a country should trade only with countries that are structurally different (i.e. the few cases at the maximum value of our dissimilarity index distribution), this result would point only to a cancellation of the impact of environment performance on reducing the importing of CO<sub>2</sub>-intensive goods. At the same time, even in this extreme case, the results still do not bring evidence of any large carbon leakage effect due to environment policy outcome. Moreover, given data availability constraints, our sectoral dissimilarity index does not cover a wide range of countries and may not be representative of dissimilarity between emerging and advanced economies.

## AppendixA4: similarity index distribution

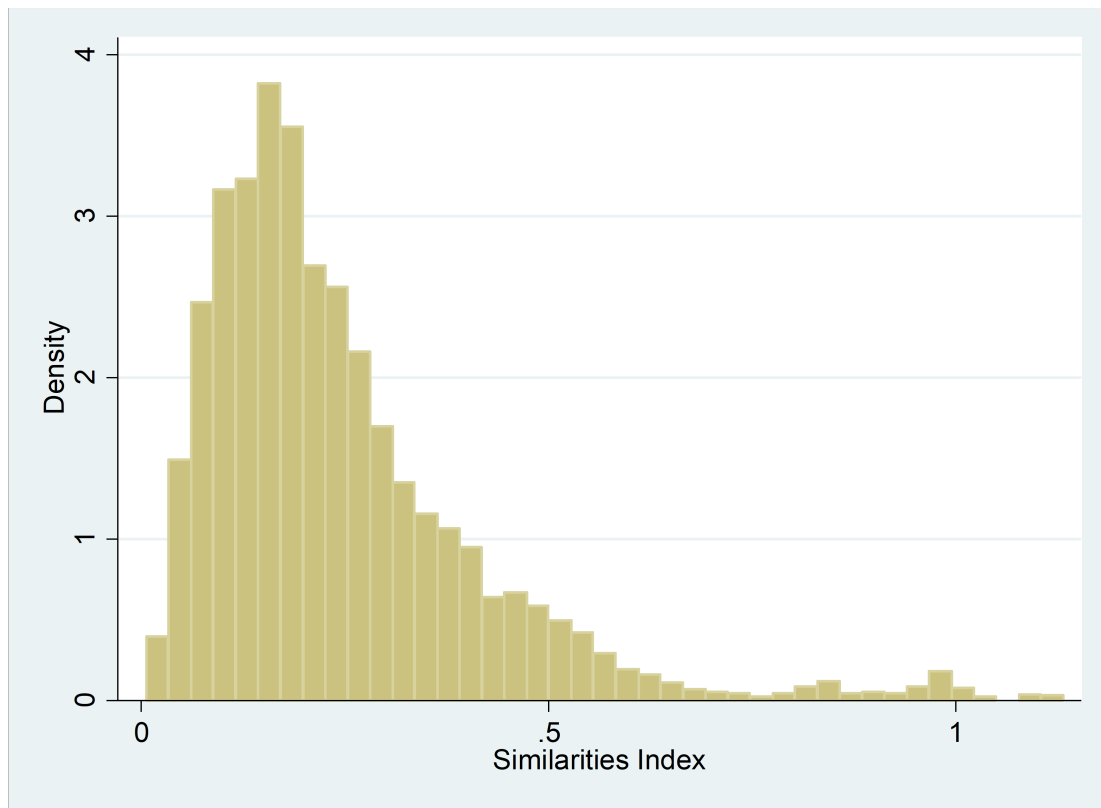


Figure 14: similarity index distribution

VARIABLES	Model 1	Model 2	Model 3	Model 4
logGDP_per_cap_i	-0.167*** (0.0342)	-0.163*** (0.0342)	-0.152*** (0.0340)	-0.0408 (0.0369)
logGDP_per_cap_j	0.649*** (0.0297)	0.653*** (0.0297)	0.664*** (0.0295)	0.744*** (0.0309)
EPSi	-0.114*** (0.0110)	-0.114*** (0.0110)	-0.114*** (0.0109)	-0.0927*** (0.0113)
EPSj	-0.0839*** (0.0103)	-0.0841*** (0.0103)	-0.0840*** (0.0102)	-0.0685*** (0.0101)
logTij	-1.007*** (0.0707)	-0.961*** (0.0705)	-0.830*** (0.0682)	-0.889*** (0.0684)
Lang		0.617*** (0.0790)	0.310*** (0.0838)	0.303*** (0.0829)
Contig			1.021*** (0.0894)	0.982*** (0.0875)
logEnergyUse_i				1.093*** (0.0944)
logElect_i				-0.0287 (0.0225)
Constant	3.557*** (0.570)	3.074*** (0.567)	2.360*** (0.545)	-4.743*** (0.853)
Observations	8,292	8,292	8,292	8,202
Number of panelid	1,056	1,056	1,056	1,056
R2	0.850	0.852	0.857	0.861

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 19: Estimations with de jure environmental policy indicators

VARIABLES	Model 1	Model 2	Model 3	Model 4
logGDP_per_cap_i	-0.277*** (0.0340)	-0.274*** (0.0340)	-0.262*** (0.0338)	-0.0760** (0.0366)
logGDP_per_cap_j	0.539*** (0.0298)	0.543*** (0.0297)	0.554*** (0.0296)	0.680*** (0.0314)
EPS_ij	-0.0150 (0.00927)	-0.0150 (0.00925)	-0.0150 (0.00918)	-0.00877 (0.00871)
logTij	-1.042*** (0.0720)	-0.996*** (0.0718)	-0.861*** (0.0695)	-0.933*** (0.0691)
Lang		0.600*** (0.0781)	0.301*** (0.0831)	0.293*** (0.0821)
Contig			1.003*** (0.0881)	0.955*** (0.0860)
logEnergyUse_i				1.446*** (0.0902)
logElect_i				-0.0768*** (0.0234)
Constant	5.618*** (0.585)	5.136*** (0.583)	4.391*** (0.563)	-5.388*** (0.854)
Observations	8,292	8,292	8,292	8,202
Number of panelid	1,056	1,056	1,056	1,056
R2	0.852	0.854	0.858	0.863

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 20: Estimations with de jure environment policy indicators (bilateral indices)

VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5
logGDP_per_cap_i	-0.0500 (0.0368)	-0.0656* (0.0364)	-0.0714* (0.0365)	-0.0843** (0.0363)	-0.0701* (0.0366)
logGDP_per_cap_j	0.704*** (0.0309)	0.736*** (0.0311)	0.677*** (0.0316)	0.677*** (0.0309)	0.676*** (0.0316)
logTij	-0.905*** (0.0688)	-0.906*** (0.0671)	-0.933*** (0.0691)	-0.929*** (0.0679)	-0.933*** (0.0691)
Lang	0.301*** (0.0826)	0.296*** (0.0826)	0.293*** (0.0821)	0.292*** (0.0823)	0.293*** (0.0821)
Contig	0.972*** (0.0868)	0.976*** (0.0869)	0.955*** (0.0859)	0.963*** (0.0859)	0.955*** (0.0860)
logEnergyUse_i	1.398*** (0.0904)	0.968*** (0.0980)	1.450*** (0.0906)	1.442*** (0.0888)	1.453*** (0.0898)
logElect_i	-0.0691*** (0.0230)	-0.00921 (0.0232)	-0.0790*** (0.0234)	-0.0706*** (0.0240)	-0.0805*** (0.0234)
EPS_MKT_i	-0.0489*** (0.00780)				
EPS_MKT_j	-0.0306*** (0.00706)				
EPS_NMKT_i		-0.0681*** (0.00890)			
EPS_NMKT_j		-0.0607*** (0.00823)			
EPS_MKT_ij			-0.00922 (0.00571)		-0.00939* (0.00569)
EPS_NMKT_ij				0.00114 (0.00676)	0.00258 (0.00672)
Constant	-5.740*** (0.851)	-3.723*** (0.849)	-5.407*** (0.854)	-5.287*** (0.841)	-5.426*** (0.852)
Observations	8,202	8,394	8,202	8,394	8,202
Number of panelid	1,056	1,056	1,056	1,056	1,056
R2	0.862	0.866	0.863	0.867	0.863

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 21: Estimations with de jure environment policy indicators (market and non-market policy indices)

VARIABLES	Model 1	Model 2	Model 3	Model 4
logGDP_per_cap_i	-0.257*** (0.0272)	-0.252*** (0.0271)	-0.244*** (0.0270)	-0.224*** (0.0291)
logGDP_per_cap_j	0.460*** (0.0253)	0.464*** (0.0253)	0.472*** (0.0252)	0.514*** (0.0264)
CCH_i	-0.00915*** (0.000648)	-0.00908*** (0.000647)	-0.00896*** (0.000645)	-0.00832*** (0.000670)
CCH_j	-0.00592*** (0.000710)	-0.00585*** (0.000708)	-0.00571*** (0.000706)	-0.00516*** (0.000708)
logTij	-0.906*** (0.0345)	-0.861*** (0.0340)	-0.784*** (0.0341)	-0.800*** (0.0344)
Lang		0.955*** (0.0667)	0.687*** (0.0703)	0.684*** (0.0700)
Contig			1.417*** (0.0952)	1.404*** (0.0950)
logEnergyUse_i				0.388*** (0.0675)
logElect_i				0.00392 (0.0197)
Constant	6.963*** (0.373)	6.349*** (0.376)	5.871*** (0.366)	3.291*** (0.616)
Observations	29,721	29,721	29,721	28,678
Number of panelid	3,031	3,031	3,031	3,031
R2	0.840	0.846	0.852	0.853

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 22: Estimations with de facto climate change indicators

VARIABLES	Model 1	Model 2	Model 3	Model 4
logGDP_per_cap_i	-0.236*** (0.0274)	-0.231*** (0.0273)	-0.224*** (0.0272)	-0.166*** (0.0292)
logGDP_per_cap_j	0.477*** (0.0253)	0.482*** (0.0253)	0.490*** (0.0252)	0.554*** (0.0265)
CCH_ij	-0.00156*** (0.000521)	-0.00156*** (0.000520)	-0.00157*** (0.000518)	-0.00119** (0.000518)
logTij	-0.863*** (0.0350)	-0.817*** (0.0345)	-0.737*** (0.0344)	-0.776*** (0.0345)
Lang		0.974*** (0.0677)	0.699*** (0.0713)	0.689*** (0.0706)
Contig			1.455*** (0.0965)	1.424*** (0.0956)
logEnergyUse_i				0.689*** (0.0665)
logElect_i				0.0469** (0.0210)
Constant	5.334*** (0.360)	4.718*** (0.363)	4.246*** (0.352)	-0.445 (0.576)
Observations	29,721	29,721	29,721	28,678
Number of panelid	3,031	3,031	3,031	3,031
R2	0.835	0.842	0.848	0.851

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 23: Estimations with de facto climate change indicators (bilateral index)

VARIABLES	Model 1	Model 2
logGDP_per_cap_i	-0.0636 (0.0440)	-0.281*** (0.0380)
logGDP_per_cap_j	0.718*** (0.0347)	0.481*** (0.0354)
logTij	-0.770*** (0.0741)	-0.553*** (0.0432)
Lang	0.234** (0.0990)	0.518*** (0.111)
Contig	1.082*** (0.0973)	1.264*** (0.122)
logEnergyUse_i	1.040*** (0.113)	0.339*** (0.0903)
logElect_i	0.0424 (0.0316)	0.0572** (0.0271)
EPSi	-0.110*** (0.0134)	
EPSj	-0.0799*** (0.0160)	
EPS_jxS_ij	0.0427 (0.0520)	
CCH_i		-0.00826*** (0.00108)
CCH_j		-0.00702*** (0.00108)
CCH_jxS_ij		0.00768*** (0.00174)
Constant	-4.641*** (0.984)	3.119*** (0.792)
Observations	5,952	12,046
Number of panelid	750	1,239
R2	0.837	0.845

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 24: Robustness estimations including structural similarity



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## **.3 Appendix to chapter 3**

### **.3.1 List of countries: yearly analysis**

- Algeria, Armenia, Australia, Austria, Bahamas. The, Bahrain, Belgium, Belize, Bolivia, Brazil, Bulgaria, Burundi, Cameroon, Canada, Central African Rep., Chile, China, Colombia, Congo, Dem. Rep. of, Costa Rica, Croatia, Cyprus, Czech Republic, Côte d'Ivoire, Denmark, Dominican Republic, Equatorial Guinea, Fiji, Finland, France, Gabon, Gambia. The, Georgia, Germany, Ghana, Greece, Hungary, Iceland, Iran. Islamic Republic of, Ireland, Israel, Italy, Japan, Latvia, Lesotho, Luxembourg, Malaysia, Malta, Mexico, Moldova, Morocco, Netherlands, New Zealand, Nicaragua, Nigeria, North Macedonia, Norway, Pakistan, Paraguay, Philippines, Poland, Portugal, Romania, Russia, Samoa, Saudi Arabia, Sierra Leone, Singapore, Slovak Republic, Solomon Islands, South Africa, Spain, Sweden, Switzerland, Togo, Tunisia, Uganda, Ukraine, United Kingdom, United States, Zambia
- Emerging countries : Algeria, Armenia, Bahamas, The , Bahrain, Belize, Bolivia, Brazil, Bulgaria, Chile, China, Colombia, Costa Rica, Croatia, Dominican Republic, Equatorial Guinea, Fiji, Gabon, Georgia, Hungary, Iran, Islamic Republic of, Malaysia, Mexico, Morocco, Nigeria, North Macedonia, Pakistan, Paraguay, Philippines, Poland, Romania, Russia, Saudi Arabia, South Africa, Tunisia, Ukraine
- Advanced countries: Australia, Austria, Belgium, Canada, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Israel, Italy, Japan, Latvia, Luxembourg, Malta, Netherlands, New Zealand, Norway, Portugal, Singapore, Slovak Republic, Spain, Sweden, Switzerland, United Kingdom, United States

### **.3.2 list of countries: quarterly analysis**

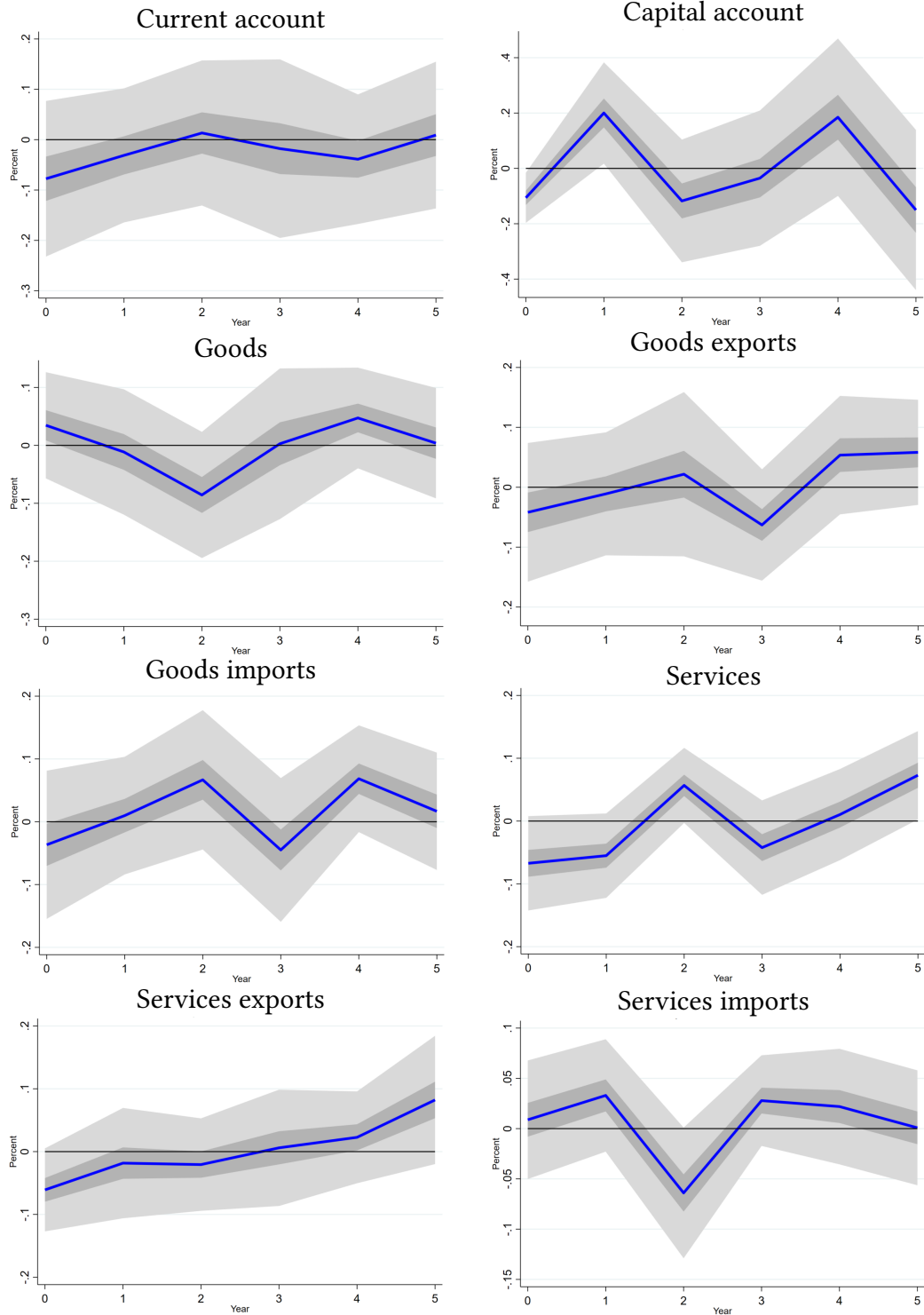
- Australia, Austria, Belgium, Brazil, Bulgaria, Canada, Chile, Colombia, Costa Rica, Croatia, Cyprus, Czechia, Denmark, Finland, France, Germany, Greece, Hungary, Ire-

land, Israel, Italy, Japan, Latvia, Luxembourg, Malta, Mexico, Netherlands (the) New Zealand, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Russian Federation (the), Slovakia, South Africa, Spain, Sweden, Switzerland, United Kingdom , United States

- Emerging countries: Brazil, Bulgaria, Chile, Colombia, Costa Rica, Croatia, Hungary, Mexico, Poland, Republic of North Macedonia, Romania, Russia
- Advanced countries: Australia, Austria, Belgium, Canada, Cyprus, Czechia, Denmark, Finland, France, Germany, Greece, Ireland, Israel, Italy, Japan, Latvia, Luxembourg, Malta, Netherlands (the), New Zealand, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland, United Kingdom, United States

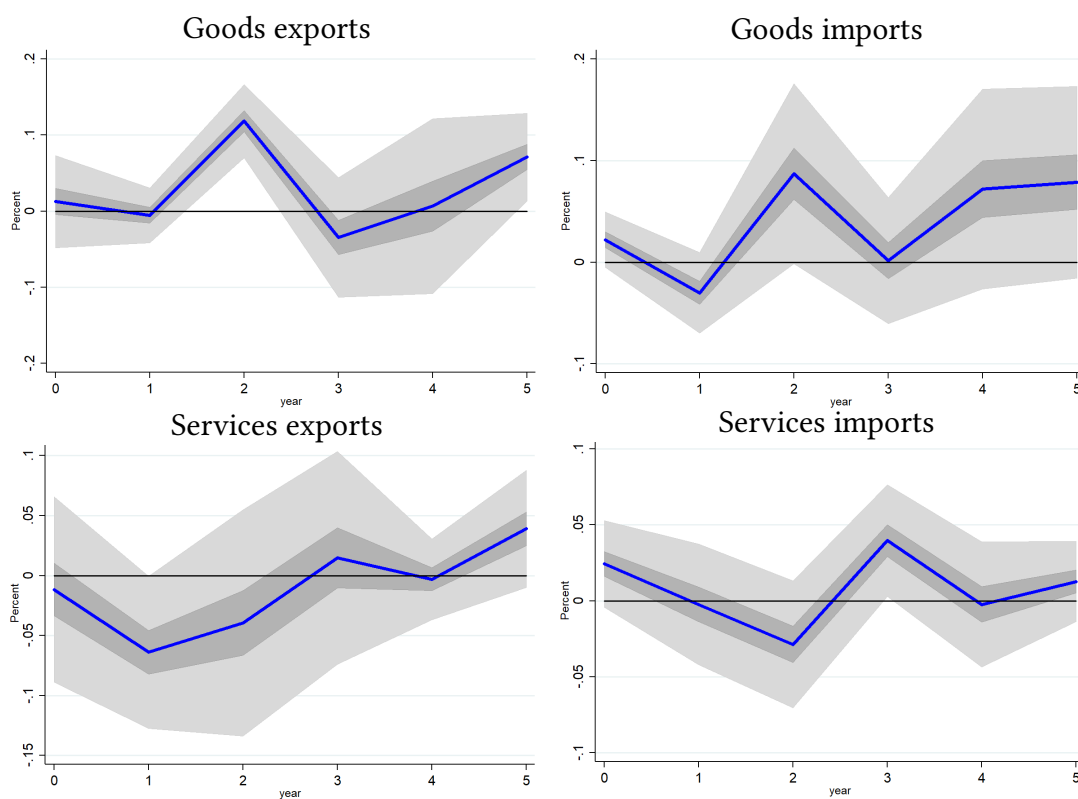
### 3.3 Storm effects

Figure 15: Current accounts variables responses to hydrological natural disasters:storms



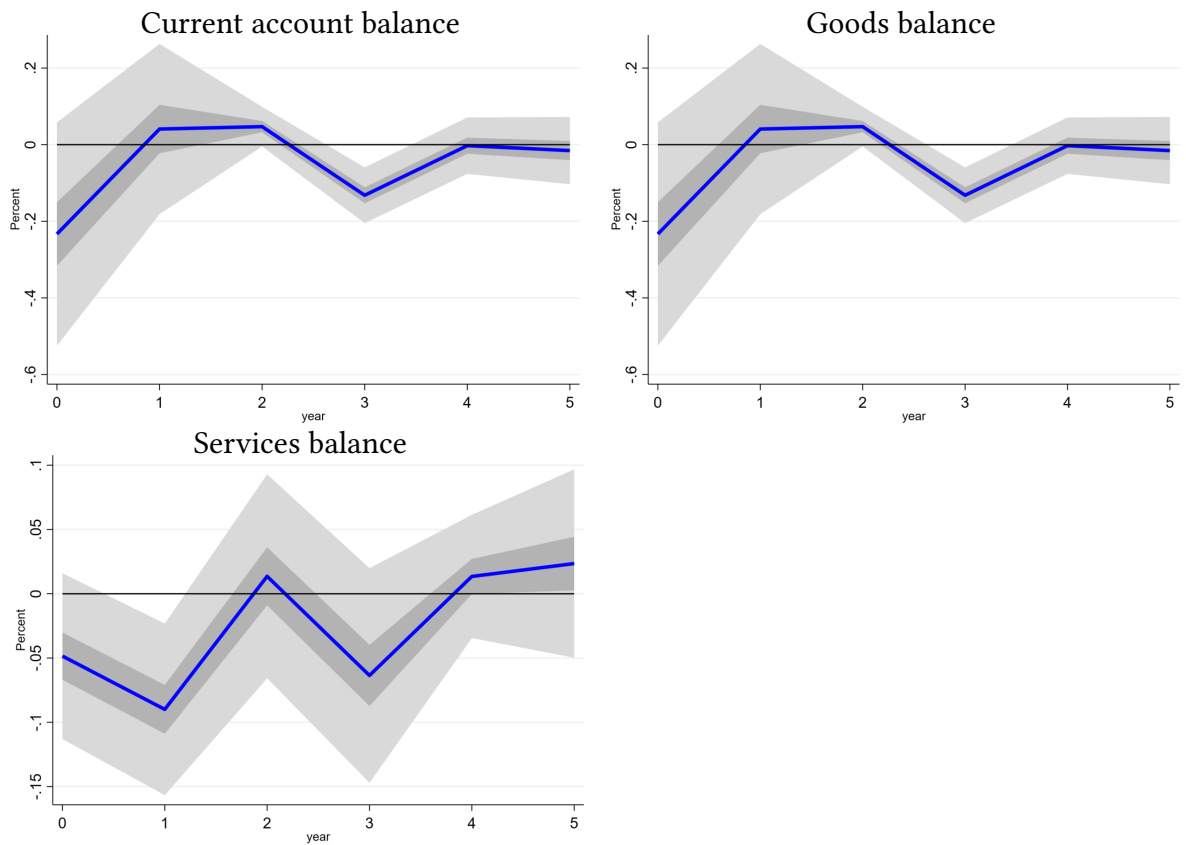
**Note:** x-axis in periods;  $t=0$  is the year where the disasters shock. Solid blue lines denote the response to the natural disasters. The two gray bands denote the confidence bands. The largest denote 90 percent confidence bands and the smallest 68 percent bands, based on standards errors clustered at country level

Figure 16: Trade components responses to large natural disasters (in % GDP): Island countries



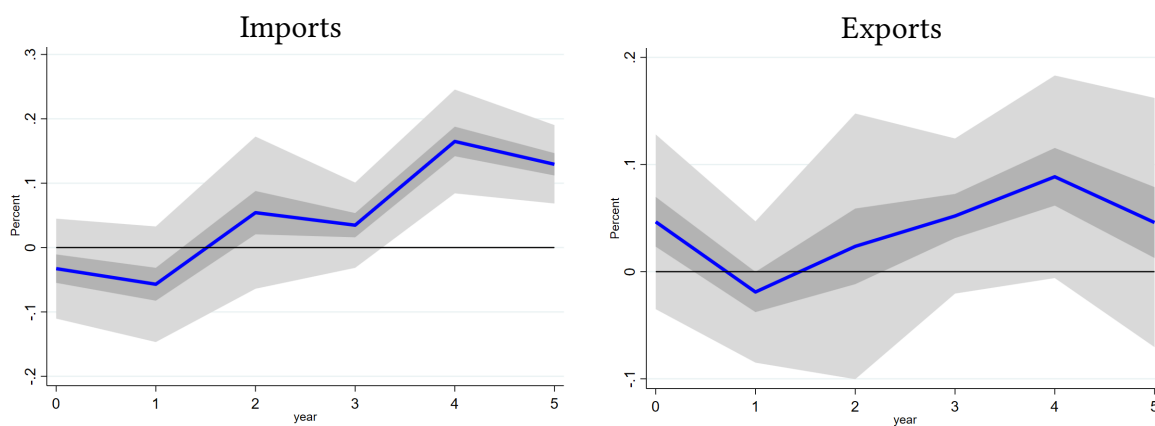
**Note:** x-axis in periods; t=0 is the year where the disasters shock. Solid blue lines denote the response to the natural disasters. The two gray bands denote the confidence bands. The largest denote 90 percent confidence bands and the smallest 68 percent bands, based on standards errors clustered at country level

Figure 17: Services to large natural disasters (Islands countries excluding the UK, Japan, New Zealand and Singapore)



**Note:** x-axis in periods; t=0 is the year where the disasters shock. Solid blue lines denote the response to the natural disasters. The two gray bands denote the confidence bands. The largest denote 90 percent confidence bands and the smallest 68 percent bands, based on standards errors clustered at country level

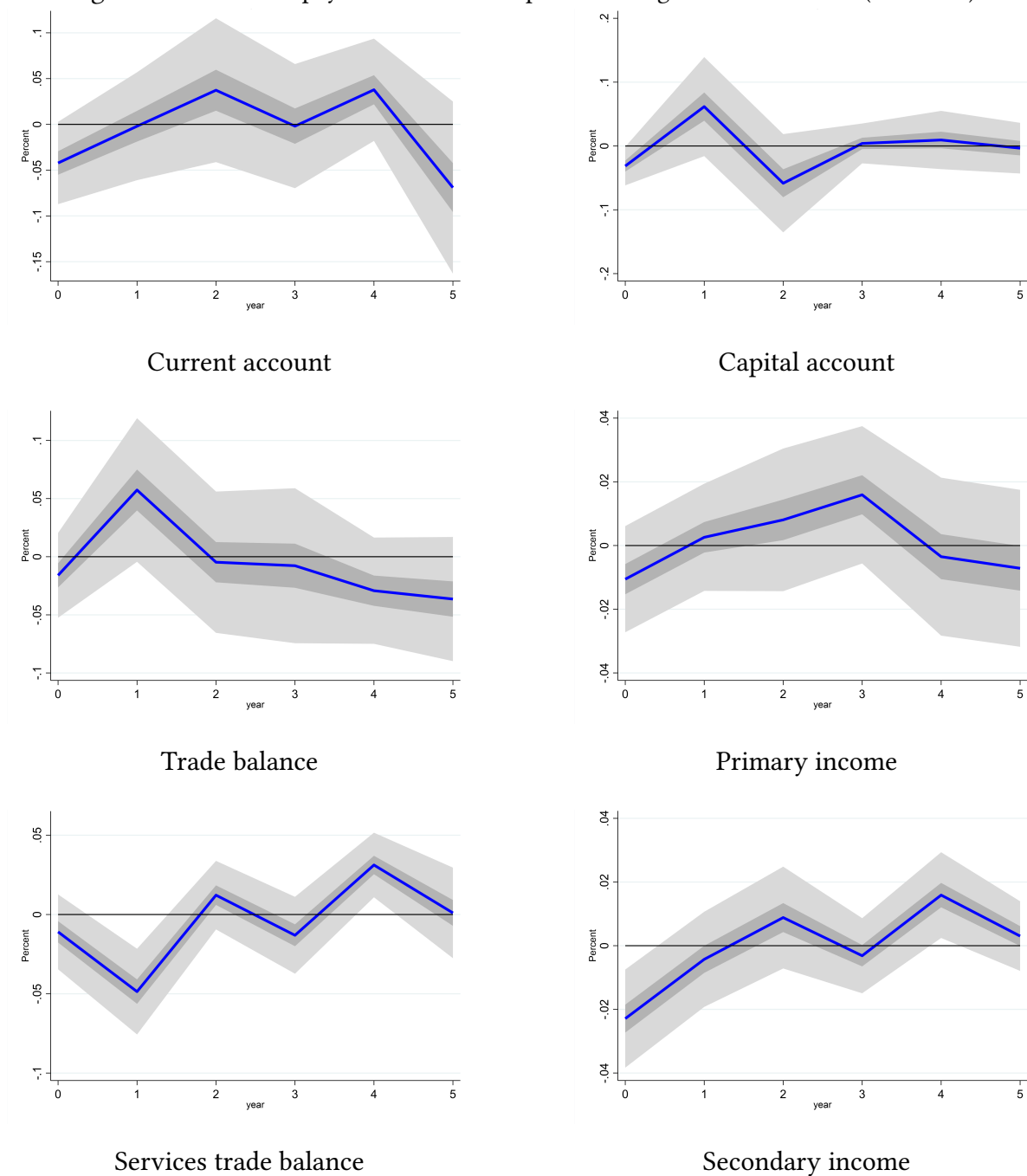
Figure 18: Goods import and export responses: tropical countries



**Note:** x-axis in periods; t=0 is the year where the disasters shock. Solid blue lines denote the response to the natural disasters. The two gray bands denote the confidence bands. The largest denote 90 percent confidence bands and the smallest 68 percent bands, based on standards errors clustered at country level

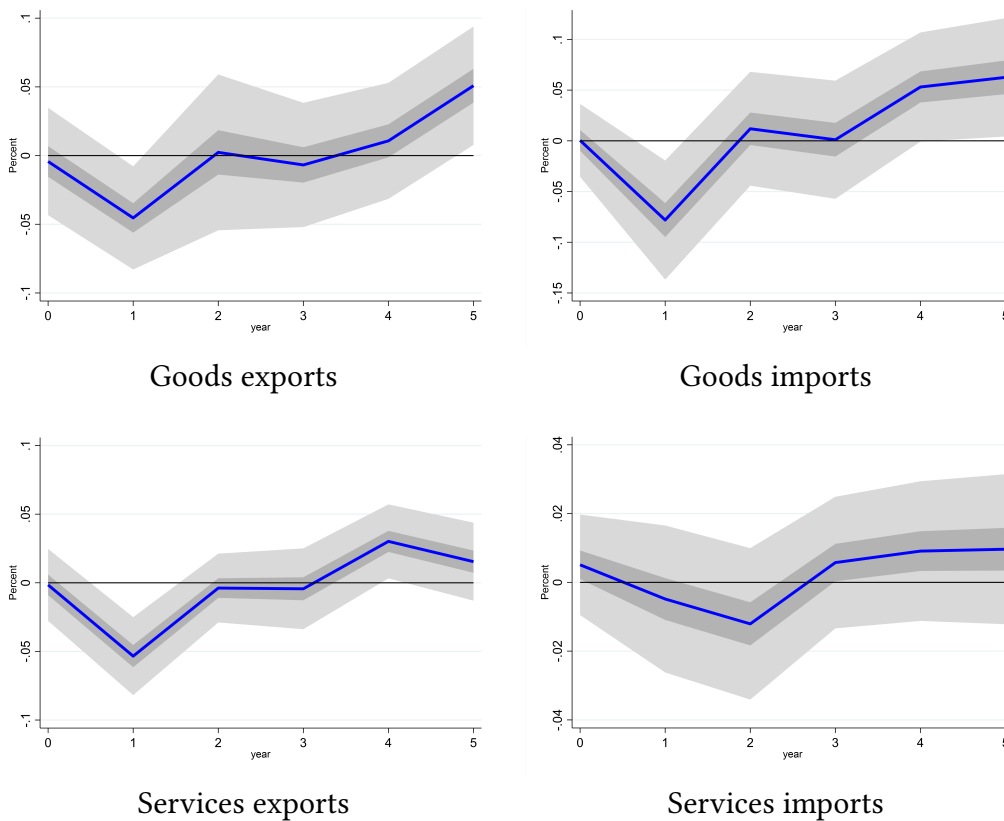
### 3.4 Results for coastal countries

Figure 19: Balance of payments account responses to large natural disasters (in % GDP)



**Note:** x-axis in periods;  $t=0$  is the year where the disasters shock. Solid blue lines denote the response to the natural disasters. The two gray bands denote the confidence bands. The largest denote 90 percent confidence bands and the smallest 68 percent bands, based on standards errors clustered at country level.

Figure 20: Trade variables to large natural disasters (in % GDP)



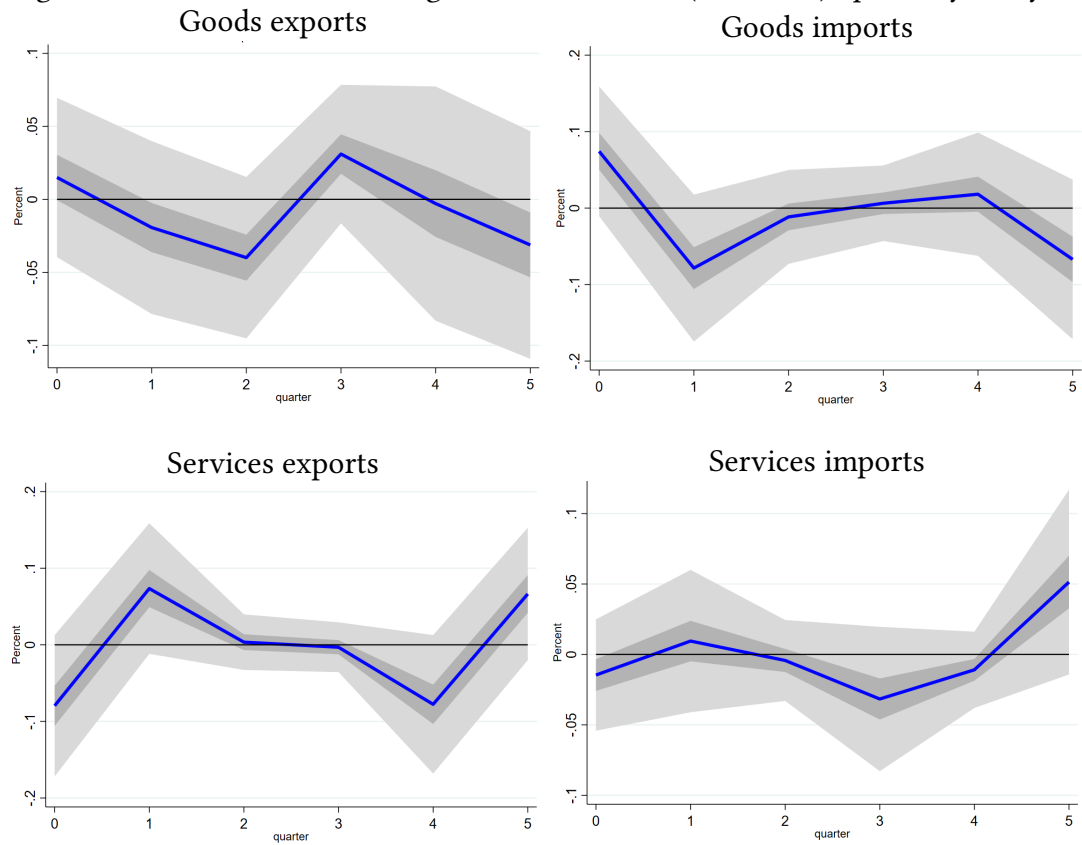
**Note:** x-axis in periods; t=0 is the year where the disasters shock. Solid blue lines denote the response to the natural disasters. The two gray bands denote the confidence bands. The largest denote 90 percent confidence bands and the smallest 68 percent bands, based on standards errors clustered at country level.



### .3.5 Quarterly data results

### .3.6 Trade components

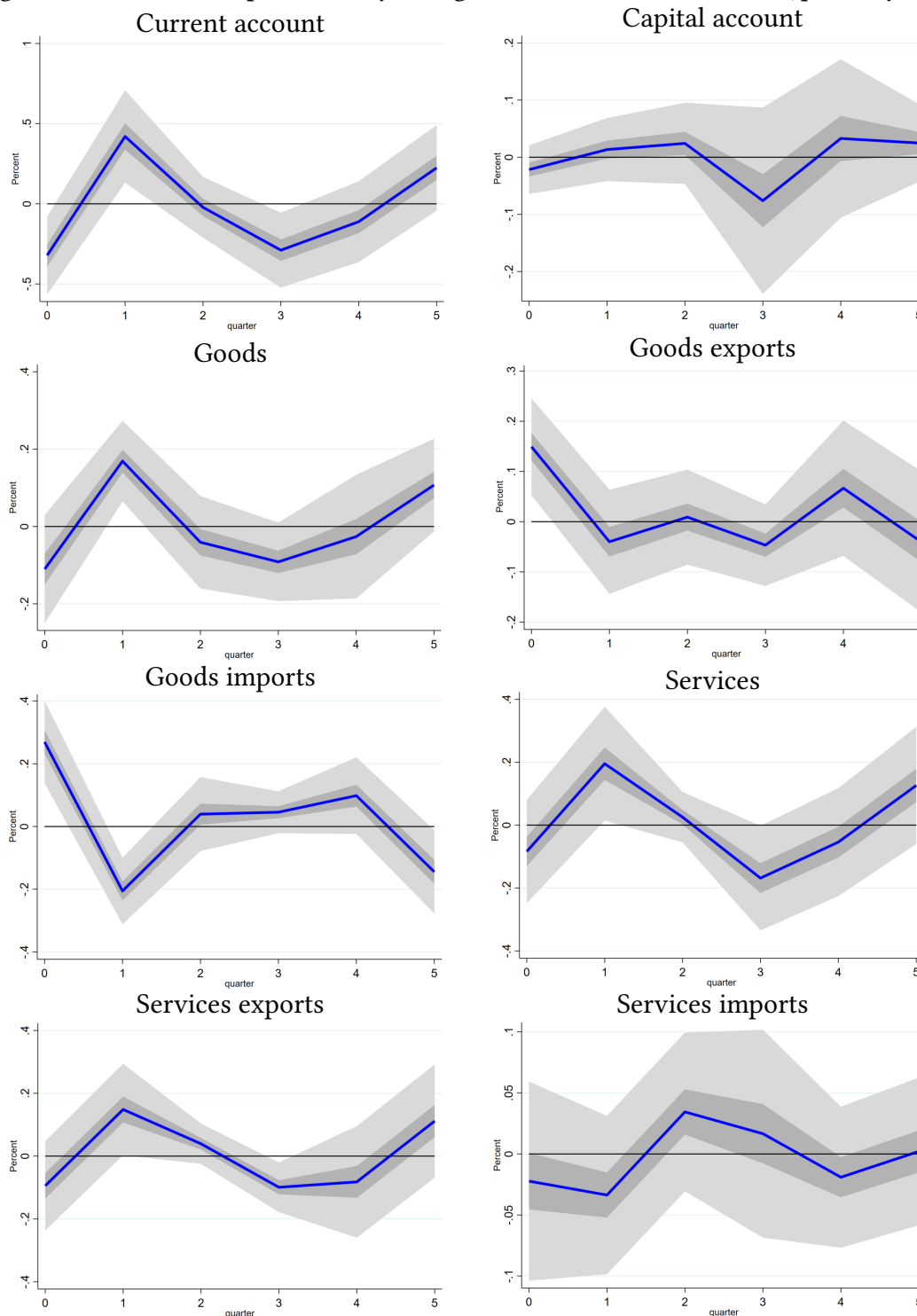
Figure 21: Trade variables to large natural disasters (in % GDP) :quarterly analysis



**Note:** x-axis in periods; t=0 is the year where the disasters shock. Solid blue lines denote the response to the natural disasters. The two gray bands denote the confidence bands. The largest denote 90 percent confidence bands and the smallest 68 percent bands, based on standards errors clustered at country level

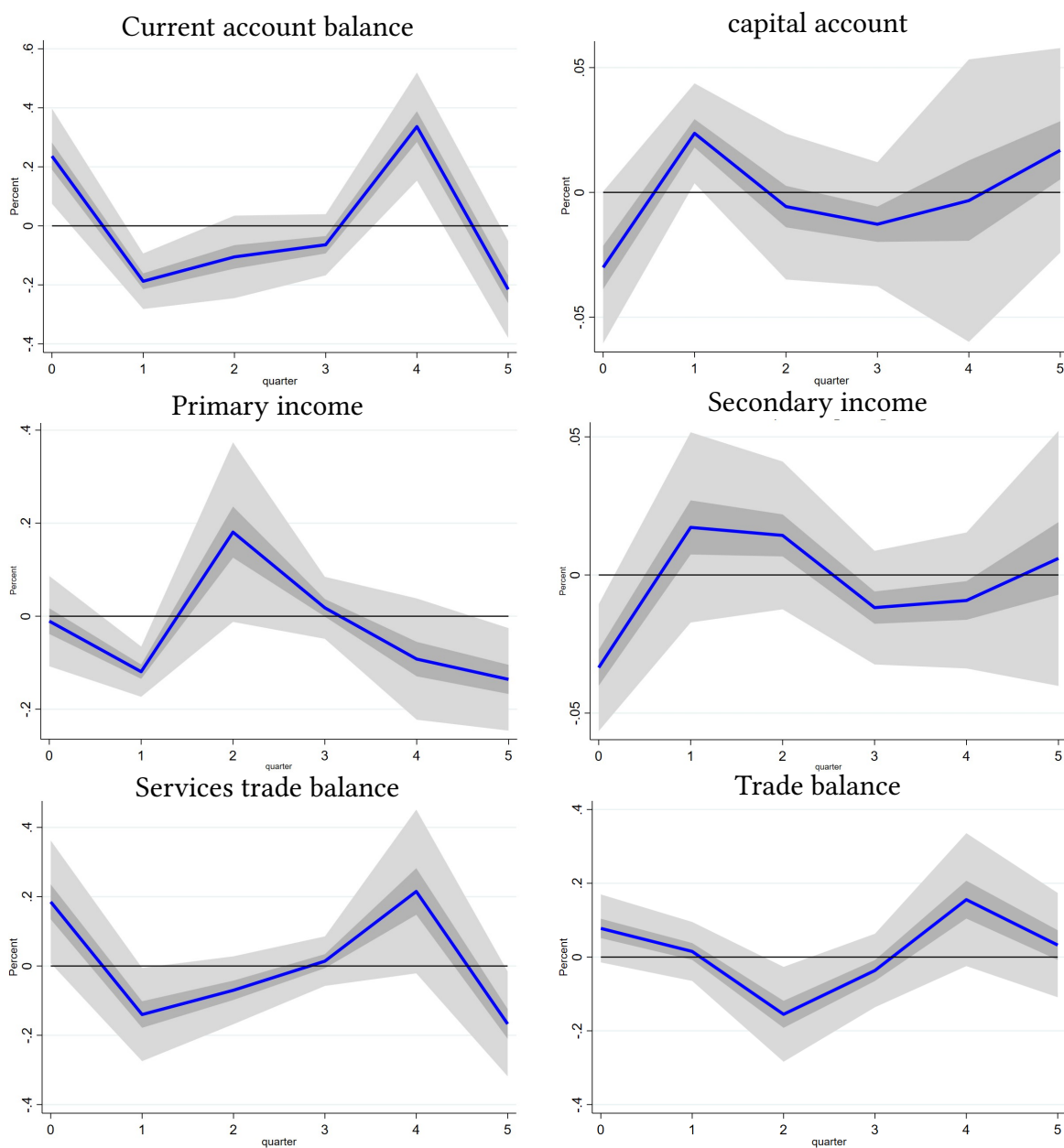
### .3.7 Hydrological disasters :quarterly data

Figure 22: Variables responses to hydrological natural disasters: flood (quarterly data)



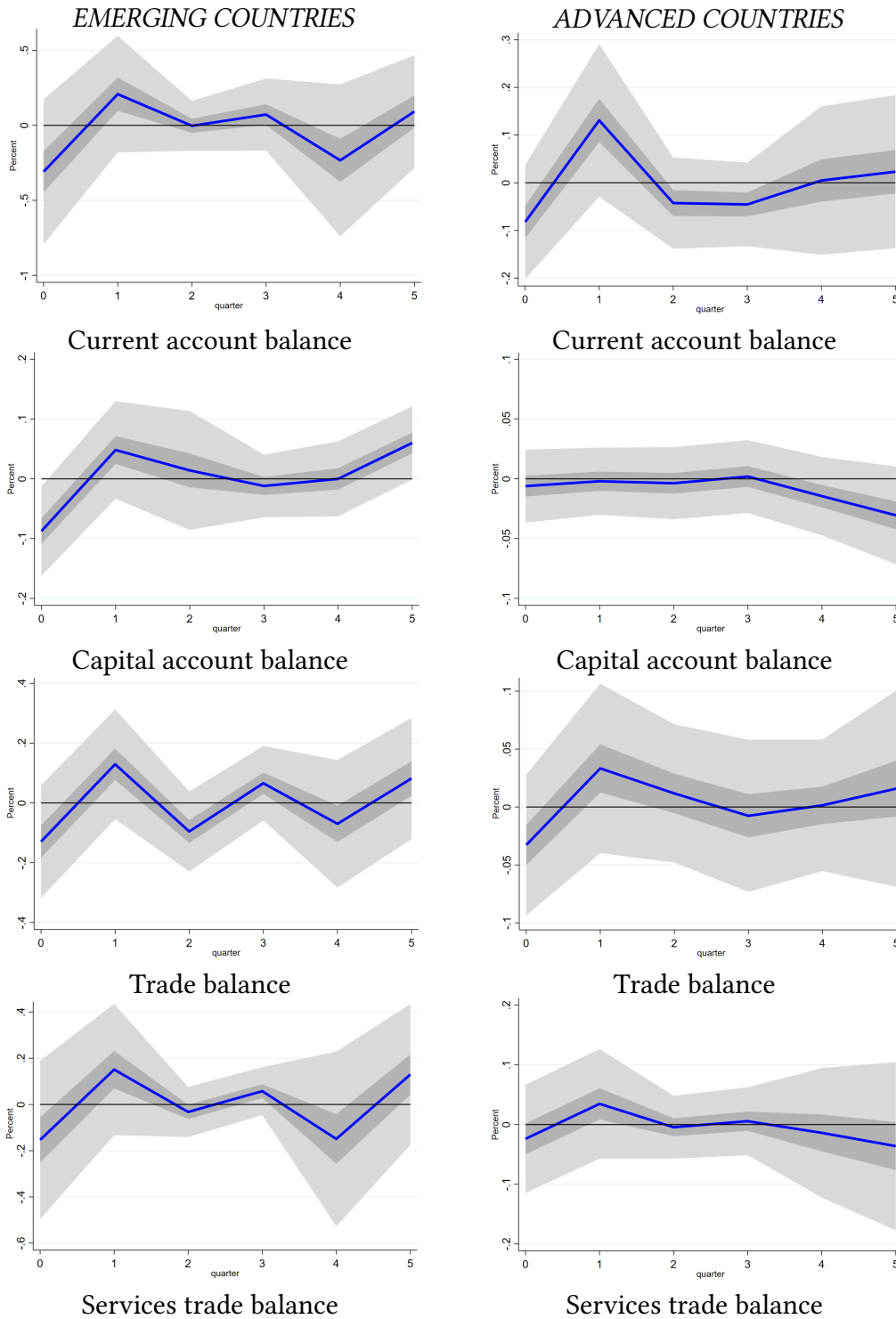
**Note:** x-axis in periods; t=0 is the year where the disasters shock. Solid blue lines denote the response to the natural disasters. The two gray bands denote the confidence bands. The largest denote 90 percent confidence bands and the smallest 68 percent bands, based on standards errors clustered at country level

Figure 23: Variables responses to large natural disasters (in % GDP): tropical countries (quarterly)



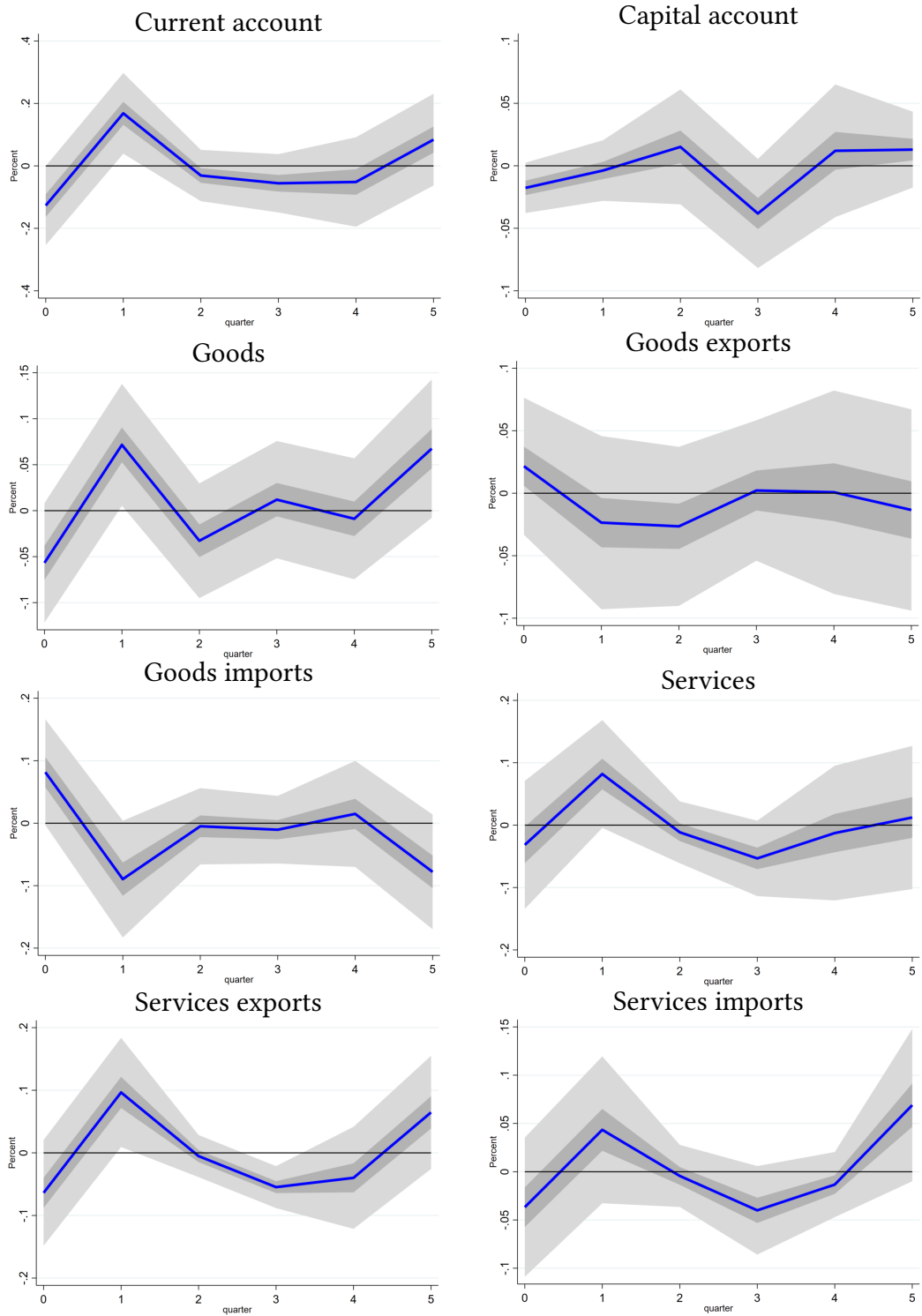
**Note:** x-axis in periods; t=0 is the year where the disasters shock. Solid blue lines denote the response to the natural disasters. The two gray bands denote the confidence bands. The largest denote 90 percent confidence bands and the smallest 68 percent bands, based on standards errors clustered at country level

Figure 24: Emerging countries versus advanced countries: responses functions to large natural disasters (in % GDP) (quarterly analysis)



**Note:** x-axis in periods; t=0 is the year where the disasters shock. Solid blue lines denote the response to the natural disasters. The two gray bands denote the confidence bands. The largest denote 90 percent confidence bands and the smallest 68 percent bands, based on standards errors clustered at country level

Figure 25: Responses to climate change natural disasters: quarterly data



**Note:** x-axis in periods;  $t=0$  is the year where the disasters shock. Solid blue lines denote the response to the natural disasters. The two gray bands denote the confidence bands. The largest denote 90 percent confidence bands and the smallest 68 percent bands, based on standards errors clustered at country level

## .3.8 Tables: summary statistics

Table 25: Annual data summary statistics

Variable		Mean	Std. dev.	Min	Max	Observations
<b>current account balance</b>	overall	-1.39607	7.820382	-65.031	27.419	N = 1765
	between		5.978568	-19.50129	18.53838	n = 86
	within		5.273041	-51.76121	26.01179	T-bar = 20.5233
<b>goods and services</b>	overall	-2.35415	13.43057	-91.67052	40.83176	N = 1682
	between		12.4996	-61.2145	32.01058	n = 84
	within		5.085958	-47.24086	22.7948	T-bar = 20.0238
<b>goods</b>	overall	-4.604691	14.28854	-64.92809	46.65453	N = 1682
	between		13.9092	-41.45676	34.65041	n = 84
	within		4.527181	-47.06413	18.4842	T-bar = 20.0238
<b>services</b>	overall	2.250517	8.139157	-29.38498	42.93647	N = 1682
	between		7.824506	-19.75774	36.67507	n = 84
	within		2.457992	-13.01872	17.45579	T-bar = 20.0238
<b>primary income</b>	overall	-1.988861	5.941947	-35.73186	54.71533	N = 1682
	between		5.388411	-25.68945	30.4121	n = 84
	within		2.518171	-19.58256	22.31437	T-bar = 20.0238
<b>secondary income</b>	overall	2.826182	5.993023	-13.75608	42.29092	N = 1682
	between		5.804096	-8.013654	31.63752	n = 84
	within		1.644318	-7.24984	19.95587	T-bar = 20.0238
<b>capital account balance</b>	overall	1.053058	3.787823	-15.40844	67.84336	N = 1713
	between		2.049626	-2.049107	11.06817	n = 84
	within		3.191374	-12.30627	57.82824	T-bar = 20.3929
<b>imports</b>	overall	31.61776	19.30386	6.7695	161.5616	N = 1186
	between		18.56751	9.224597	123.9642	n = 58
	within		5.260309	-3.509496	69.21511	T-bar = 20.4483
<b>exports</b>	overall	29.88505	23.78836	1.79498	189.4769	N = 1186
	between		23.00251	4.788927	151.9078	n = 58
	within		6.41076	-9.97118	67.45421	T-bar = 20.4483
<b>drought</b>	overall	.0703212	.2825186	0	3	N = 1806
	between		.1515958	0	1.095238	n = 86
	within		.2389353	-1.024917	1.975083	T = 21
<b>volcanic activity</b>	overall	.0204873	.1701262	0	3	N = 1806
	between		.0764494	0	.5714286	n = 86
	within		.1521945	-5509413	2.687154	T = 21
<b>earthquake</b>	overall	.1777409	.7524458	0	11	N = 1806
	between		.5796065	0	4.666667	n = 86
	within		.4836872	-3.488926	6.511074	T = 21
<b>mass movment</b>	overall	.003876	.0621537	0	1	N = 1806
	between		.01821	0	.1428571	n = 86
	within		.0594572	-1389812	.9562569	T = 21
<b>storm</b>	overall	.7630122	2.171149	0	19	N = 1806
	between		2.006312	0	14.09524	n = 86
	within		.8562718	-5.332226	8.524917	T = 21
<b>flood</b>	overall	.9590255	1.715978	0	20	N = 1806
	between		1.350058	0	9.666667	n = 86
	within		1.068699	-3.707641	11.43522	T = 21
<b>landslide</b>	overall	.0930233	.4529816	0	8	N = 1806
	between		.3017805	0	2.52381	n = 86
	within		.339308	-2.430786	5.569214	T = 21
<b>wildfire</b>	overall	.1162791	.5023939	0	8	N = 1806
	between		.3593753	0	3	n = 86
	within		.3531007	-2.883721	5.116279	T = 21
<b>extreme temperature</b>	overall	.1638981	.4324037	0	3	N = 1806
	between		.2150289	0	.7619048	n = 86
	within		.3758296	-.5980066	2.59247	T = 21
<b>fog</b>	overall	0	0	0	0	N = 1806
	between		0	0	0	n = 86
	within		0	0	0	T = 21
<b>glacial lake outburst flood</b>	overall	0	0	0	0	N = 1806
	between		0	0	0	n = 86
	within		0	0	0	T = 21
<b>total natural disasters</b>	overall	2.367663	4.54719	0	43	N = 1806
	between		4.20629	0	27.95238	n = 86
	within		1.783286	-13.58472	20.55814	T = 21
<b>trade openness</b>	overall	88.46945	57.63332	19.5596	437.3267	N = 1777
	between		55.91289	26.26447	364.2999	n = 86
	within		14.14236	24.14785	161.4963	bar = 20.6628
<b>large natural disasters</b>	overall	1.879845	4.641671	0	43	N = 1806
	between		4.273938	0	27.95238	n = 86
	within		1.865735	-14.07254	20.07032	T = 21
<b>climate change natural disasters</b>	overall	2.072536	3.881021	0	31	N = 1806
	between		3.539346	0	22.85714	n = 86
	within		1.635286	-8.546512	16.45349	T = 21

Table 26: Quarterly data summary statistics

Variable		Mean	Std. dev.	Min	Max	Observations
<b>current account balance</b>	overall	-.597359	6.408951	-49.50632	33.133	N = 4505
	between		4.033951	-7.618038	10.99358	n = 53
	within		5.019075	-49.43613	35.02415	T-bar = 85
<b>goods and services</b>	overall	.8289314	8.932169	-41.10305	48.57937	N = 4513
	between		7.664506	-19.53525	33.55647	n = 53
	within		4.943777	-43.58769	35.41428	T-bar = 85.1509
<b>goods</b>	overall	-2.283239	9.499471	-45.71373	45.06719	N = 4513
	between		9.088579	-24.16514	27.56132	n = 53
	within		3.722288	-23.83183	15.22263	T-bar = 85.1509
<b>services</b>	overall	3.112128	7.560094	-66.38539	47.69373	N = 4513
	between		6.737155	-8.934949	36.47857	n = 53
	within		3.505185	-54.33831	37.06937	T-bar = 85.1509
<b>primary income</b>	overall	-2.414017	5.24002	-56.82579	9.762927	N = 4513
	between		4.686738	-27.4618	2.871079	n = 53
	within		2.533372	-31.77801	23.27575	T-bar = 85.1509
<b>secondary income</b>	overall	1.006203	3.890415	-4.992889	28.13958	N = 4513
	between		3.936952	-1.840149	20.08015	n = 53
	within		1.073347	-10.15929	9.205531	T-bar = 85.1509
<b>capital account balance</b>	overall	.3338349	2.024782	-63.26856	41.41678	N = 4389
	between		.7953886	-2.713199	2.264959	n = 52
	within		1.874575	-60.22153	39.70502	T-bar = 84.4038
<b>imports</b>	overall	33.10413	15.84408	6.343997	91.74856	N = 4514
	between		14.98895	9.47629	69.20846	n = 53
	within		5.42746	-4.214811	72.0497	T-bar = 85.1698
<b>exports</b>	overall	30.81758	16.16984	5.917232	89.61579	N = 4514
	between		15.04521	7.907006	67.56974	n = 53
	within		6.325919	-15.87533	63.92628	T-bar = 85.1698
<b>drought</b>	overall	.0218855	.1519701	0	2	N = 4752
	between		.046349	0	.2727273	n = 54
	within		.1448655	-2.2508418	1.874158	T = 88
<b>volcanic activity</b>	overall	.0124158	.1181021	0	2	N = 4752
	between		.0420735	0	.2727273	n = 54
	within		.1105004	-2.2603114	1.887416	T = 88
<b>earthquake</b>	overall	.0719697	.3280817	0	6	N = 4752
	between		.1947332	0	1.170455	n = 54
	within		.2653507	-1.098485	4.901515	T = 88
<b>mass movment</b>	overall	.0014731	.0383563	0	1	N = 4752
	between		.005428	0	.0340909	n = 54
	within		.0379774	-.0326178	.9901094	T = 88
<b>storm</b>	overall	.263468	.8268462	0	9	N = 4752
	between		.5902163	0	3.625	n = 54
	within		.5845497	-3.361532	7.240741	T = 88
<b>flood</b>	overall	.3449074	.9076138	0	13	N = 4752
	between		.5100357	0	2.352273	n = 54
	within		.7539164	-2.007365	10.99263	T = 88
<b>landslide</b>	overall	.042298	.2531627	0	5	N = 4752
	between		.1177103	0	.6022727	n = 54
	within		.2246984	-.5599747	4.440025	T = 88
<b>wildfire</b>	overall	.0475589	.2608422	0	4	N = 4752
	between		.114322	0	.7840909	n = 54
	within		.2349648	-.736532	3.263468	T = 88
<b>extreme temperature</b>	overall	.0664983	.2599267	0	2	N = 4752
	between		.0667885	0	.3522727	n = 54
	within		.251362	-.2857744	1.975589	T = 88
<b>fog</b>	overall	0	0	0	0	N = 4752
	between		0	0	0	n = 54
	within		0	0	0	T = 88
<b>glacial lake outburst flood</b>	overall	.0004209	.0205131	0	1	N = 4752
	between		.0030928	0	.0227273	n = 54
	within		.0202829	-.0223064	.9776936	T = 88
<b>total natural disasters</b>	overall	.8728956	1.800701	0	18	N = 4752
	between		1.353772	0	6.863636	n = 54
	within		1.20141	-5.990741	12.00926	T = 88
<b>trade openness</b>	overall	.6392172	.3057304	.1504316	1.808427	N = 4514
	between		.2862618	.2042572	1.367782	n = 53
	within		.111819	-.2009013	1.35976	T-bar = 85.1698
<b>large natural disasters</b>	overall	.6395202	1.785456	0	18	N = 4752
	between		1.331384	0	6.784091	n = 54
	within		1.203217	-6.144571	11.85543	T = 88
<b>climate change natural disasters</b>	overall	.7880892	1.660872	0	17	N = 4752
	between		1.203267	0	5.977273	n = 54
	within		1.156355	-4.905093	12.09491	T = 88

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