SPES Sustainability performances, evidence & scenarios

SPES Focus - Work Package #7
A GVAR analysis of the macroeconomic effects of the Carbon Border Adjustment Mechanism in the Global South

April 2025

Funded by the European Union

Funded by European Union's Horizon Europe Programme under Grant Agreement No. 10109455

Authors

Afees A. Salisu - Researcher of the SPES Project, Centre for Econometrics and Applied Research, Ibadan, Nigeria

Idris A. Adediran - Researcher of the SPES Project Centre for Econometrics and Applied Research, Ibadan, Nigeria

Contributors and peer reviewers

Jacopo Cammeo, European University Institute; Jorge Elias Davalos-Chacon, PEP – Partnership for Economic Policy.

Acknowledgments

The authors would like to thank all SPES partners for their inputs provided in several SPES meetings and communications.

Cite as

Salisu, A., A., Adediran, A., I. (2025), *A GVAR analysis of the macroeconomic effects of the Carbon Border Adjustment Mechanism in the Global South*. SPES Focus - Work Package #7, SPES project - Sustainability Performances, Evidence and Scenarios. Florence: University of Florence. Available at: https://www.sustainabilityperformances.eu/publications-deliverables

Disclaimer

This Focus for the project SPES has been prepared by PEP - Partnership for Economic Policy and the Centre for Econometrics and Applied Research (Ibadan, Nigeria) as part of Task 7.3 "The possible impact of CBAM in the Global South " / Work Package 7. This task has allowed SPES research partners to assess whether the CBAM has contributed to improving the climate policy framework of EU and Global South countries.This deliverable contains original unpublished work except where clearly indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both.

The information and views set out in this report are those of the authors and do not necessarily reflect the official opinion of the Commission. Neither the Commission nor any person acting on the Commission's behalf may be held responsible for the use which may be made of the information contained therein.

The project SPES is funded by the European Union's Horizon Europe Programme under Grant Agreement No. 101094551.

Table of Contents

Abstract

The Carbon Border Adjustment Mechanism (CBAM) is a market-based approach to carbon pricing designed to accelerate the EU's 2050 energy transition by mitigating carbon leakage and enhancing sectoral competitiveness. We assess the associated costs of CBAM by simulating the macroeconomic impacts of the policy using the latest global VAR framework (1979Q2-2023Q3) of 33 advanced and emerging economies. While modelling the international trade linkages between the EU and its Global South and Global North trade partners, we trace the direct and indirect impacts of the CBAM policy to real output, real exchange rate and inflation of the Global South countries. We find that the indirect effects through the worldwide supply pressure index & global economic conditions index and the direct impact through the disaggregated EU industry and manufacturing import prices present potential welfare losses to the Global South countries regarding the decline in real GDP and real exchange rate depreciation. The most striking implication of the results is that the policy could have far-reaching negative welfare consequences without proper mitigation measures such as: ploughing back proceeds from the CBAM scheme to support climate action internationally and exemption of poor and low-emission countries from the program as ways to moderate the impacts on the economies.

Introduction

The Carbon Border Adjustment Mechanism (hereinafter, CBAM) emanating from the European Union is a form of carbon taxation from the class of carbon pricing mechanisms[1], and serves as a policy strategy targeted at promoting clean energy transition, incentivizing green technology adoption in energy-intensive countries and sectors, and mitigating the impacts of climate risk and climate change (Maeno, 2023; Boto-García et al., 2024). The CBAM is a policy stance set up by the European Union (EU) to dissuade carbon leakage and promote sectoral competitiveness in the energy transition goal of the EU by 2050, and as such, ensure that all products consumed in the EU are subject to the same carbon costs (Perdana and Vielle, 2022; Pan & Liu, 2024; Zhang et al., 2024). Thus, as an additional step to the European Union Emissions Trading System (EU-ETS) and other stringent carbon regulations, the EU, via the CBAM, seeks to impose carbon prices on selected industrial sectors based on the embedded emissions of goods, towards a more effective and less-regressive carbon pricing system in the region.

A comprehensive background information about the CBAM including its scope, coverage and alternative implementation options can be found in the works of Beaufils et al. (2023) and therefore requires no further duplication[2]. The CBAM policy portends positive climate and clean energy outcomes within and outside the European Union. With the Union, the policy represents an important step in the search for an equitable framework for carbon pricing in the EU that captures both locally produced goods from targeted high carbon emission sectors and foreign products imported from the rest of the world (Chu et al., 2024). Thus, within the EU, the CBAM, based on the findings of Merkie and Dolphin (2024), could help achieve a more progressive carbon taxation through equitable distribution of carbon pricing among households in the union (Feindt et al., 2021). Further, by extending the carbon pricing net with the CBAM, there is a potential to contribute positively to the global energy transition and the decarbonization drive by indirectly spurring clean energy policy in the trading partners.

The present research focuses on the macroeconomic effects of CBAM beyond the EU, particularly the likely implications on the economic growth and macroeconomic stability of the Global South countries. The main point of concern regarding the Carbon Border Adjustment Mechanism (CBAM) is its potential to influence both energy policy and macroeconomic conditions worldwide. It could create global shocks in commodities, demand, and supply by affecting trade and financial flows between countries. Additionally, there is a risk that it could provoke a trade war between the EU and its trading partners (Casoli et al., 2024; Diaz et al., 2024; Sun et al., 2024). Hence, a study on CBAM is interesting to understand the global impacts of the policy on international economies, which has remained largely unclear before. Given that the Global South is largely home to developing countries that are more susceptible to external shocks[3], research of this nature is justified to examine the resilience or otherwise of Global South countries to the carbon tax on imports coming into the EU

[1] The existing carbon pricing scheme in the EU, i.e. the EU ETS, seeks to constrain the volume of greenhouse gas emissions by offering a market-based structure where CO2 emission allowances are freely traded in spot and futures markets (Adediran and Swaray, 2023; Bellora and Fontagné, 2023).

[2] New set of packages are being proposed to simplify the CBAM such as proposal for exception of SMEs within an acceptable threshold, simplification of compliance issues to automate computation of emissions and financial liabilities, as well as strengthening compliance measures (see: https://taxation-customs.ec.europa.eu/news/cbam-new-commission-proposal-will-simplify-and-strengthen-2025-02-26_en).

[3] Further argument on the focus on developing and emerging economies is the argument that the CBAM needs to be deployed to provide a level playing ground for economic actors on cleaner production practices globally and serve as an instrument to counteract any attempts at transferring carbon-intensive industries from countries with relatively less strict environmental laws to the EU (Perdana and Vielle, 2022; Sun et al., 2024).

with the latter's status as a large open economic unit and a major global trading block (Claeys and Vasícek, 2019).

The main research objective of this paper is to examine the vulnerability and resilience of Global South countries to the Carbon Border Adjustment Mechanism (CBAM). The aim is to provide valuable insights to policymakers in the EU regarding carbon pricing strategies. We seek answers to four research questions: (i) Do the Global South countries show macroeconomic resilience or exhibit vulnerability (via economic growth) in the face of global shocks posed by the CBAM? (ii) What is the nature of the effects of the CBAM on inflationary pressures in the Global South countries? (iii) What likely impacts are on the Global South's international trade competitiveness (via real exchange rates)? (iv) Are there dissimilarities in the macroeconomic effects of CBAM between the Global South and Global North countries to provide good insights for policymakers in the EU in the context of CBAM?

We pursue three-fold contributions with this research. First, by focusing on the international transmission of the macroeconomic impacts of carbon tax originating from the EU, this study presents a global perspective to the study of Merkle and Dolphin (2024), which is mainly limited to a sectoral analysis of carbon pricing across the EU. Our study also differs markedly from Beaufils et al. (2023) which although has a global appeal but applies a dated input-output data of the year 2016 to project the likely effects of the CBAM on emissions of the EU trading partners. The approach overlooks dynamic adjustments in production, trade, and consumption patterns as a number of trading partners are gradually transiting to low-carbon energy production, and the EU is gradually shifting towards importing goods with lower carbon intensity due to the Paris Agreement. These dynamic adjustments are essential for understanding both initial and future responses to the CBAM policy, thus, highlighting an obvious limitation of the input-output model, which may produce biased outcomes if there is a significant structural shift that establishes a new equilibrium from the equilibrium established in the base year. However, the present study in addition to capturing relevant dynamics, addresses a more pressing concern, which is the evaluation the potential spillover effects on macroeconomic stability and welfare. This paper is thus the first to present empirical results on the broader scope that examines both direct and indirect channels of the policy, contributing to the emerging literature on the CBAM policy.

Second, this study is the first to conduct an analysis of CBAM policy with a truly international appeal, given our choice of the global VAR technique that connects macroeconomic fundamentals of countries that make up to 90 per cent of the global economy through various interlinkages such as common global variables (e.g. global oil price, commodity prices, and global measures of supply and demand dynamics) and financial linkages via bilateral trade flows among the constituent economies (see Sikiru and Salisu, 2020; Salisu et al., 2021; Tumala et al., 2021) that permit both policy simulations and shock analysis of this nature to be conducted. This global large model adopted enables us to advance methodological contribution to studies such as Pan and Liu (2024), which is largely descriptive in nature, as well as Bellora and Fontagné (2023), Hinterlang (2024), Lin and Zhao (2024), Sun et al. (2024), and Zhang et al. (2024) that are based on less-efficient general equilibrium models.

Third, applying the GVAR methodology leads to empirical contributions where we trace the propagation of the global demand and supply shocks and comfortably simulate the macroeconomic effects of the CBAM originating from the EU across several countries and compare results between developed countries against those of the Global South countries. Such a contribution finds root in extant comparative and global studies such as Aor et al. (2022), Salisu et al. (2022b), and Sikiru and Salisu (2024). In other words, the effect of the ensuing carbon tax on imports can be specifically examined on the macroeconomic fundamentals (economic growth, inflation and real exchange rates) of the Global South countries individually (i.e. country-specific), regionally (Africa, Asia Pacific,

Latin America & the Caribbean, and Arab regions), and as a unit, as well as comparative analyses between the Global South regions against advanced economies in the global VAR modelling framework. The outcomes from this paper allow us to offer suggestions to policymakers in the EU on how to effectively implement a carbon tax on imports based on responses from various energy-intensive products/sectors, particularly the Global South trading with the EU region.

The rest of the paper is structured in the following manner. Section 2 discusses the theoretical framework for tying the study, including the channels for the shocks to permeate through the macro economies. Section 3 details the methodology as well as the data issues, whereas Section 4 conducts preliminary data analyses and highlights stylized facts. Section 5 extensively discusses findings highlighting economic intuition and policy implications. The final section articulates policy recommendations in Section 6.

2. Literature and Theoretical Framework

In theory, at any given price, carbon pricing offers an effective approach to generate reductions in greenhouse gas emissions by integrating the environmental cost of emissions into the cost of production of final outputs to dis-incentivize carbonization in production and consumption (Timilsina, 2022; Merkie and Dolphin, 2024). The neoclassical international trade theories are based on perfect market assumptions under which there is no distinction between private and social marginal costs, and between private and social marginal benefits. In his factor price equalization theory, Professor Paul Samuelson explains that as free trade continues, this condition will equalize the prices of products and factors across countries (Samuelson, 1948). Meanwhile, market imperfection usually exists due to various factors, including externalities. Carbon emission increases global greenhouse gases, and countries have signed an agreement (Paris Agreement) to pursue a reduction in carbon emissions. While the EU is committed and uses less carbon-intensive technology in the production process, some of its trading partners use high carbon-intensive technology, thus polluting the atmosphere for everyone, including the EU, which is low-carbon compliant. This causes carbon leakage to the EU; a negative externality. The Carbon Border Adjustment Mechanism (CBAM) adds carbon tax in the form of an environmental pollution tax on imported carbon-intensive goods to reduce carbon leakage to the EU and discourage producers from using high carbon-intensive technology. Higher prices of these imported goods induced by the addition of carbon tax are expected to reduce output and export supplies and increase the relative prices of foreign to EU-produced goods, thus reducing the trade competitiveness of the foreign countries.

Furthermore, the Carbon Border Adjustment Mechanism represents an important step to complement the pre-existing carbon pricing mechanism towards the carbon-neutral goal of Europe by the year 2050. Through the policy, the EU is expected to push both energy policy and macroeconomic-type shocks internationally since the shocks are difficult to self-absorbed by the EU (Casoli et al., 2024). The EU is a large economic unit and trading block responsible for about one-quarter of global GDP and a host to many multinational companies involved in the global supply chain (Claeys and Vasícek, 2019)[4]. Hence, climate policy stringency in the EU can engender strict climate policies in the trading partners and causing spillover effects on macroeconomic

[4] Its carbon allowance trading market (EU ETS) was the largest for over 15 years, from 2005 to 2021, when China introduced a similar trading system (Merkie and Dolphin, 2024).

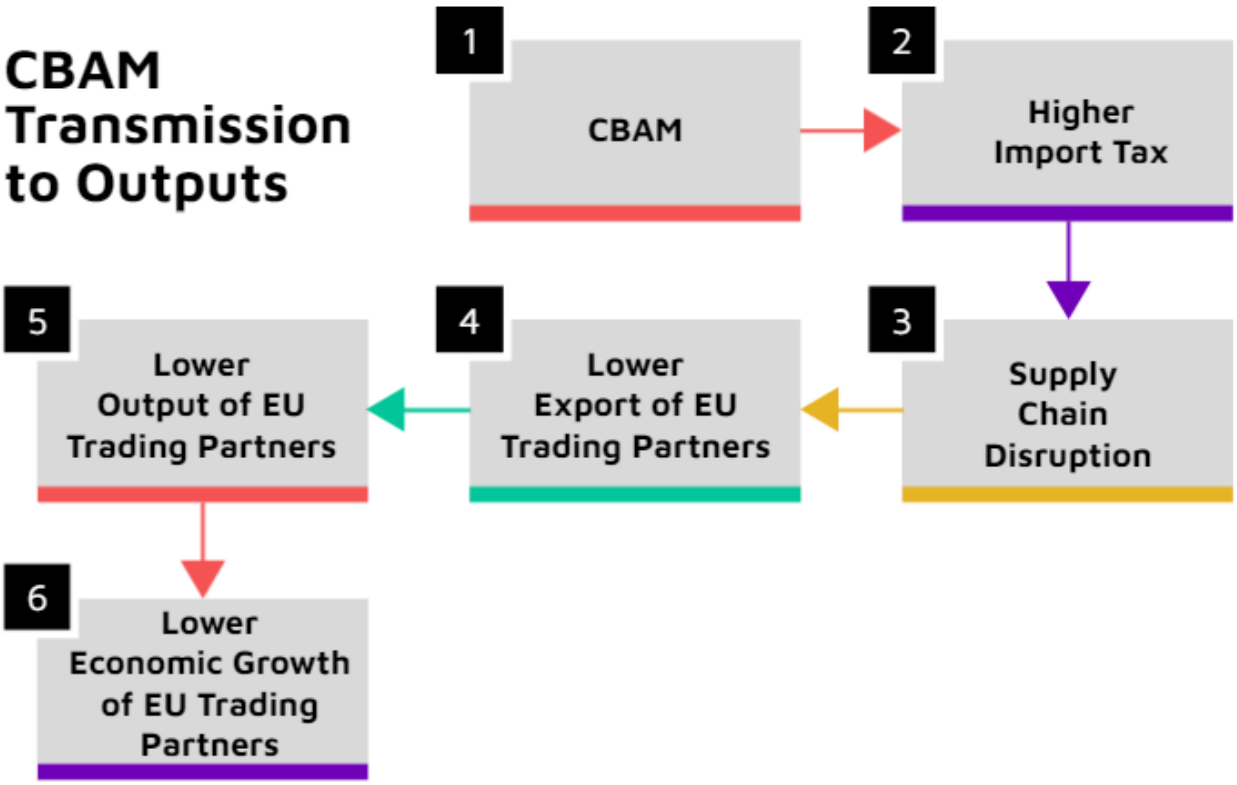
fundamentals through global trade and demand and supply disruptions. Further, the success of the EU's clean transitions via the CBAM will give the region a stronger voice to leverage favourable conditions in international discussions (Bertoldi et al., 2023; Fields and Lindequist, 2024).

The CBAM is a carbon pricing mechanism aimed at reducing the rate of carbon leakage in the EU by levying carbon costs on products being imported into the EU. The literature suggests that by pursuing collective carbon pricing across Europe (rather than individual policies), the CBAM is expected to promote sustainable economic growth in the long term in the EU, although there may be short-term welfare losses within the region (see Merkle and Dolphin, 2024). The literature also indicates that the policy presents potential welfare losses for countries outside the EU, particularly less-developed economies, in terms of weakened exports (Merkle and Dolphin, 2024). Hence, the strongest link to trace the CBAM to the macroeconomic fundamentals of international economies appears to be via the international trade channel.

The CBAM policy has global implications with the possibility of influencing global trade through the EU trading partners and also intertwined with global supply chains through commodities since the transition from fossil fuels to clean energy technologies will necessarily involve the purchase of raw materials for constructing clean energy technologies which is contingent on happenings in commodity markets and overall international trade. (Andersen et al., 2024; Diaz et al., 2024; Jensen, 2024). The international trade transmission channel of carbon emission costs largely passes through a series of industrial, manufacturing and other goods traded internationally to the international macroeconomic conditions and, therefore, highlights the role of supply disruption and demand conditions as the transmitting agents. These present possible negative implications for economic activity, general price inflation, and other vulnerabilities of trading partners that depend on exports of high-carbon content products (Maeno, 2023; Cuestas et al., 2024; Hensel et al., 2024; Jensen, 2024; Nguyen et al., 2024).

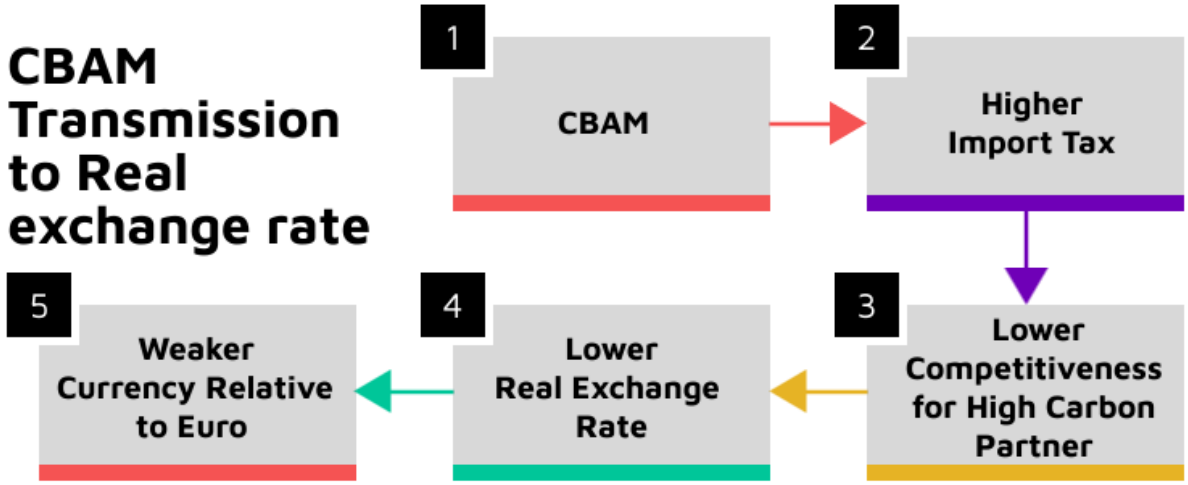
In other words, carbon taxation to promote low carbon restructuring tends to impose additional costs on productivity, which are greater in energy-intensive sectors such as manufacturing, petroleum, transportation, and electricity generation, among others, as the sectors with the most carbon reduction potential. The carbon tax can be viewed as a higher production cost imposed on sectors/countries of origin, which could lead to output decline in the short term because exports have declined. Since the carbon tax is intended to prevent the relocation of carbon-intensive products to the EU, the costs will be higher on products from sectors or countries with higher carbon content. In other words, the higher the carbon content of the product, the greater the negative impact on the exports and outputs from the sector or country of origin.

Figure 1: *Channel of transmission of CBAM to outputs*



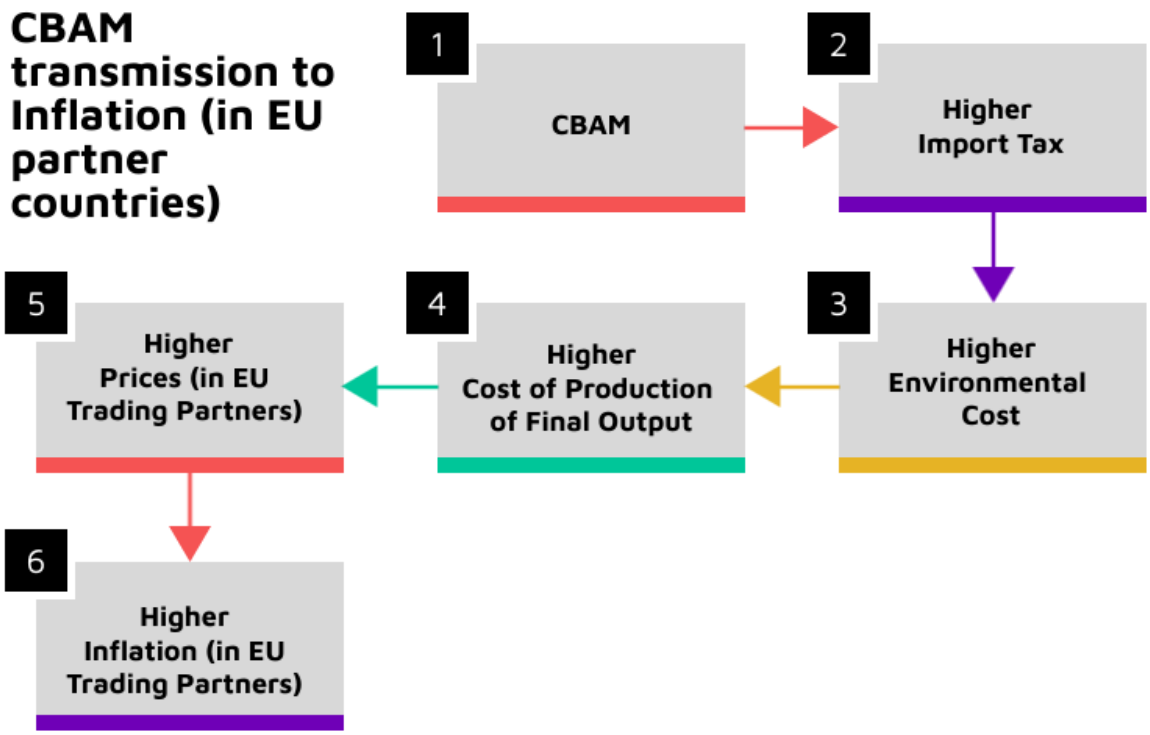
The supply shock argument (alongside demand shock) suggests that global macroeconomic disruptions could ensue when the CBAM hinders trade, and disruptions to exports from the EU's trading partners that could lower investment and business confidence and slow down growth, and if not well-managed under a well-coordinated international policy arrangement could lead to trade wars and further worsening economic growth outlook (Bertoldi et al., 2023). The foregoing could also negatively affect the trade competitiveness of the trading partners as it becomes costlier for them to export to the EU. Figure 1 spells out the channel of transmission of CBAM to output growth of the EU's trading partners, while Figure 2 traces the transmission to real exchange rates.

Figure 2: *Channel of transmission of CBAM to real exchange rates*



Another side of the argument links global factors such as global trade/supply chain disruptions, commodity shocks, and carbon policies to domestic prices and inflation (see, for example, Auer et al., 2019; Ascari et al., 2024; Boto-García et al., 2024; Diaz et al., 2024; Hensel et al., 2024) suggest that such disruptions pass through to domestic prices driving up inflation. The argument in this regard is that carbon policies are linked with higher inflation expectations, and as such, when expectations rise about the future evolution of prices due to the signaling effect of global supply shocks, and therefore firms may raise their prices in expectation of higher input cost to protect against potential revenue losses. Also, the carbon tax constitutes an increased environmental cost that raises the cost of production of goods and services produced in the trading partner's country and could, therefore, be inflationary (see Figure 3).

Figure 3: *Channel of transmission of CBAM to inflation*



We now provide a brief review of the empirical literature. Empirical analysis of the CBAM is not essentially new although the concerns addressed in this paper are novel. Sector-level and country-level analyses conducted in studies such as Perdana and Vielle (2022), Chu et al. (2024), and Hinterlang (2024) find that the CBAM will reduce the rate of carbon leakage within Europe by pushing the transition from high carbon intensity industries to those with lower-emission levels, and lead to positive economic growth in the long-term especially when Europe collectively adopts the carbon pricing rather than unilateral adoptions by some European countries. However, the studies suggest that the policy presents potential welfare losses for less-developed economies in terms of weakened exports. Beaufils et al. (2023) produce similar outcomes by reporting negative consequences for the EU's trading partners especially the poorer countries even under a conservative implementation option. This leads to the suggestion to review the inclusion of vulnerable countries within the CBAM scheme.

Cross-country analyses based on computable general equilibrium and input/output frameworks, for example, Bellora and Fontagné (2023), Cleary and Willcott (2024) and Lin and Zhao (2024) also appear to be unanimous on the effectiveness of the CBAM to curb carbon leakage in the EU and promote diminishing greenhouse gas emissions; however, the impact on production costs appear to lead to output decline in the short-term, which is greater outside the EU than within (see Zhang et al., 2024). In order to achieve the desired outcome, Merkle and Dolphin (2024), in an EU-wide study, conclude that a uniform carbon price is preferred to make the scheme more objective by increasing the carbon costs associated with the imported goods consumed by the high-income groups in the EU (see also, Tarr et al., 2023).

Empirical arguments against the CBAM herewith highlighted indicates that its ability to curtail carbon risks is restricted because the CBAM leads to significant household welfare losses in the EU as well as outside of it due to retaliatory trade policies that could affect households in poorer countries more (Tarr et al., 2023; Sun et al., 2024; Zhang et al., 2024). The general conclusion that proceeds from the naysayers is that the CBAM cannot be effective in mitigating climate change in isolation, but the recommendation is that it should be conducted within international cooperation.

3. Methodology & Data

This study relies on the Global Vector Autoregression (henceforward, GVAR) methodology (see Pesaran et al., 2004; Chudik and Smith, 2013; di Mauro and Pesaran, 2013; Smith and Galesi, 2014; Chudik and Pesaran, 2016; Chudik et al., 2016; Mohaddes and Raissi, 2020, 2024) to capture the impact of carbon tax on import implied by the CBAM is theoretically transmitted via the international trade channel and shock to global supply and demand. The GVAR approach is suitable for the present study given that it offers a compact model of the global economy where the Global South countries alongside EU and other advanced and emerging economies are interlinked via bilateral trade flows (used for the computation of weighting matrix), and therefore allows the transmission of the EU carbon tax to be traced transnationally to the Global South and elsewhere.

Consider a classic GVAR (p_i, q_i, s_i) model expressed as follows:

$$x_{it} = \sum_{\ell=1}^{p_i} \Phi_{i\ell} x_{i,t-\ell} + \Lambda_{i0} x_{it}^{*} + \sum_{\ell=1}^{q_i} \Lambda_{i\ell} x_{i,t-\ell}^{*} + \Gamma_{i0} C_{it} + \sum_{\ell=1}^{s_i} \Gamma_{i\ell} C_{i,t-\ell} + \varepsilon_{it}$$
$$i = 0, 1, 2, \dots, n;\ t = 1, 2, \dots, T \qquad (1)$$

There are three types of variables captured in this GVAR framework; one, country-specific endogenous variables (x_{it}) with dimension k_i namely, log of real GDP, inflation rate, short-term interest rate, long-term interest rate, real exchange rate, and real equity prices; two, weakly exogenous foreign variables (x_{it}^{*}) with dimension k_i^{*} which are the foreign counterparts of the domestic variables included in the country-specific VAR models; and three, global variables (C_{it}) as external factors common to all the countries such as oil price, agricultural raw material, and metals prices. The US economy is treated as the benchmark (i.e. $i = 0$)[5] and the rest of the 32 advanced and developing countries are indexed by $i = 1, 2, \dots n$.

The foreign counterparts of the domestic variables, x_{it}^{*} are the trade-weighted versions of the domestic variables constructed by multiplying the x_{it} with the matrix of trade weights (w_{ij}) where the latter is computed from the bilateral trade flows among the countries as follows:

$$x_{it}^{*} = \sum_{\mathrm{j}=0}^{n} w_{ij}\, x_{jt};\ i, j = 0, 1, 2, \dots n \qquad (2)$$

[5] This dominant role of the US is in line with several extant empirical studies (see for example, Wu et al., 2014; Antonakakis, Gabauer, and Gupta, 2019; Salisu, Adediran and Gupta, 2021; Salisu et al., 2022a) as the biggest contributor to global output, trade, financial markets, and the role of the US dollar as the most internationalized currency.

The description of the matrix of trade weights is that they sum up to one column-wise (see Eq. 3) such that these cross-country trade relations help to model the transmission of the CBAM shocks via the trade channel, whereas, the diagonal elements that represent own trade between country $i's$ are zeros (see Eq. 4).

$$\sum_{\mathrm{j}=0}^{n} w_{ij} = 1 \qquad (3)$$

$$w_{ij} \neq 0;\ w_{ii} = 0 \qquad (4)$$

We denote unobserved common factors to the models by incorporating the weighted cross-sectional averages of the observables ($\tilde{x}_{it}$) in the models constructed as follows:

$$\tilde{x}_{it} = \sum_{\mathrm{i}=0}^{n} \widetilde{w}_i\, x_{it} \qquad (5)$$

where $\widetilde{w}_i$ is the weight matrix representing the relative importance of country i as informed by their GDP-PPP values.

This study employs the latest GVAR database updated by Mohaddes and Raissi (2024). The database has been revised to cover the period 1979Q2 to 2023Q3[6]. There are thirty-three (33) countries in the GVAR framework that can be characterized into advanced and emerging economies. Fourteen (14) of these belong to the Global South, namely, Argentina, Brazil, China, Chile, India, Indonesia, Malaysia, Mexico, Peru, Philippines, Saudi Arabia, South Africa, Thailand, and Turkey[7]. The rest of the countries that include top European countries are Australia, Austria, Belgium, Canada, Finland, France, Germany, Italy, Japan, Korea, Netherlands, New Zealand, Norway, Spain, Sweden, Singapore, Switzerland, the United Kingdom, and the United States. This obvious advantage makes it possible for comparison between advanced economies and the Global South countries.

Table 1*: Countries & regions in the GVAR*

European Union	Austria, Belgium, Finland, France, Germany, Italy, Netherlands, Spain, Sweden
Global South	Argentina, Brazil, China, Chile, India, Indonesia, Malaysia, Mexico, Peru, Philippines, Saudi Arabia, South Africa, Thailand, Turkey
The rest [Global North]	Australia, Canada, Japan, Korea, New Zealand, Norway, Singapore, Switzerland, United Kingdom, and the United States

In line with the study's objectives, we augment the GVAR framework with import prices as an additional exogenous common factor (source: the IMF's International Financial Statistics) and proxies for global supply disruption and demand shock with which to quantify the indirect and direct macroeconomic effects of carbon tax on imports from all the trading partners with the EU. With this

[6] Freely available online at https://www.econ.cam.ac.uk/people-files/emeritus/mhp1/GVAR/GVAR.html
[7] See the UNESCO's classification of the Global South countries (https://owsd.net/sites/default/files/OWSD%20138%20Countries%20-%20Global%20South.pdf)

structure, the impact of the CBAM can be distinctly assessed on economic growth (log differences in real GDP) and economic stability (measured with inflation rate and real exchange rates) of the respective countries.

For in-depth data analysis and robust discussion of the findings, the analyses are rendered as follows:

1. Analysis of the macroeconomic effects of the CBAM on the Global South as a unit,
2. Individual country analyses of the CBAM effects on the Global South countries;
3. Regional analyses of **Asia Pacific region** [China, India, Indonesia, Thailand, Malaysia, Philippines, and Turkey], **Latin America & the Caribbean region** [Brazil, Mexico, Argentina, Chile, and Peru], **Africa** [South Africa], and **Arab region** [Saudi Arabia];
4. Comparative analysis between advanced economies (excluding EU) and the Global South.

4. Preliminary Analyses

4.1 Stylized facts

This section presents stylized facts from the data regarding what to expect as to the likely macroeconomic effects on the Global South economies if the EU proceeds with the carbon tax that raises the import prices of goods coming into the region. The datasets utilized for this exercise encompass six key variables; three of them are macroeconomic fundamentals of the Global South countries (inflation rate, real output, real exchange rate) extracted from the GVAR database[8]. The disaggregated EU import price indexes for industrial and manufacturing goods are sourced from the Federal Reserve database with which to simulate the CBAM effect[9]. The other two are the global supply chain pressure index (also obtained from the Federal Reserve Bank)[10], as well as the global economic conditions index[11], as measures of global supply and global demand shocks that could ensue if a large open economy like the EU simultaneously pushes energy-related shock intertwined with trade shock globally. In line with previous discussions, we examine the effects of supply and demand disruptions against the countries' outputs and compare the disaggregated EU import prices against price variables, i.e., inflation and exchange rates.

The stylized facts are specifically provided for the 2009Q1-2023Q3 for want of space and to clearly highlight the recent global dynamics that could be of immediate concern to the policymakers regarding the implementation of the CBAM (and also, the global supply chain data are quite recent and do not extend over the entire period of study). For the purpose of the preliminary analyses, charts are produced (see Figure 4) to explore the relationship between the supply pressure index and real output across the countries. The demand side involves the relationship between demand conditions and real output (see Figure 5). Further, the analyses are complemented with graphical evidence to illustrate the temporal trends and interactions between the disaggregated EU import price indexes and inflation rate and between the disaggregated EU import price indexes and Global South real

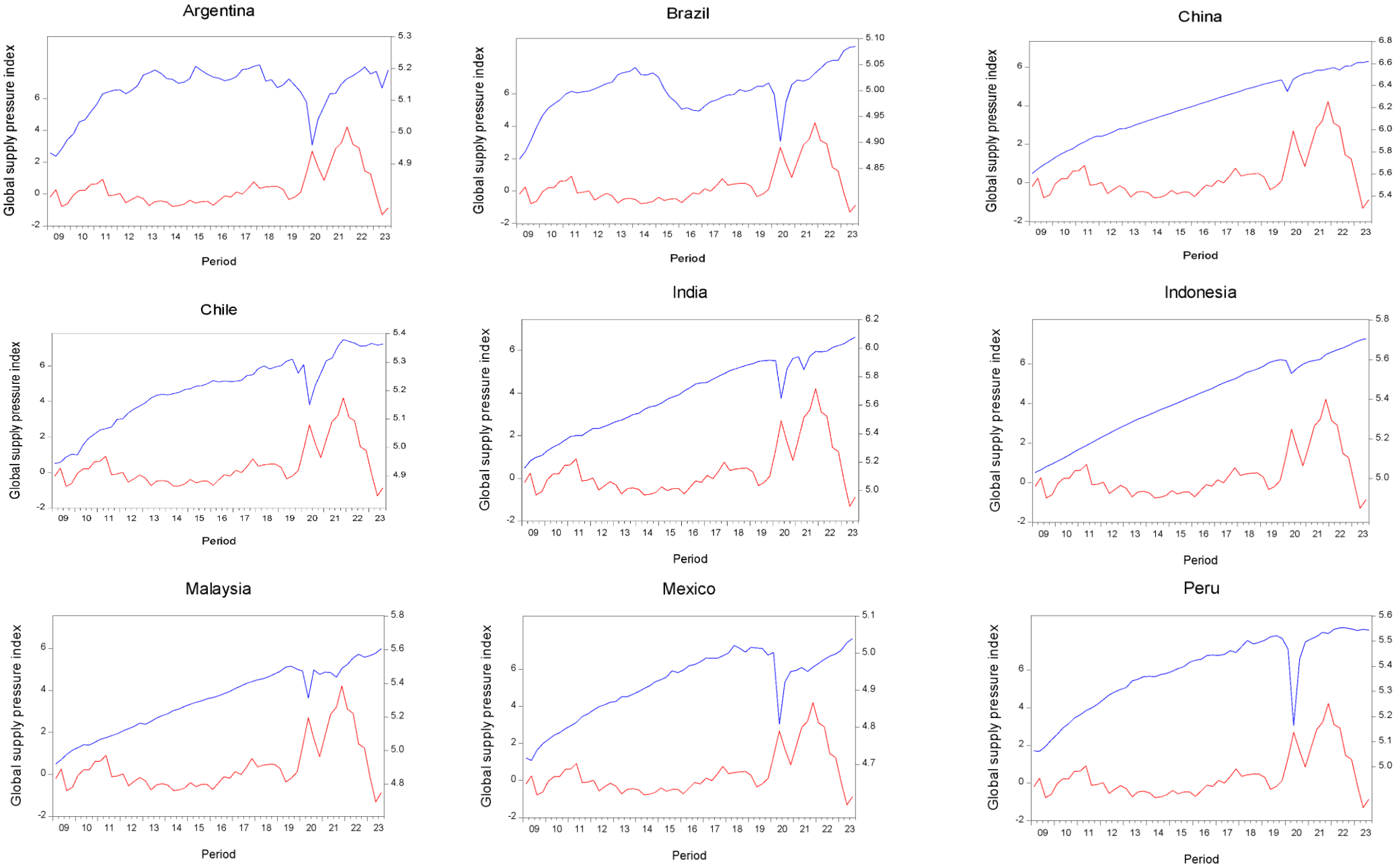
[8] From the data source, real output is measured as the log of real GDP, inflation as log differences of consumer prices, and real exchange rate as the nominal external value of the domestic currency deflated by the consumer price index (in natural log form). For obvious reasons, the disaggregated EU import prices for industry and manufacturing sectors are also expressed in log form.
[9] Online at: https://fred.stlouisfed.org
[10] Online at: https://www.newyorkfed.org/research/policy/gscpi#/interactive
[11] Online at: https://sites.google.com/site/cjsbaumeister/datasets

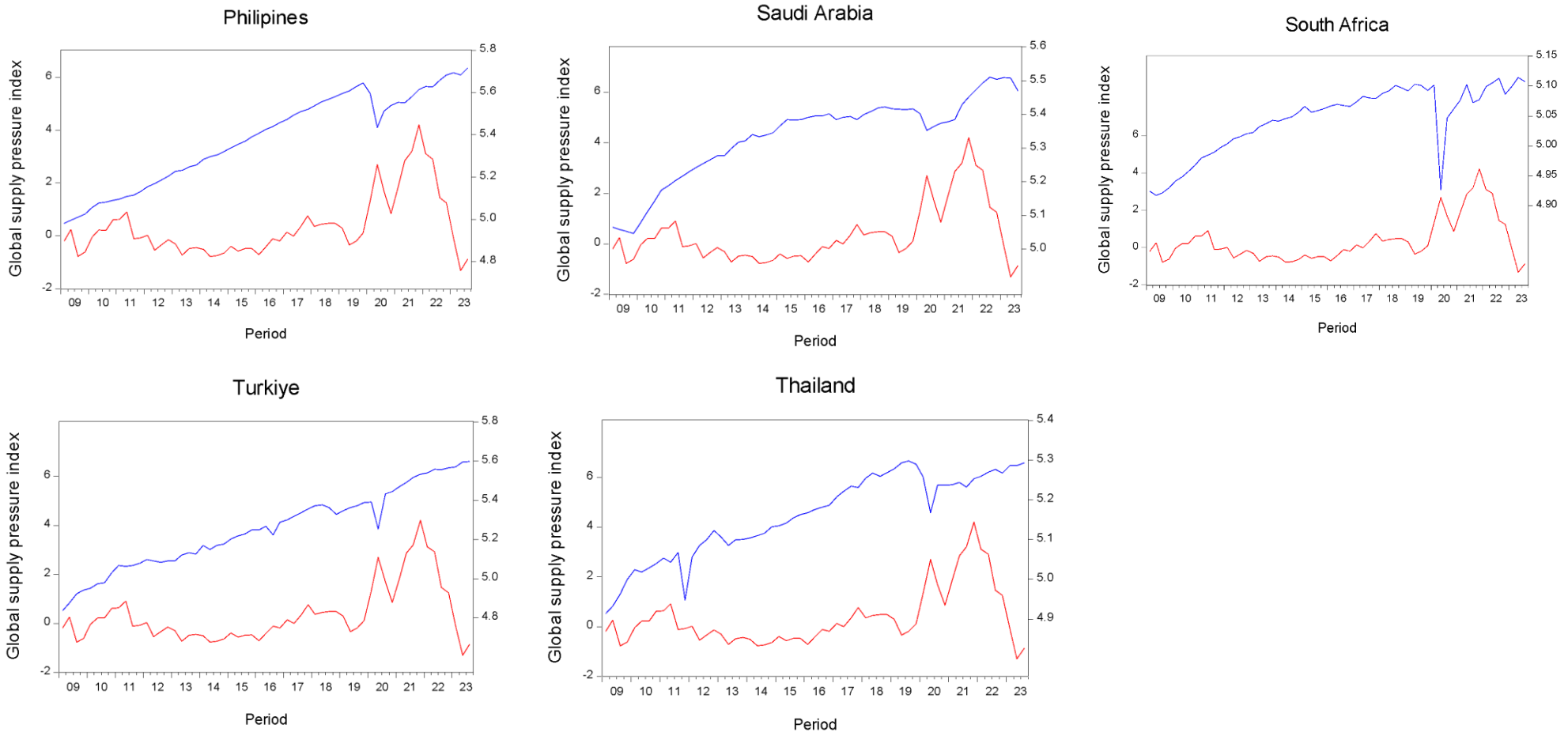
exchange rates (see Figures 6&7 and 8&9, respectively). The data analytics highlight some interesting country-specific distinctions as to how global supply disruptions and the cost of EU imports interact with real output, consumer inflation and real exchange rates in the fourteen Global South countries.

A striking observation from the charts in Figure 4 shows a sustained rise in the real GDP of the countries (as expected of developing and emerging economies) after the global recession witnessed earlier during the 2007/08 global financial crisis, with real output rising steadily since 2009. This may not be unconnected to the relative calm recorded in the global supply value chain during the same period. At the onset of the COVID-19 pandemic in 2020, real outputs fell sharply (but in varying magnitudes) in all the Global South countries sampled. Notably, also, this period saw a spike in the global supply chain pressure index as global supply chain disruptions heightened with a sharp increase in 2020 coinciding with a sudden decline in real outputs. This might suggest that any major event that causes a significant spike in the global supply chain pressure (like the one that could ensue if the CBAM is not properly targeted) could precede an economic recession. However, the magnitude of such a recession would depend on the resilience or otherwise of the economy to cope with global shocks. From a closer look, the worst hit countries are Argentina, Brazil, Mexico, Peru, and South Africa, while some of the least affected are China, Indonesia, and Saudi Arabia.

From the demand side, we look at the relationship between the country's real outputs and a measure of global demand conditions: the global economic conditions index. The charts in Figure 5 show that the global economic conditions index also responded negatively to the COVID-19 pandemic as global demand dropped around the year 2020 when various economic activities were hampered due to sit-at-homes, movement restrictions, and similar precautions put in place to mitigate the pandemic. Secondly, the downward spike in the global demand observed during this period also coincides with drops in the levels of real outputs, which, as a matter of empirical scrutiny, may be compared in magnitudes with those associated with the global supply disruption. Hence, two key observations can be drawn from Figure 4 and Figure 5. One, the indirect impact of the CBAM (or any similar phenomenon on a global scale) can be examined from either the demand or supply side using the foregoing measures employed. Two, in the formal data analysis, the logical shock impact that should be traced to the countries' output based on the nature of the indices is a positive shock to the global supply pressure index and a negative shock to the global demand conditions index.

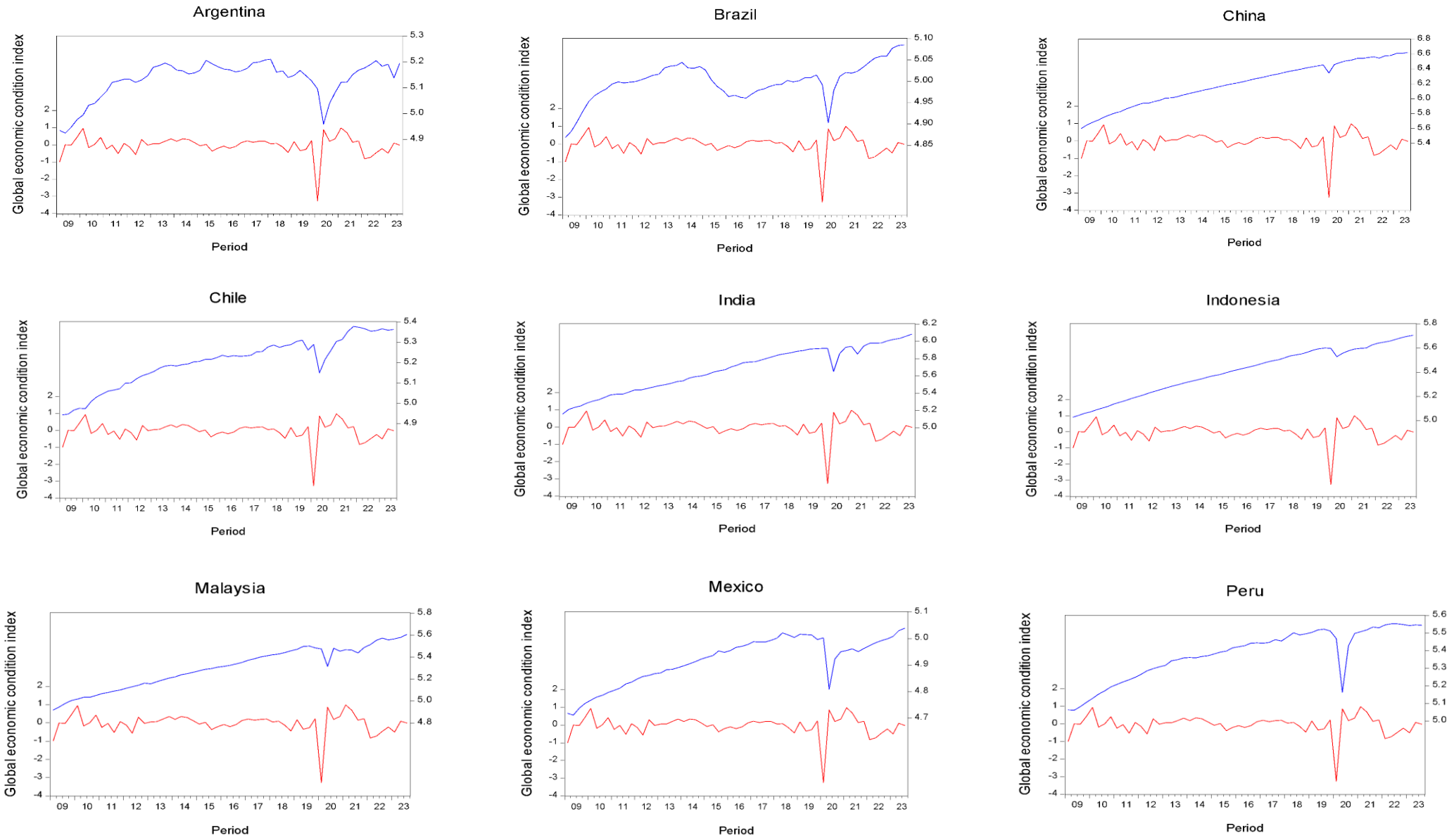
Figure 4: *Trends in global supply pressure and Global South real GDP*

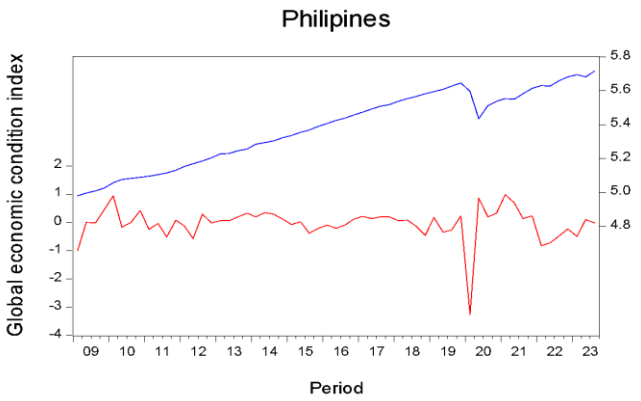


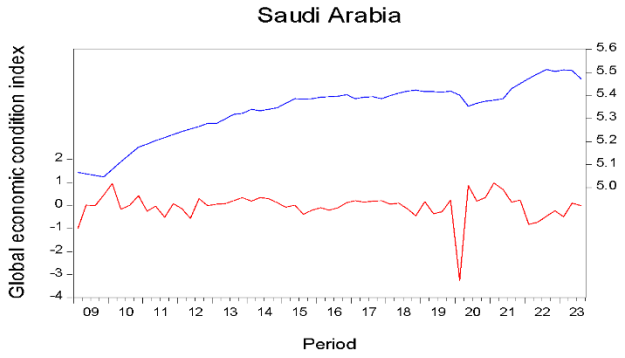


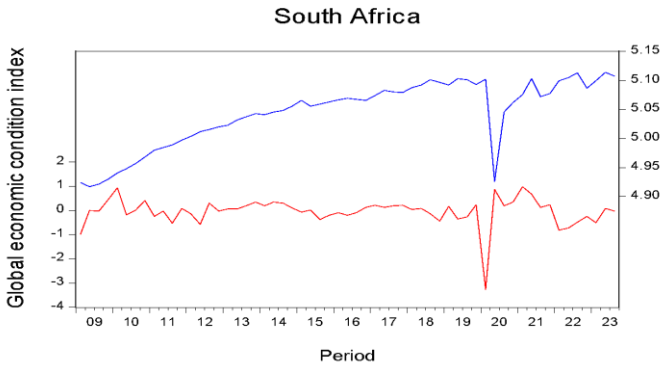
Note: These charts describe movements in two fundamentals: the global supply pressure index (**red line**) and log real GDP (**blue line**) of the fourteen Global Southern countries. The countries in question are Argentina, Brazil, China, Chile, India, Indonesia, Malaysia, Mexico, Peru, Philippines, Saudi Arabia, South Africa, Thailand, and Turkey. The review period covers the last fifteen years (2009Q1-2023Q3) to highlight the recent dynamics in the area of interest.

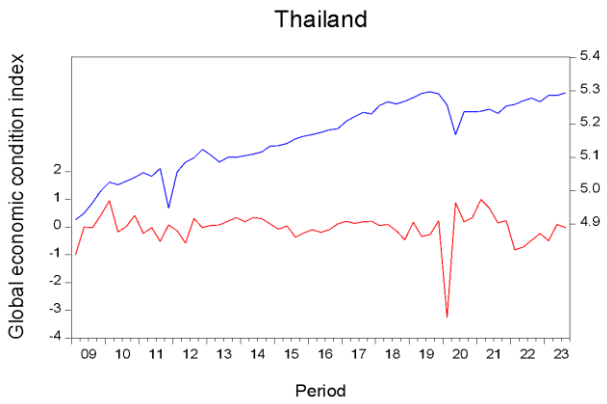
Figure 5: *Trends in global demand conditions and Global South real GDP*

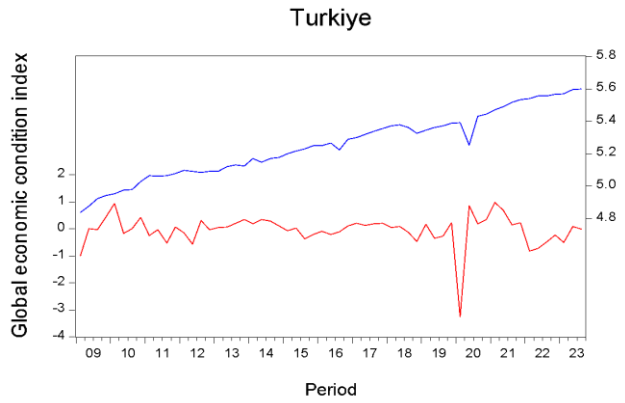










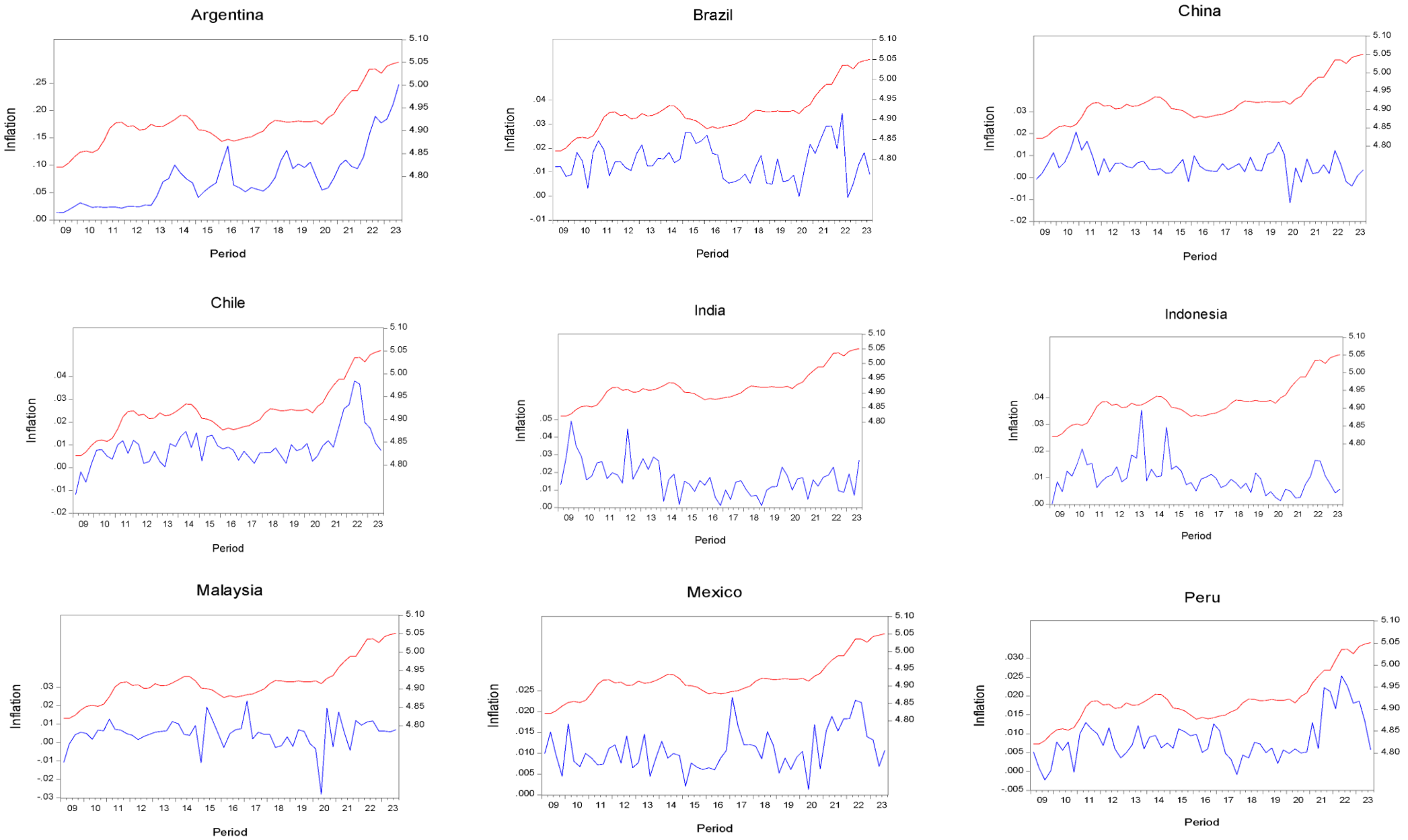


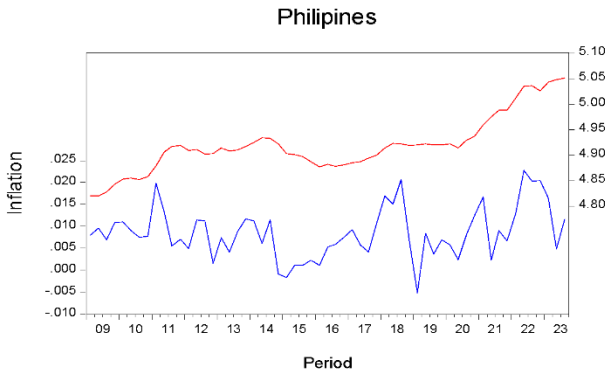
Note: These charts describe movements in two fundamentals: the global economic conditions index (**red line**) and the log real GDP (**blue line**) of the fourteen Global South countries. The countries in question are Argentina, Brazil, China, Chile, India, Indonesia, Malaysia, Mexico, Peru, Philippines, Saudi Arabia, South Africa, Thailand, and Turkey. The review period covers the last fifteen years (2009Q1-2023Q3) to highlight the recent dynamics in the area of interest.

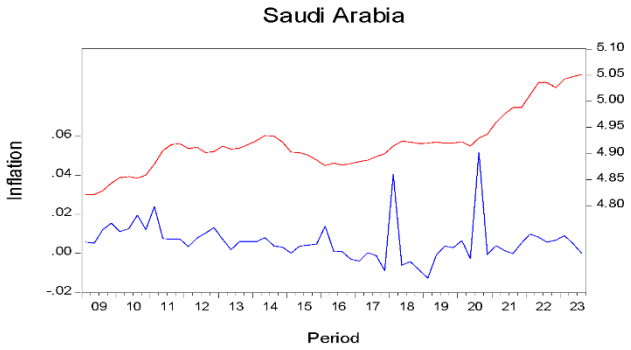
Figure 6 and Figure 7 potentially examine the transmission of disaggregated EU import prices to inflation in the Global Southern countries. A close look at the graphs comparing EU import prices (industry and manufacturing import prices) with consumer price inflation series shows a possible positive association between the two fundamentals, especially in Argentina, Brazil, Chile, and Peru, but the direction of the relationship is largely unclear in the remainder of the countries. The reason for this is not far-fetched. One, inflation most likely responds primarily to the domestic economy's macroeconomic fundamentals. Two, proper analysis would imply tracing the impact (rather than a direct impact) of the import price on inflation (as in the GVAR model), the former being a foreign variable determined internationally; hence, a data analysis of this nature involving only the two series may be inadequate. Therefore, the response of the country-specific inflation to the EU import prices may not be readily clear until the impact is traced through the relevant transmission channel offered by the GVAR methodology.

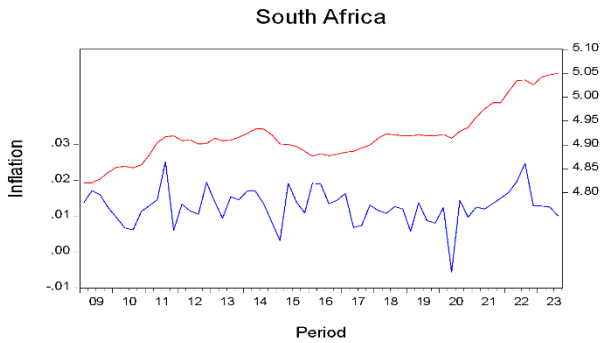
The association between the disaggregated EU import prices (industry and manufacturing import prices) and real exchange rate is examined in the charts rendered in Figure 8 and Figure 9 to comment on the external competitiveness of the countries due to import price shock from the EU. Interestingly, mixed outcomes in the fourteen charts show divergence in the relationship between the two series captured. The real exchange rates of the countries and the disaggregated EU import price indexes appear to move in opposite directions in some and otherwise in some countries. This is the case since the relationship between the two series is not direct. In the formal analysis, however, where the interrelationships are formalized, the theoretical expectation is to expect higher EU import prices to be linked to exchange rate depreciation in the countries since higher (lower) exchange rates indicate exchange rate depreciation (appreciation). If this becomes the case, the Global South countries could most likely incur welfare losses in terms of real exchange rate depreciation when the CBAM that causes a positive import price shock comes into effect as the real worth of the goods from those countries becomes costlier.

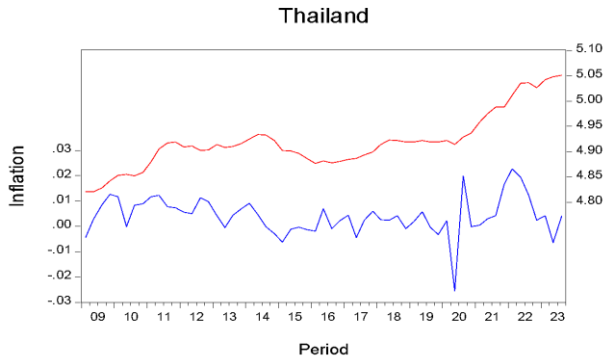
Figure 6: *Trends in EU industry import prices and inflation in Global South countries*

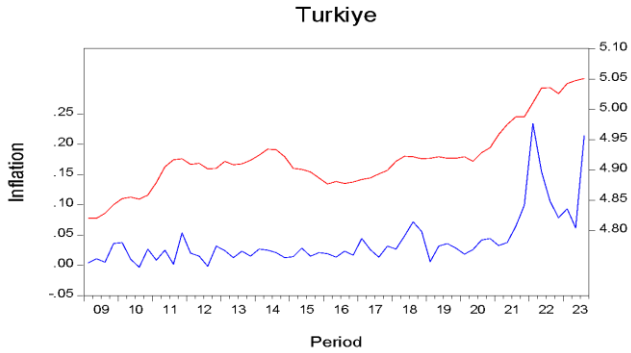






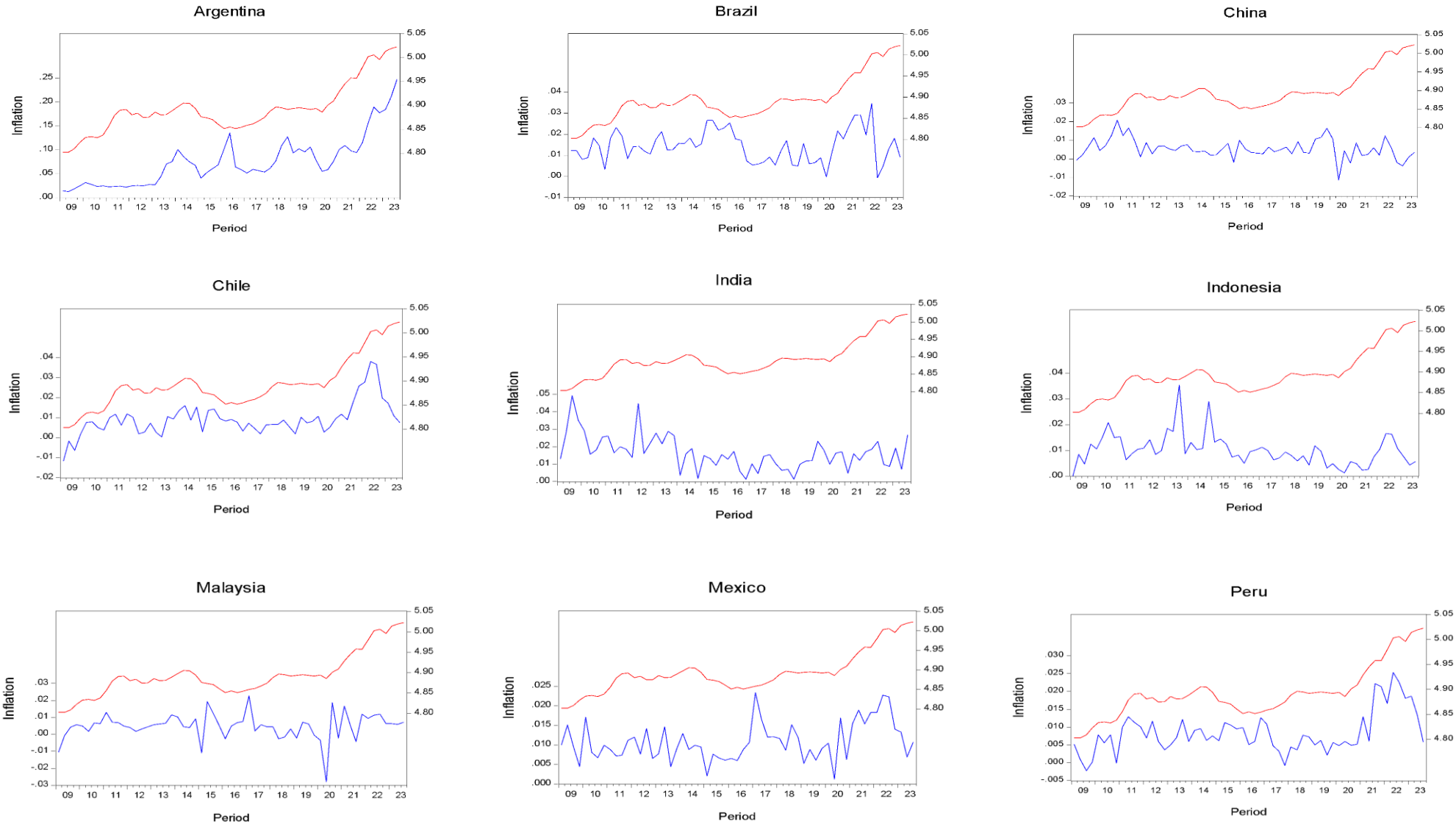


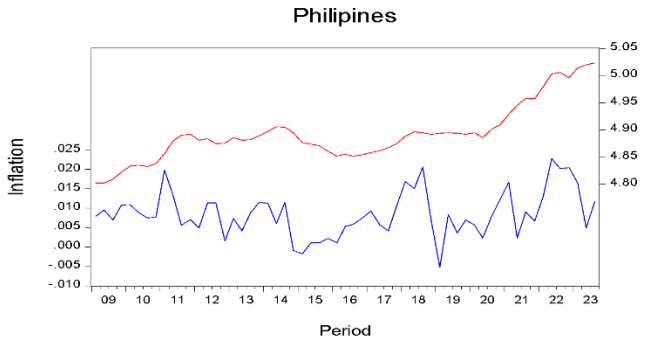


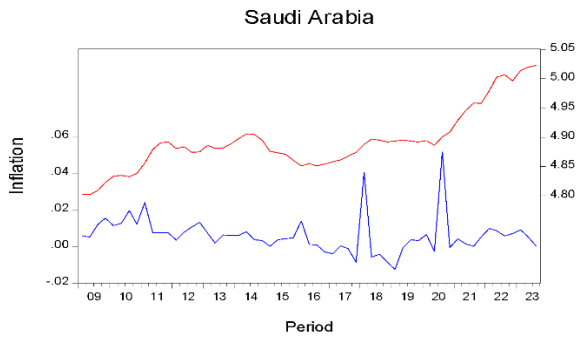


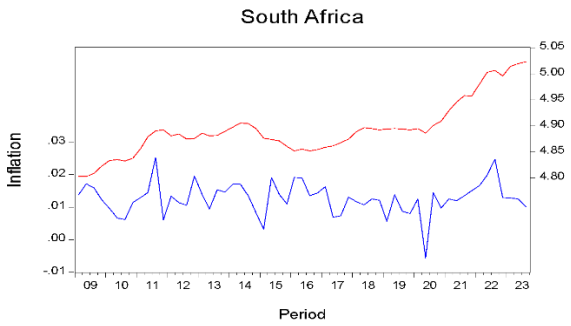
Note: These set of charts describe movements in two price fundamentals; that is, the log of the EU [industry] import price index (**red line**) and inflation series (**blue line**) of the fourteen Global Southern countries. The countries so captured are Argentina, Brazil, China, Chile, India, Indonesia, Malaysia, Mexico, Peru, Philippines, Saudi Arabia, South Africa, Thailand, and Turkey. The review period covers the last fifteen years (2009Q1-2023Q3) in order to highlight the recent dynamics in the area of interest.

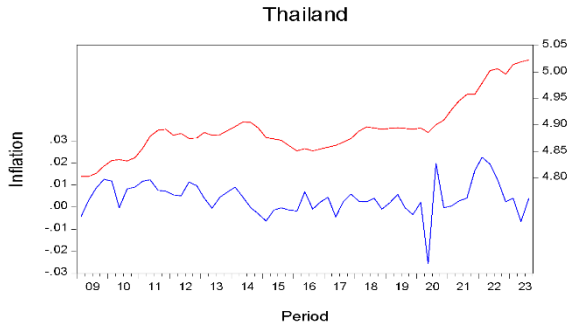
Figure 7: *Trends in EU manufacturing import prices and inflation in Global South countries*

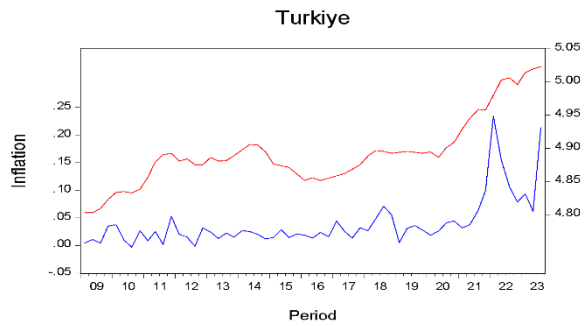








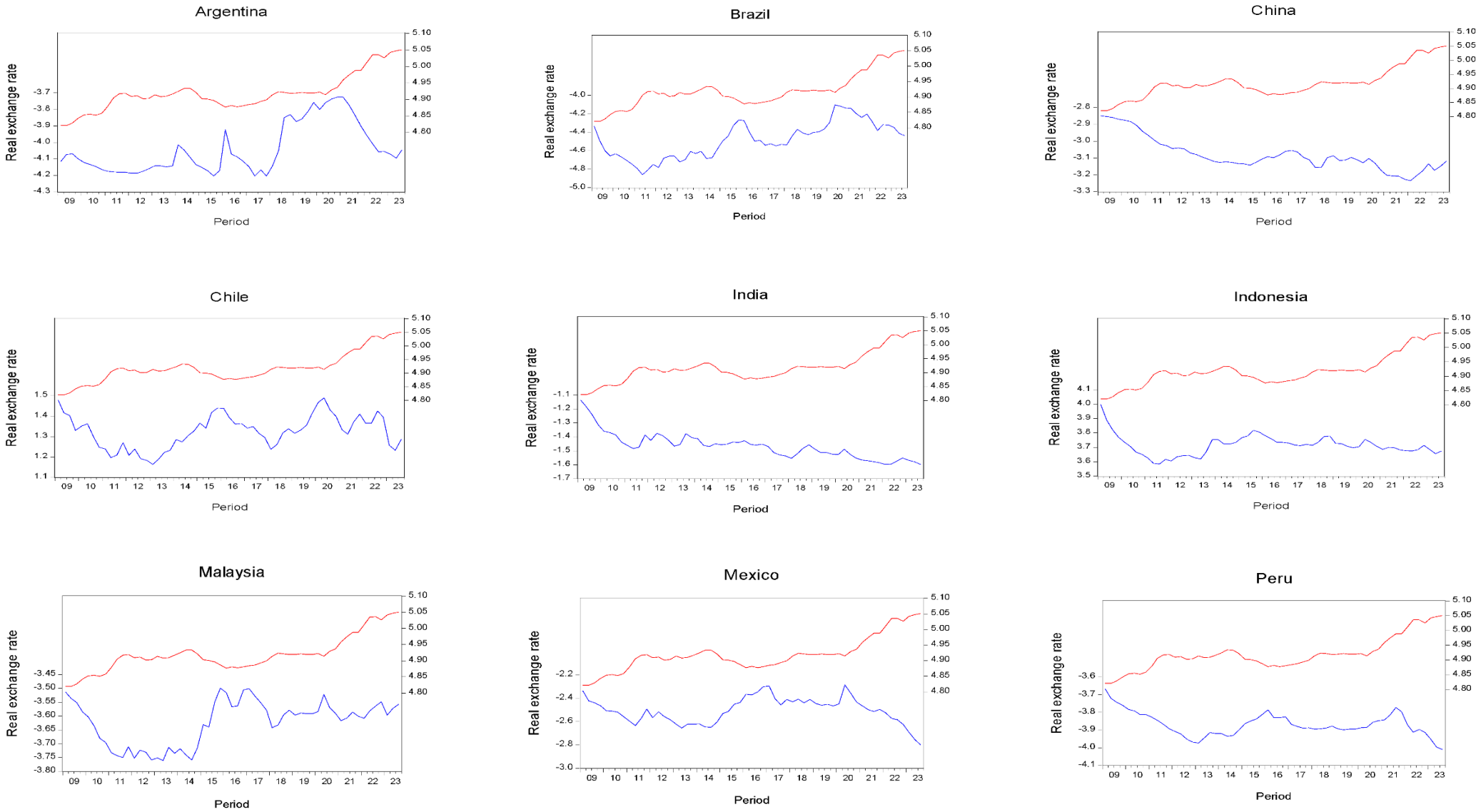


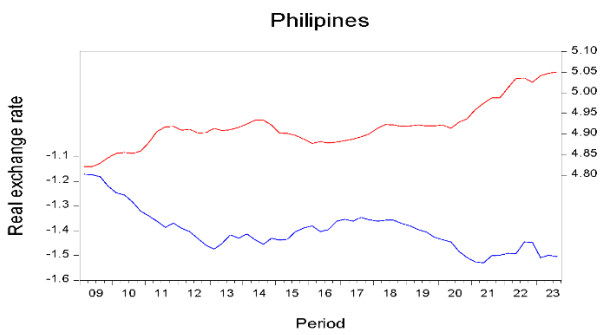


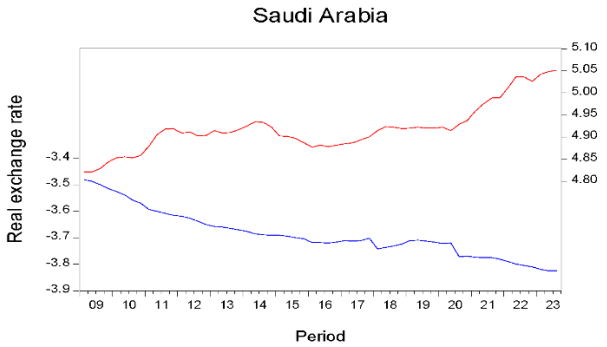
Note: These set of charts describe movements in two price fundamentals; that is, the log of the EU [manufacturing] import price index (**red line**) and inflation series (**blue line**) of the fourteen Global Southern countries. The countries so captured are Argentina, Brazil, China, Chile, India, Indonesia, Malaysia, Mexico, Peru, Philippines, Saudi Arabia, South Africa, Thailand, and Turkey. The review period covers the last fifteen years (2009Q1-2023Q3) in order to highlight the recent dynamics in the area of interest.

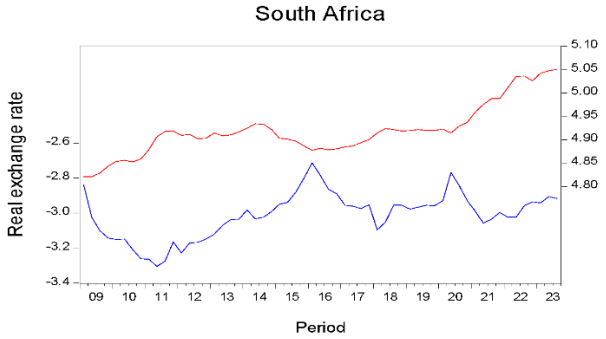
The preliminary results are robust to alternative import price proxies, i.e. industry and manufacturing import prices. The foregoing exploratory analyses have provided key insights that can be held onto pending proper modelling and formal data analyses. So far, we have highlighted that (i) global shocks that are capable of disrupting the global supply chain and causing a decline in global demand are antithetical to the growth potentials of emerging and developing economies in the Global South, although some are more resilient to absorb shocks than others; (ii) the logical shock analysis to explore is to trace impacts of positive shock to the global supply pressure index and negative shock to the global demand conditions index to the countries real outputs; (iii) a positive shock to the disaggregated EU import prices which the CBAM carbon tax signifies could lead to real exchange rate depreciation in the countries; (iv) the response of the countries' inflation rate to movements in the disaggregated EU import prices is positive in few of the countries but not readily clear in most of the others since a proper model is required to trace the transmission mechanism. Therefore, we seek more emphatic evidence from the modelling and data analysis to be able to properly advise policymakers on the effects of the carbon tax on the macroeconomic fundamentals of the Global South countries.

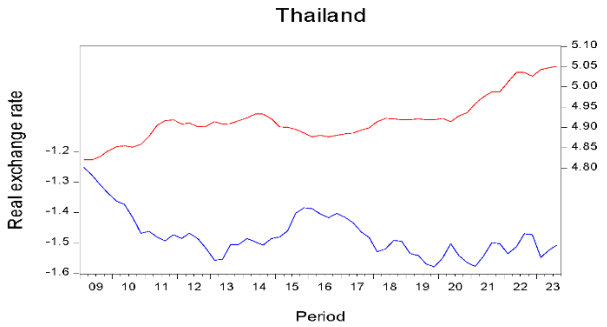
Figure 8: *Trends in EU industry import prices and real exchange rate in Global South countries*

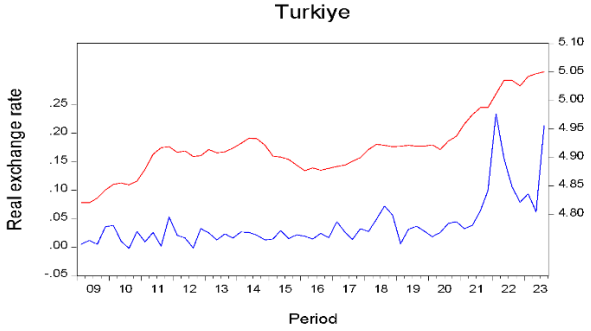






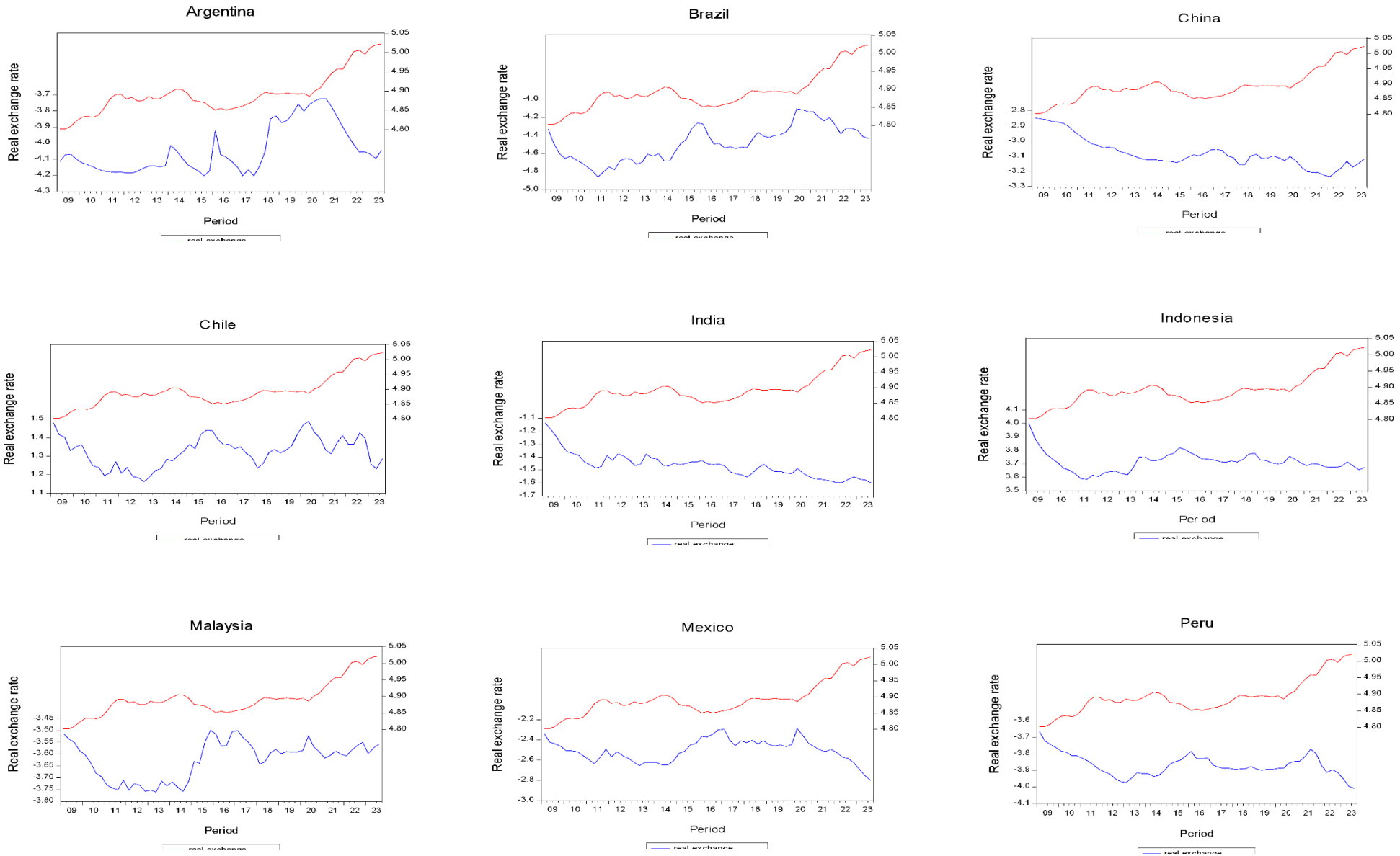


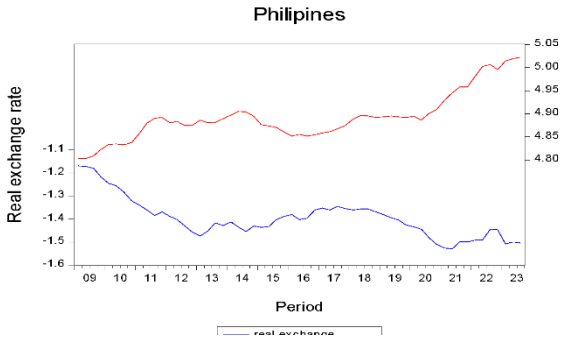


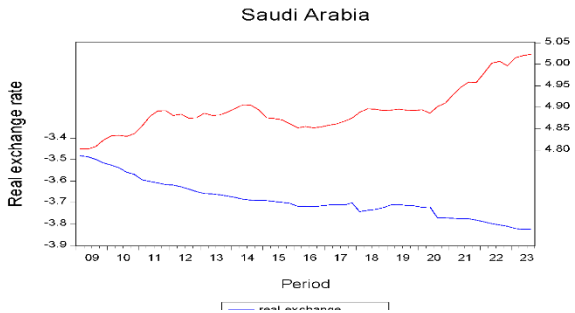


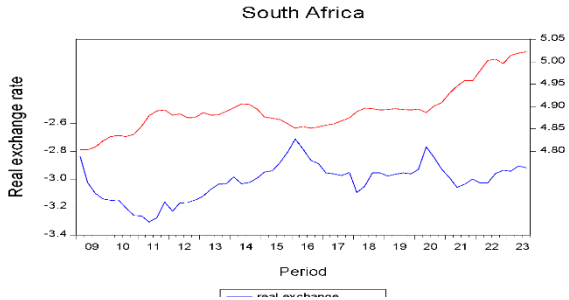
Note: These set of charts describe movements in two price fundamentals; that is, the log of the EU [industry] import price index (**red line**) and the log of the real exchange rate (**blue line**) of the fourteen Global Southern countries. The countries so captured are Argentina, Brazil, China, Chile, India, Indonesia, Malaysia, Mexico, Peru, Philippines, Saudi Arabia, South Africa, Thailand, and Turkey. The review period covers the last fifteen years (2009Q1-2023Q3) in order to highlight the recent dynamics in the area of interest.

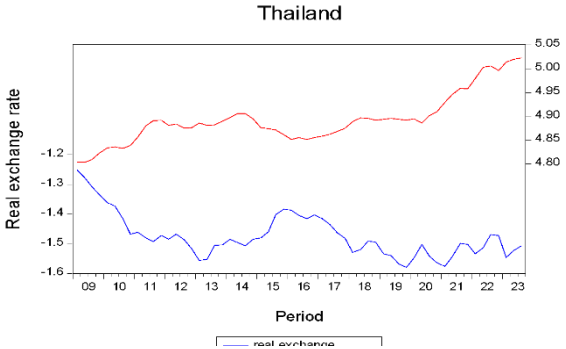
Figure 9: *Trends in EU manufacturing import prices and real exchange rate in Global South countries*

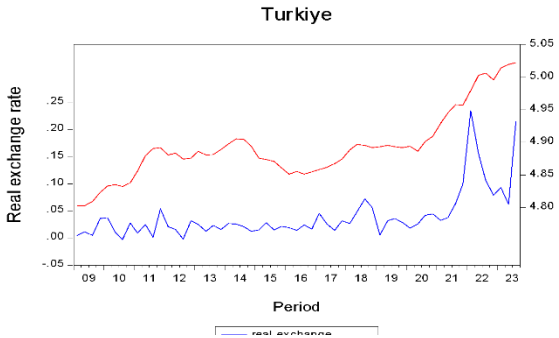












Note: These set of charts describe movements in two price fundamentals; that is, the log of the EU [manufacturing] import price index (**red line**) and the log of the real exchange rate (**blue line**) of the fourteen Global Southern countries. The countries so captured are Argentina, Brazil, China, Chile, India, Indonesia, Malaysia, Mexico, Peru, Philippines, Saudi Arabia, South Africa, Thailand, and Turkey. The review period covers the last fifteen years (2009Q1-2023Q3) in order to highlight the recent dynamics in the area of interest.

4.2 A note on measurement of CBAM effects

Prior to proper estimation, it becomes essential to establish a framework for measuring the CBAM effect in the formal model estimation. How do we quantify the carbon tax emanating from the CBAM in variable terms? An in depth understanding of the framework is relevant to provide the relevant guidance[12]. First, recall that CBAM constitutes a carbon pricing framework specifically focused on certain goods imported into the EU, aimed at curbing carbon leakage and ensuring carbon emission declines in the EU and non-EU supplier countries. Therefore, the strategy constitutes integrating environmental policy within international trade to make the latter more sustainable. Hence, the ensuing carbon tax can potentially influence international trade dynamics and supply chains. The foregoing represents justification for analyzing the CBAM within an analytical framework that incorporates international trade and assesses the indirect impact of the CBAM through the supply chain index series.

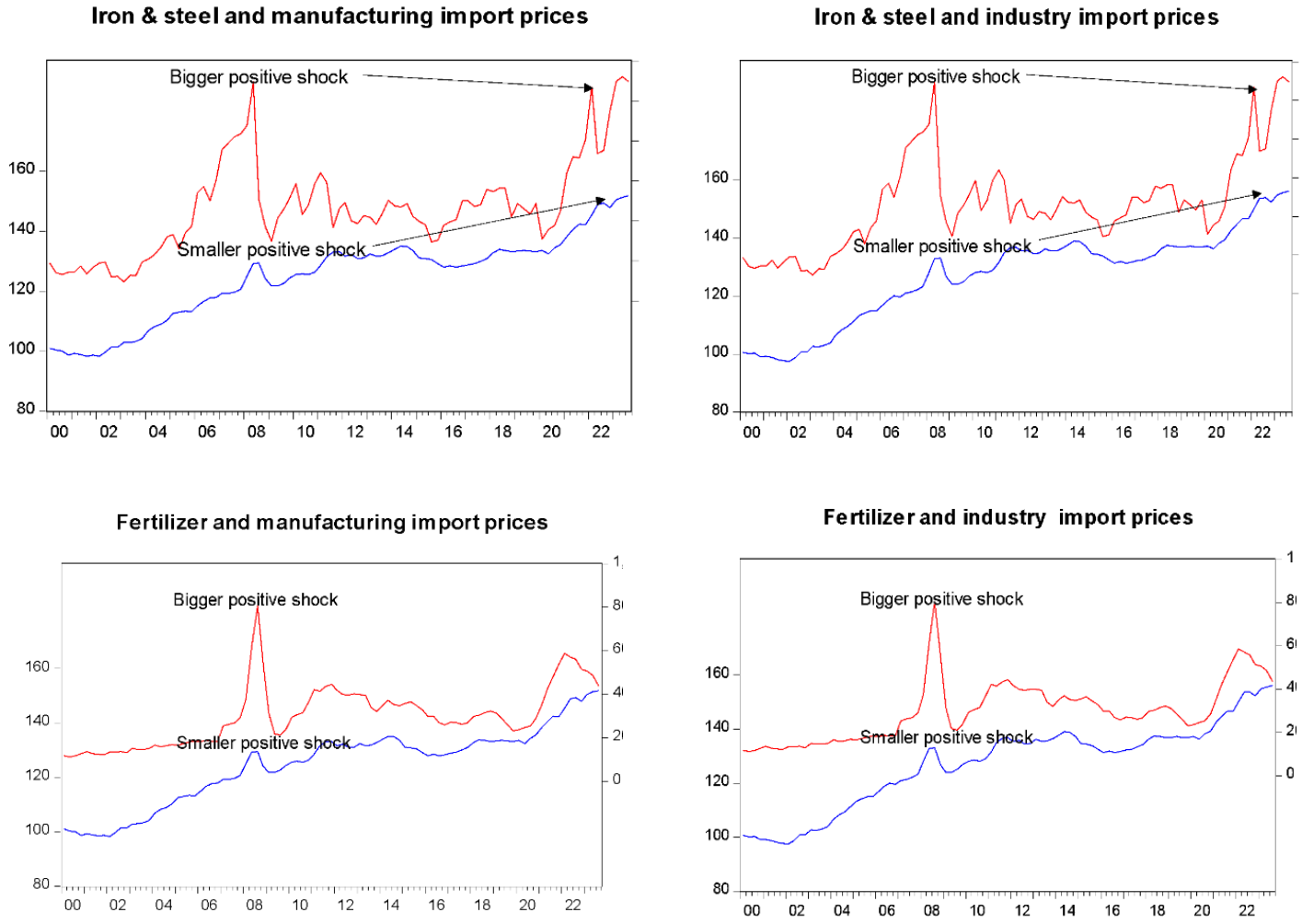
Looking at the direct measurement of the CBAM, the goal of the CBAM is to make imports reflect similar carbon footprint standards as goods produced within the EU. Therefore, the resulting carbon tax will be directly infused into the import prices of the goods captured in the mechanism. Since providing a level playing field for EU and non-EU producers requires that imported goods reflect their carbon footprints in their prices, thus, it is only logical to measure the carbon price through the import prices of products captured in the CBAM mechanism.

The CBAM program comprises two phases: one, the transition phase (October 2023 to December 2025), and two, the full implementation phase (January 2026 onwards). The transition phase largely involves documentation of imported goods and their direct & indirect emissions quantities but precludes any financial obligation from the importers or their representatives at this stage. This phase focuses on high carbon-intensive products/sectors, namely, (i) steel & iron, (ii) electricity, (iii) fertilizer, (iv) aluminum, (v) hydrogen, and (vi) cement. The focus on these critical carbon-intensive sectors helps to foster an overarching goal of strengthening industrial decarbonization; hence, it is not out of place for this study to measure the impact of this mechanism via the composite import price indices such as industrial and manufacturing import prices, the broad divisions that the sectors can be categorized.

Some stylized facts are offered in Figure 10 to suggest that shocks to the individual products targeted in the CBAM can be traced through the import prices. For example, in Figure 10, we show a strong positive connection between some selected CBAM product prices (restricted iron & steel and fertilizer prices due to data availability constraints) and aggregate EU import prices. In addition to the positive co-movement, we also show that the distinct and composite prices tend to respond to similar shocks to justify why the latter can be used to explore the shock due to the CBAM effect. Corresponding ideas to measure individual price fluctuations with composite price indices can be traced to seminal works such as Sims (1992), Bernanke, Boivin, & Eliasz (2005), Boivin and Ng (2006) for analyzing broader trends in macroeconomic modelling. Figure 10 demonstrates how both manufacturing and industry import prices experience positive shocks (albeit reduced shock) contemporaneously as there we positive shocks to the CBAM product prices around the global financial crisis period in the third quarter of 2008 and the fourth quarter of 2022, which may not be unconnected to some aftermaths of the war in Ukraine and the post-pandemic global inflation.

[12] Official documents on the policy can be found here: (1) https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism_en; (2) https://eur-lex.europa.eu/eli/reg/2023/956/oj/eng; (3) https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism_en#guidance; (4) https://www.europarl.europa.eu/RegData/etudes/BRIE/2022/698889/EPRS_BRI(2022)698889_EN.pdf.

Figure 10: *Selected CBAM products and composite import prices*



Further, the carbon price will not be charged until January 2026, when the CBAM comes into full implementation; thereafter, the policy can be extended to other sectors, such as chemicals, plastics where carbon leakages may also be sources of concern, and companies can buy CBAM certificates to cover for excess emissions embedded in the carbon-intensive goods brought into the EU. Thus, rather than examine the impacts of the CBAM via the individual product prices, it is more practical to employ macro variables to measure the CBAM effect, such as the composite import price indices to capture the backward and forward linkages of all the under-listed individual sectors with the outputs and prices of the aggregated manufacturing and industrial sectors. In other words, in the succeeding section, this study assesses the impacts of the CBAM on the macroeconomic fundamentals by shocking the import prices as the most probable route through which the policy will run its course.

5. Presentation and Discussion of Results

This section presents the formal results of the GVAR estimations analyzed via impulse responses of various macroeconomic fundamentals (real output, real exchange rate and inflation rate) to shocks to relevant global variables towards understanding the macroeconomic effects of the CBAM on the economies of the Global South countries. Following the estimation of the GVAR model discussed in Section 3, three shocks are explored to examine the indirect and direct effects of the CBAM. Indirectly, the effect of the CBAM is investigated via the global demand- and supply sides by examining the effect of global supply disruption shock (sudden jump in global supply pressure index) as well as shock to global demand (sudden decline in the index of global economic conditions) with and without accounting for the disaggregated EU import prices. On the other hand, the direct impact is probed via shocks to the disaggregated EU import prices which are instantaneously affected if the carbon tax is implemented on imported goods from abroad. Hence, the impact of a positive shock to EU import prices of manufacturing and industry goods (as limited by data availability) is explored. The impulse responses are rendered to help us understand the nature of the macroeconomic impacts: (i) in terms of direction (whether positive or negative effects); (ii) extent of the impacts (the size or magnitude of the impacts); and (iii) timespan of the impacts (whether the effect is short-lived or long-term)[13].

5.1 Empirical Analysis of Indirect Effects of CBAM [Demand & Supply Shocks]

Starting from the indirect impacts of the CBAM from the global demand side on the real output of the Global South (aggregate and disaggregated - Africa, the Arab region, Asia-Pacific, and Americas) and Global North regions (see the graphs in Figure 11 involving EU industry import prices as a control variable, and Figure 12 when the EU manufacturing import prices are considered as the control variable). The regions' responses to global demand shock with the two CBAM indicators are identical, suggesting that the two import prices transmit similar macroeconomic impacts abroad. From Figure 11, the negative demand shock simulated produces statistically significant negative impacts on the real outputs of the Global South (Aggregate and disaggregated - Africa, Arab region, Asia-Pacific, and Americas) and Global North regions across the entire forecast horizon (note that the lower and upper bound critical values share the same sign). Taking the average impacts over the entire horizon as the reference point, we observe that a one per cent negative demand shock triggered by CBAM causes Africa's real output to decline by about 2.1 per cent, Arab region by 1.8 per cent, Asia Pacific, 2.2 per cent (the magnitude falls by 2.4 per cent if China is excluded), Americas, 2.6 per cent, Global South as a unit, 2.2 per cent (it reduces by 2.4 per cent if we exclude China), and Global North as a unit, 1.8 per cent[14]. The widespread negative impacts do not only cut across; they are long-term since their effects fail to taper off over the 40-quarter forecast horizon.

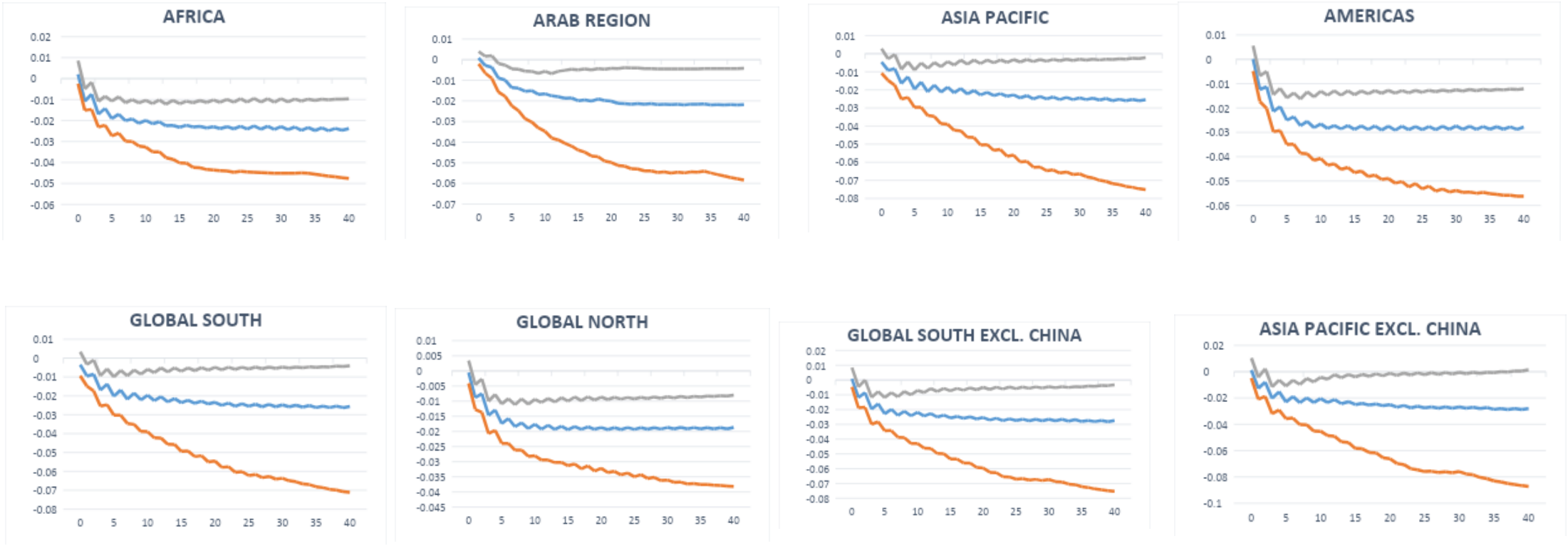
Despite the similarities, the negative output effects of the demand shock triggered by CBAM appear to be slightly higher for some regions when the EU import prices on manufactured goods are

[13] Readers are referred to standard papers in the literature such as (but not limited to) Aor et al. (2021), Salisu et al. (2023a&b), and Salisu (2024) for proper interpretation guide.
[14] In order to interpret in terms of percentages, the reported estimates are multiplied by 100 since the shock variable is expressed in units, whereas the target variable is in log form.

accounted for (see Figure 12). Looking also at the average over the forecast horizon, real output in Africa drops by about 2.2 per cent, about 1.9 per cent in the Arab region, 2.3 per cent in the Asia Pacific (there is a slightly higher magnitude when we discount for China), 2.7 per cent in the Americas, 2.3 per cent among the Global South countries (a greater decline in the magnitude of 2.4 per cent is observed when the sample excludes China), and 1.8 per cent among the Global North countries. The foregoing results are tenable based on counterfactual evidence where the results in Figures 11 & 12 are compared with a different set-up where the model excludes either of the disaggregated EU import prices (see Figure 13). When the import prices are excluded (as a control variable), the impacts are mostly negative, but they are all consistently inconsequential judging by the statistical insignificance of the median estimates (note that the lower and upper bound critical values now share alternate signs). In other words, it is safe to draw from the results that the disaggregated EU import prices have an important role to play in how global demand shocks influence macroeconomic fundamentals, particularly real outputs of the Global South countries and other EU trading partners.

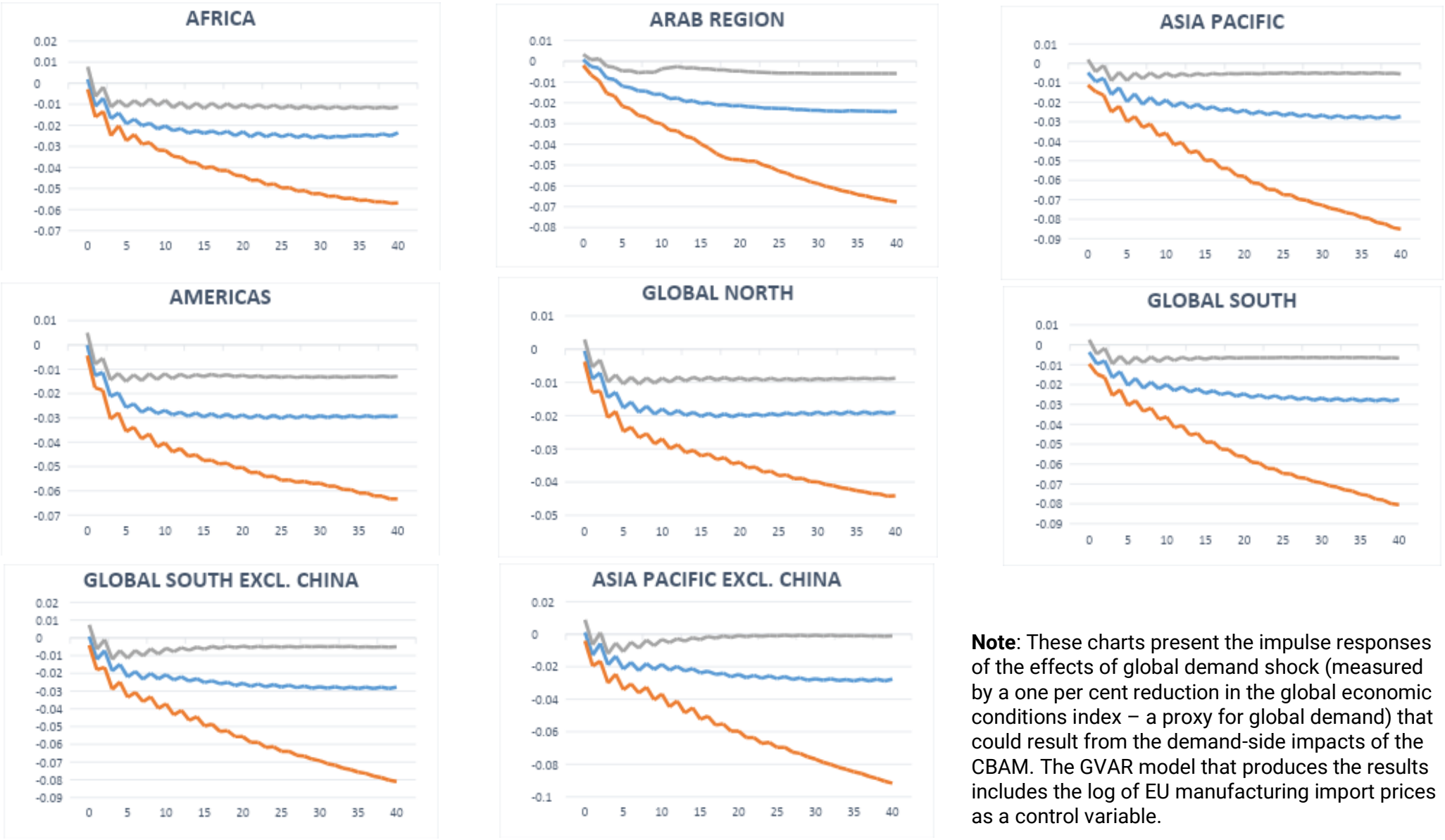
The ability of the CBAM to curb carbon leakage and aid the EU's clean transition process by blocking the transfer of carbon to Europe through importation is not under dispute (see, for example, Perdana and Vielle, 2022; Bellora and Fontagné, 2023; Cleary and Willcott, 2024; Chu et al., 2024; Hinterlang, 2024; Lin and Zhao, 2024). However, the results indicate associated costs on the economies of the EU's trading partners, emphasizing economies of the Global South being majorly developing and emerging economies prone to shocks. The observed welfare losses in terms of declined real output as the carbon tax policy affects global trade through weakened exports among the countries or when it triggers retaliatory trade policies and therefore affect economic activities, as such, disruptions to exports from the EU’s trading partners could lower investment and business confidence and slow down growth (Bertoldi et al., 2023; Tarr et al., 2023; Diaz et al. 2024; Jensen, 2024; Zhang et al., 2024). The implication of the foregoing for policymakers in the EU region is that the CBAM policy could have far-reaching negative welfare consequences on the countries if it is allowed to disrupt macroeconomic conditions.

Figure 11*: Impacts of global demand shock triggered by CBAM [EU industry import prices]*



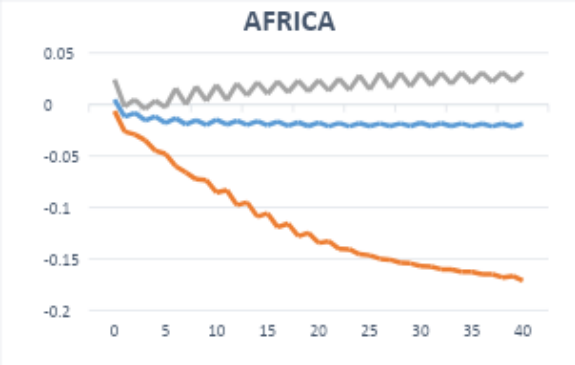
Note: These charts present the impulse responses of the effects of global demand shock (measured by a one per cent reduction in the global economic conditions index – a proxy for global demand) that could result from the demand-side impacts of the CBAM. The GVAR model that produces the results includes the log of EU industry import prices as a control variable. For want of space, the impulse responses are aggregated across regions: **Africa** (South Africa), **Arab region** (Saudi Arabia), **Asia Pacific** (China, India, Indonesia, Malaysia, Thailand, Philippines, and Turkey), **Americas** (Argentina, Brazil, Mexico, Chile, and Peru), the fourteen **Global South** countries, as well as the nineteen **Global North** countries (Australia, Austria, Belgium, Canada, Finland, France, Germany, Italy, Japan, Korea, Netherlands, Norway, New Zealand, Singapore, Spain, Sweden, Switzerland, UK, and US). While the **blue line** depicts the impulse responses, the **red** and **green lines** represent 95% lower and upper confidence bands, respectively. The long-term impacts of the shock are traced over forty (40) quarters.

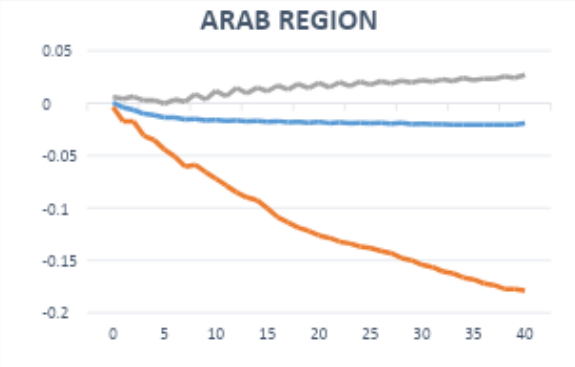
Figure 12: *Impacts of global demand shock triggered by CBAM [EU manufacturing import prices]*

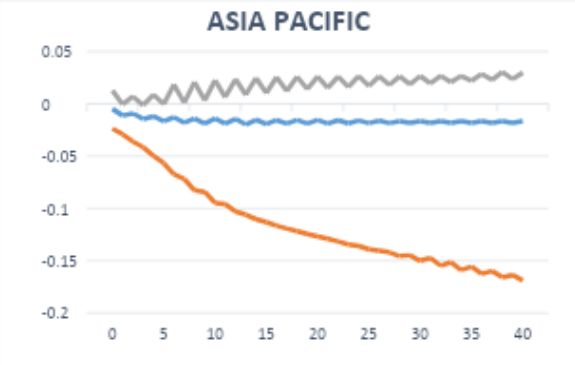


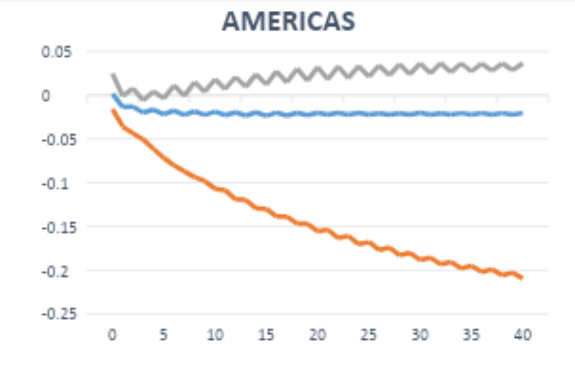
Note: These charts present the impulse responses of the effects of global demand shock (measured by a one per cent reduction in the global economic conditions index – a proxy for global demand) that could result from the demand-side impacts of the CBAM. The GVAR model that produces the results includes the log of EU manufacturing import prices as a control variable.

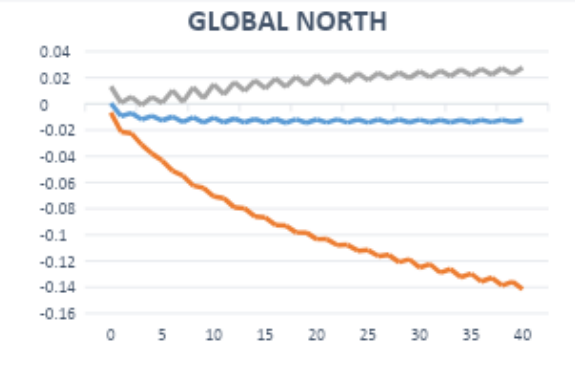
Figure 13*: Impacts of global demand shock without CBAM*

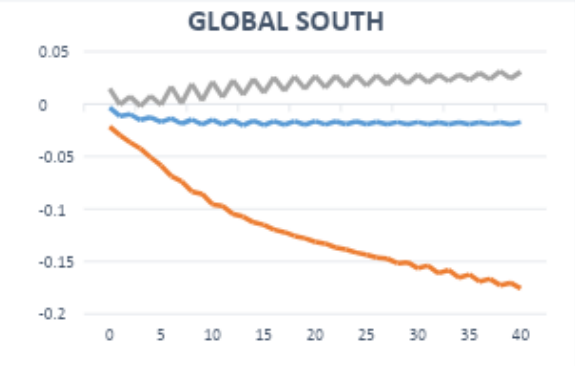


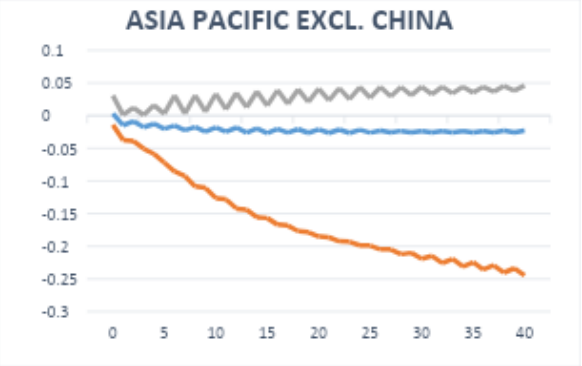


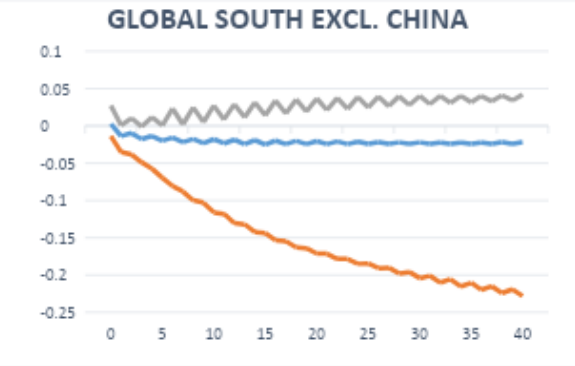












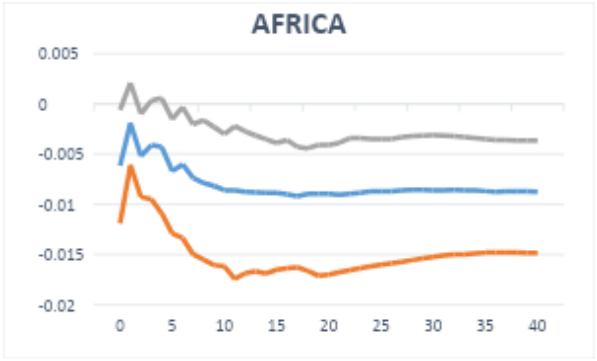
Note: These charts present the impulse responses of the effects of global demand shock (measured by a one per cent reduction in the global economic conditions index – a proxy for global demand) that could result from the demand-side impacts of the CBAM. The GVAR model that produces the results does not incorporate the EU import prices as a control variable.

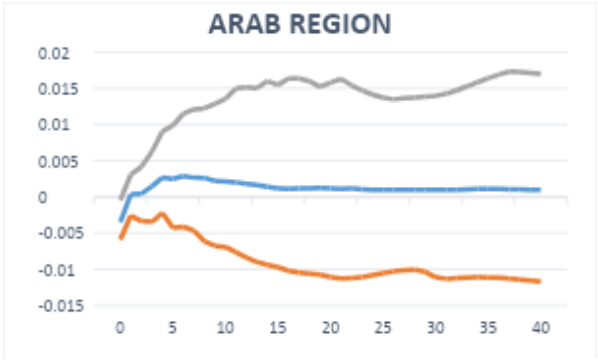
The supply-side of the indirect impacts of carbon tax on imported goods to the EU are examined, and the results presented in Figure 14 (includes EU industry import prices as a control variable), Figure 15 (accounts for EU manufacturing import prices as an intervening variable), and Figure 16 (excludes the consideration of import prices as a mediating variable in order to facilitate counterfactual analysis). Unlike the demand shock, the supply shock impacts are less emphatic. Of the four Global South sub-regions, the supply shock produces significant negative real output effects only in two, namely, Africa and the Americas, and fails to have a significant impact in the Arab region and Asia Pacific. On the whole, the effects are greater in the Global North than in the Global South when the geographic units are compared. These outcomes are indeed similar for the two EU import price proxies, thereby confirming the similarities in the results when the industrial and manufacturing import prices are controlled for.

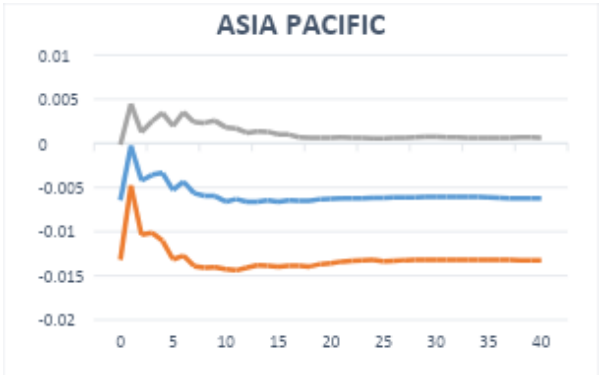
It is important to highlight that in situations where the CBAM impacts are statistically significant, the magnitudes of the supply-side shock impacts are lower than those of the demand-side shocks. We find that a 1% supply shock triggered by CBAM reduces real output in Africa by about 0.80 per cent, Americas, 0.86 per cent Asia Pacific excluding China, 0.86 per cent Global South excluding China, 0.79 per cent, and the Global North unit, 0.69 per cent (see Figure 14 for the results involving industry import prices over 40 quarters average). The results with manufacturing import prices are, however, comparatively lower over the same horizon: Africa, 0.73 per cent; Americas, 0.72 per cent; Asia Pacific excluding China, 0.72 per cent; Global South unit, excluding China, 0.66 per cent and the Global North unit, 0.58 per cent. Interestingly, also, all the estimates become statistically insignificant when we drop the EU import prices as controls (as in Figure 15), thus affirming the important role of the supply side shock in the propagation of the CBAM effect, although it is relatively lower than the demand side shock.

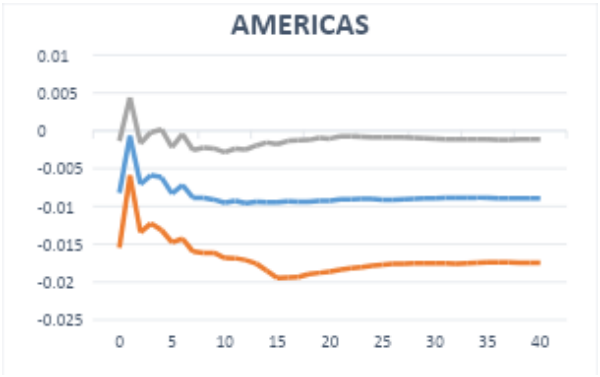
In summary, the outcomes from the indirect effects show that: (i) the CBAM impacts the economies of the Global South negatively in most of the cases; (ii) the demand-side effect of the CBAM is stronger than the supply-side; (iii) while the demand-side highlights the effects of EU manufacturing import prices more, the supply-side gives more importance to EU industry import prices; the expected impacts of CBAM are justified by showing that the macroeconomic impacts are statistically significant when the disaggregated EU import price data are incorporated into the modelling framework, whereas the estimates lose statistical significance when the import prices are excluded.

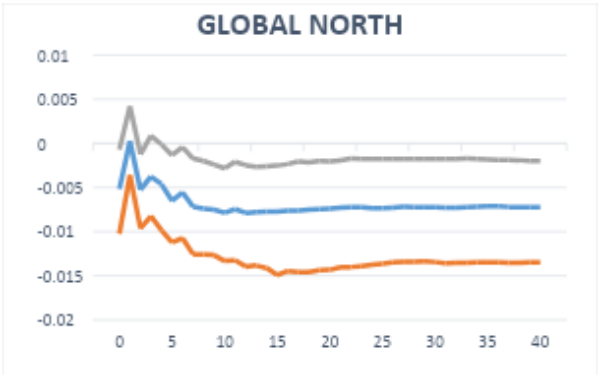
Figure 14: *Impacts of global supply shock triggered by CBAM [EU industry import prices]*

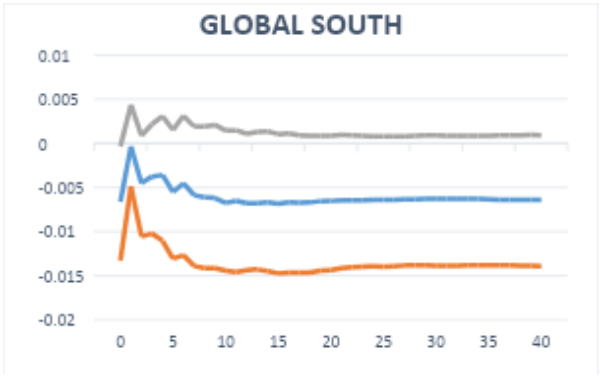


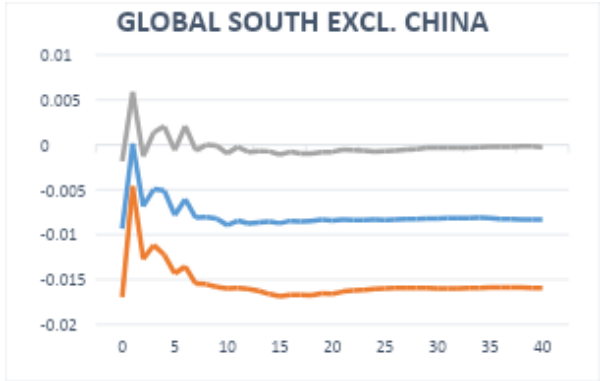


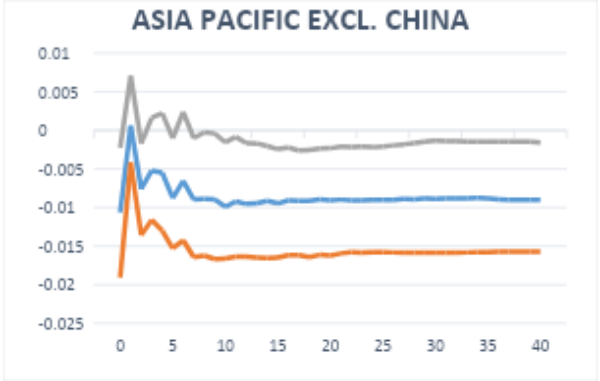






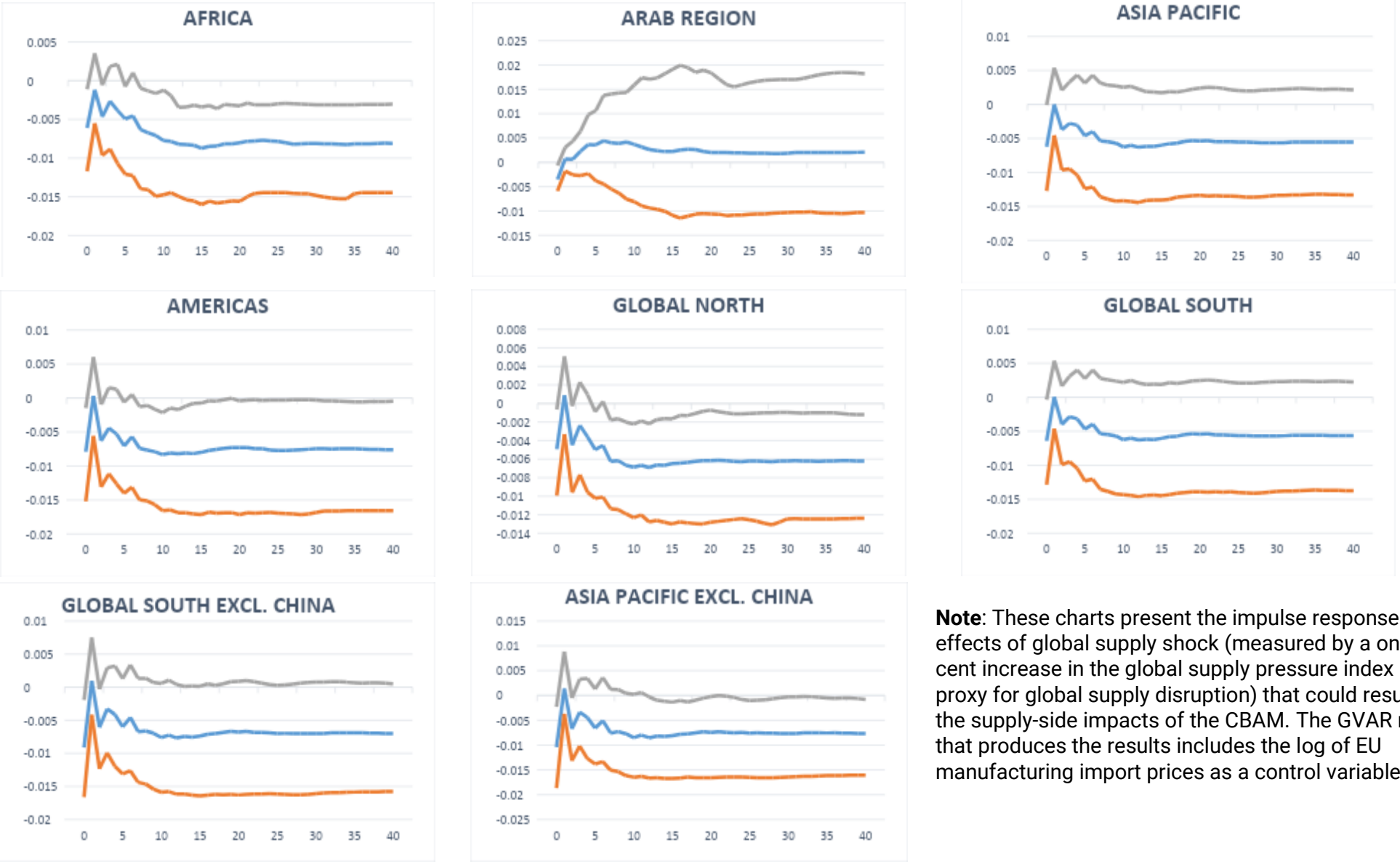






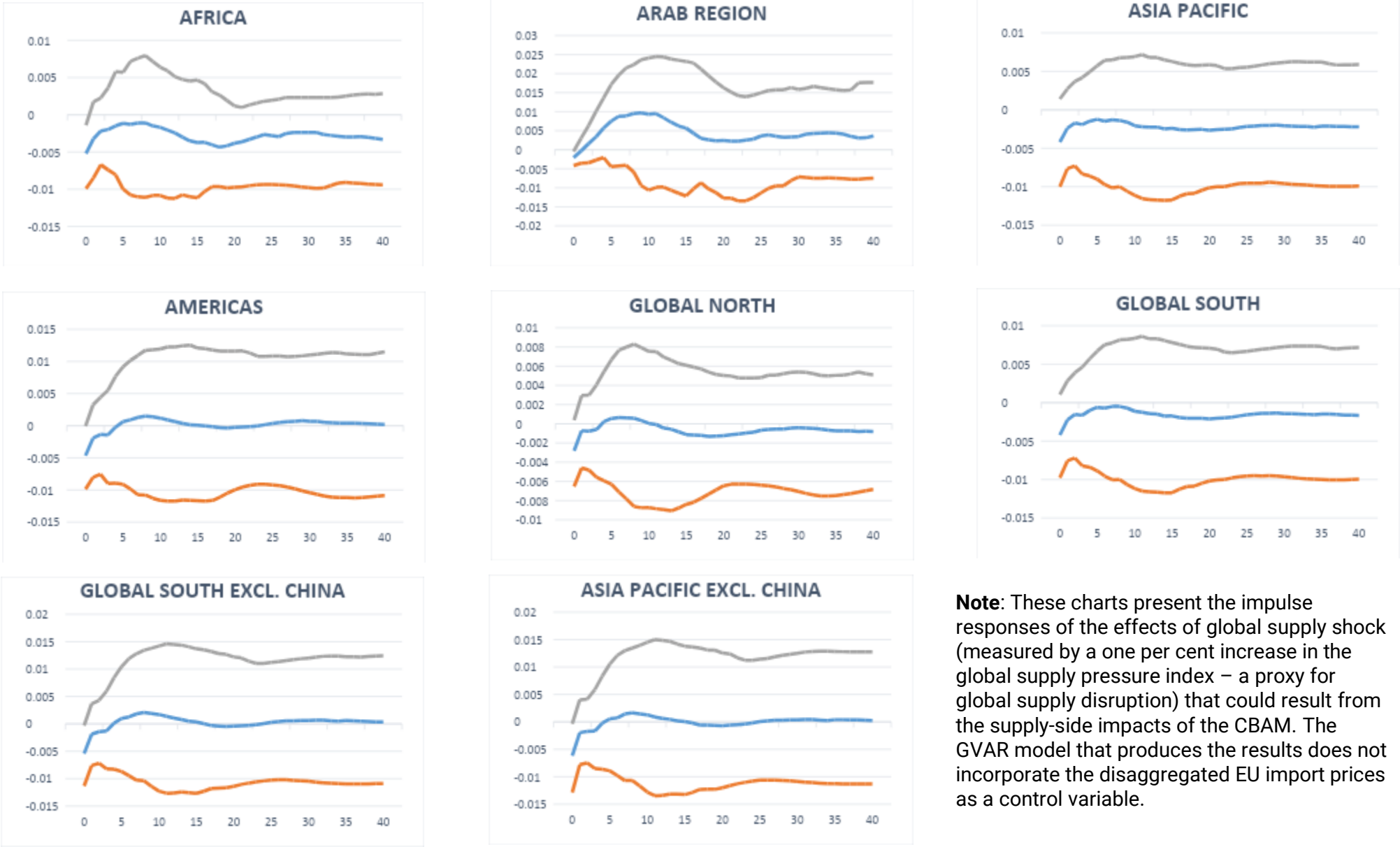
Note: These charts present the impulse responses of the effects of global supply shock (measured by a 1 per cent increase in the global supply pressure index – a proxy for global supply disruption) that could result from the supply-side impacts of the CBAM. The GVAR model that produces the results includes the log of EU industry import prices as a control variable.

Figure 15*: Impacts of global supply shock triggered by CBAM [EU manufacturing import prices]*



Note: These charts present the impulse responses of the effects of global supply shock (measured by a one per cent increase in the global supply pressure index – a proxy for global supply disruption) that could result from the supply-side impacts of the CBAM. The GVAR model that produces the results includes the log of EU manufacturing import prices as a control variable.

Figure 16*: Impacts of global supply shock without CBAM*



Note: These charts present the impulse responses of the effects of global supply shock (measured by a one per cent increase in the global supply pressure index – a proxy for global supply disruption) that could result from the supply-side impacts of the CBAM. The GVAR model that produces the results does not incorporate the disaggregated EU import prices as a control variable.

5.2 Empirical Analysis of Direct Effects of CBAM

Moving on to the direct (but simulated) macroeconomic impacts of the CBAM on the Global South countries here discussed. These results document the transmission of positive import price shock (from the intuition that the carbon tax will increase the prices of imported products to the European Union) on the countries' real outputs (Figures 17 & 18), real exchange rates (Figures 19 & 20), and inflation rates (Figures 21 & 22)[15]. The impulse responses measuring shocks to the two import prices – the log of EU industry import prices and the log of EU manufacturing import prices – are explored and reported with similarities. When we simulate the CBAM effects on real outputs (see Figures 17 & 18), we find that the CBAM impacts are sufficiently negative and statistically significant over the entire forecast horizon, which indicates that the negative impacts are permanent. On average, in response to the 10% CBAM carbon tax, the real output will be expected to decline by about 1.3 per cent in Africa, 0.98 per cent in the Arab region, 1.47 per cent in the Asia Pacific region (excluding China), 1.64 per cent in the Americas, and real output decline of 1.48 per cent in the Global South unit (excluding China) against 1.14 per cent in the Global North. These estimates are consistent over the two import price measures. Hence, whether directly or indirectly observed, the real output effect of the proposed carbon tax on EU imports is depressing.

Considering the price series such as real exchange rate, the CBAM policy portends real exchange rate depreciation in all the regions, including the Global North[16], with the exception of Saudi Arabia, whose economy remains insulated and competitive. The real worth of the goods will be costlier in the regions by 3.23 per cent in Africa, 2.25 per cent in the Asia Pacific, and 4.09 per cent in Latin America and the Caribbean. Hence, Africa and the Americas are the most affected among the Global Southern countries. Comparing the north and south divides, the Global North would experience about 0.73 per cent real exchange rate depreciation compared to the Global South with about 2.64 per cent real exchange rate depreciation. However, unlike the other macroeconomic variables, we fail to establish worthwhile inflation impacts in regions since the estimates are largely statistically insignificant.

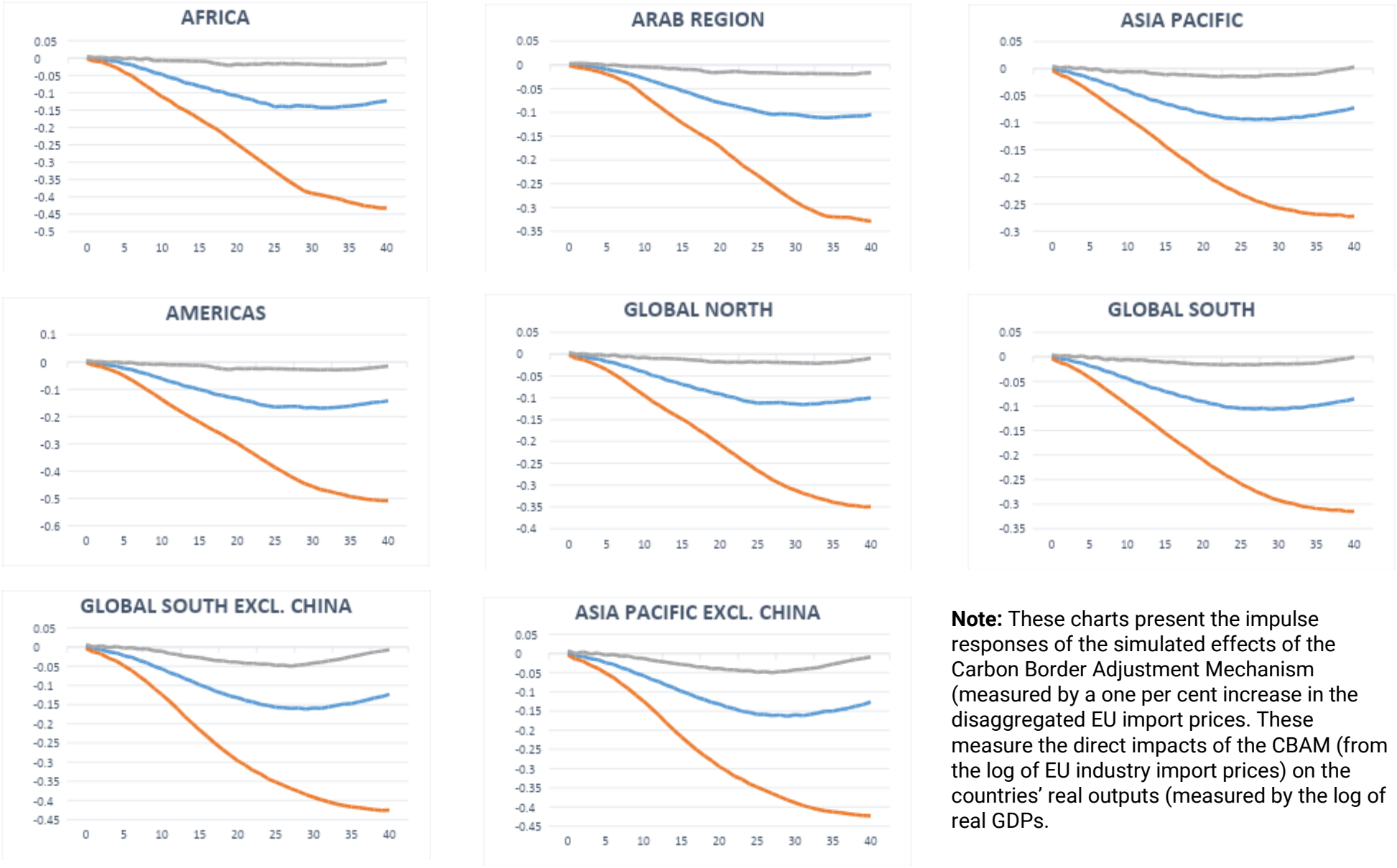
Therefore, the major impacts of the CBAM are expected to be felt on real outputs and exchange rates (see other corroborating evidence scattered in studies such as Maeno, 2023; Cuestas et al., 2024; Hensel et al., 2024; Jensen, 2024; Nguyen et al., 2024). Hence, the policymakers in the EU should be aware that the CBAM policy presents likely negative impacts for the EU's trading partners in terms of growth decline and real exchange rate deprecation, especially if trade wars are allowed to fester as a result, and the tax discourages consumption and causes supply chain disruptions. To mitigate these apprehensions, this study suggests to the European Commission to widen its exclusion net beyond not just low-carbon sectors but also less-advanced countries whose emission levels are below a certain predetermined threshold. Such economies and the worst-hit countries by the CBAM policy could also be major targets of climate finance funding to achieve two goals; one, to implement the Paris agreement, and two, to cushion the effect of the policy on the economies. These suggestions are anticipated to complement some of the recent proposals packaged by the European Commission including the exemption of small businesses that fall within an acceptable emission threshold, strengthening of compliance measures to forestall evasion, as well as automation and simplification of computation of emission content and ensuing financial liabilities[17].

[15] See the country-specific results in Appendix A1 to C2.

[16] Keep in mind that the shock variable and target variable are both expressed in log form.

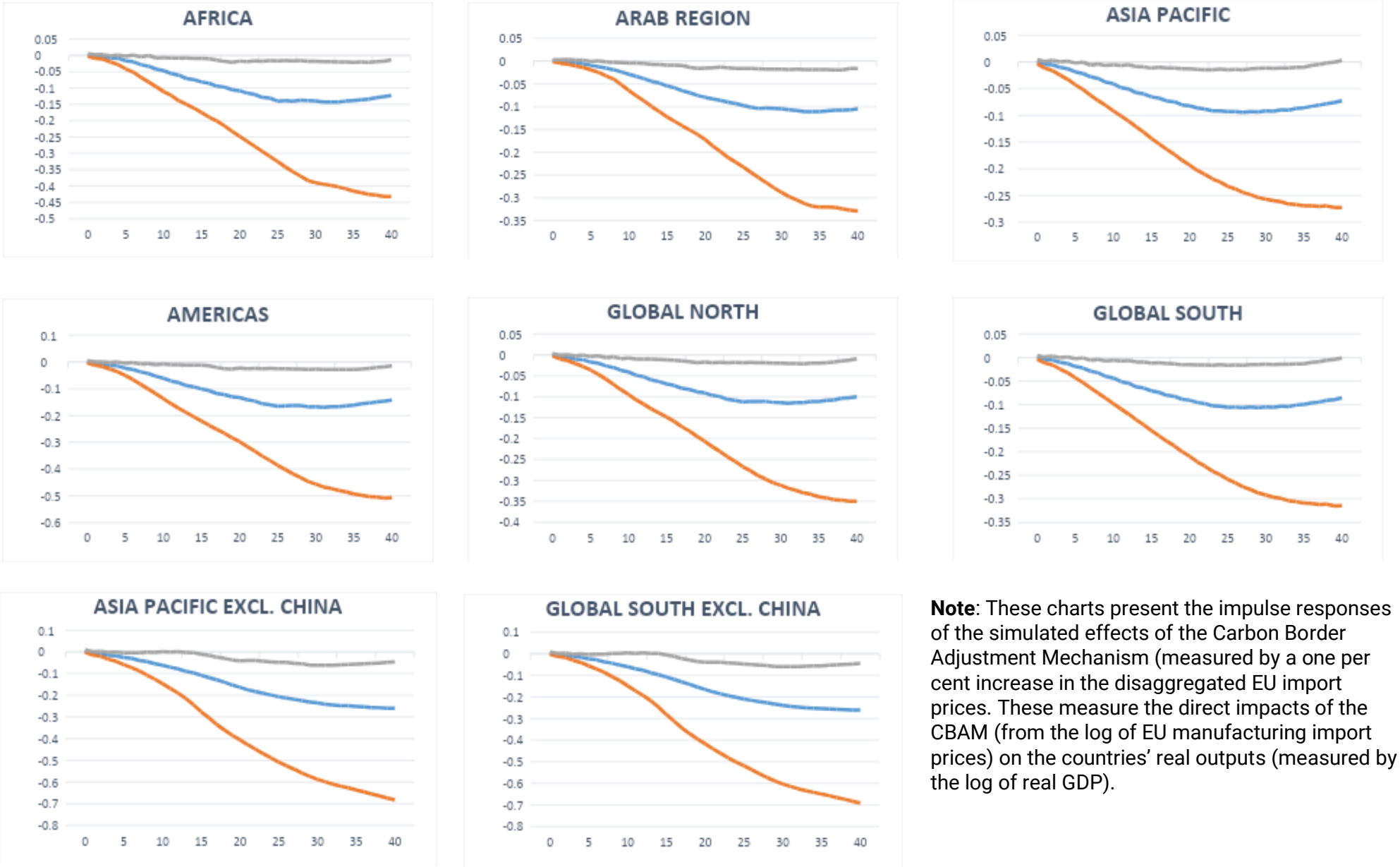
[17] See the pronouncement online at: https://taxation-customs.ec.europa.eu/news/cbam-new-commission-proposal-will-simplify-and-strengthen-2025-02-26_en.

Figure 17: *Simulated impacts of the CBAM on real outputs [via EU industry import prices]*



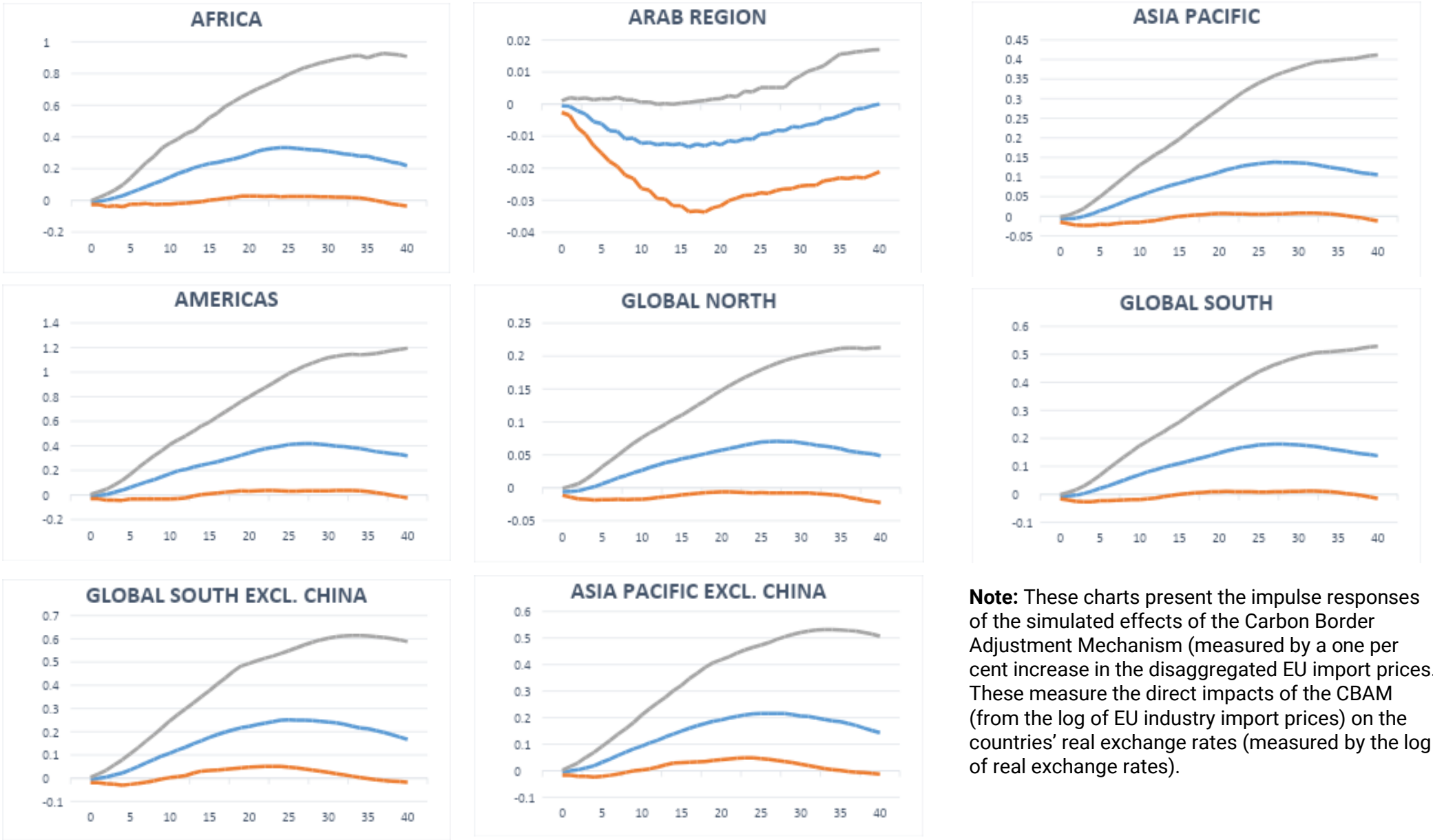
Note: These charts present the impulse responses of the simulated effects of the Carbon Border Adjustment Mechanism (measured by a one per cent increase in the disaggregated EU import prices. These measure the direct impacts of the CBAM (from the log of EU industry import prices) on the countries' real outputs (measured by the log of real GDPs.

Figure 18: *Simulated impacts of the CBAM on real outputs [via EU manufacturing import prices]*



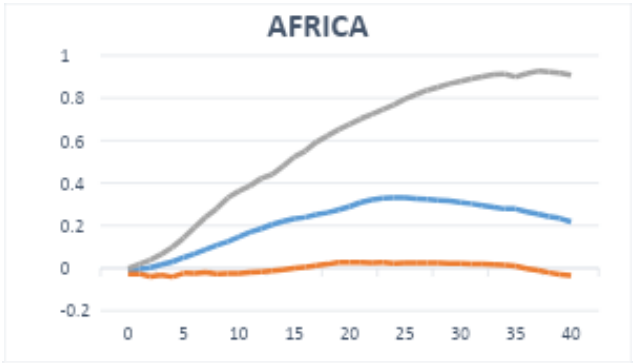
Note: These charts present the impulse responses of the simulated effects of the Carbon Border Adjustment Mechanism (measured by a one per cent increase in the disaggregated EU import prices. These measure the direct impacts of the CBAM (from the log of EU manufacturing import prices) on the countries' real outputs (measured by the log of real GDP).

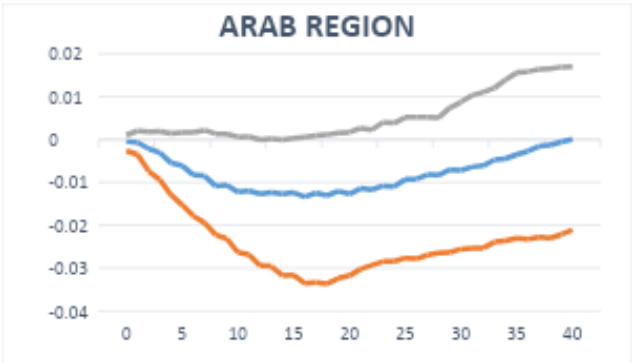
Figure 19: *Simulated impacts of the CBAM on real exchange rates [via EU industry import prices]*

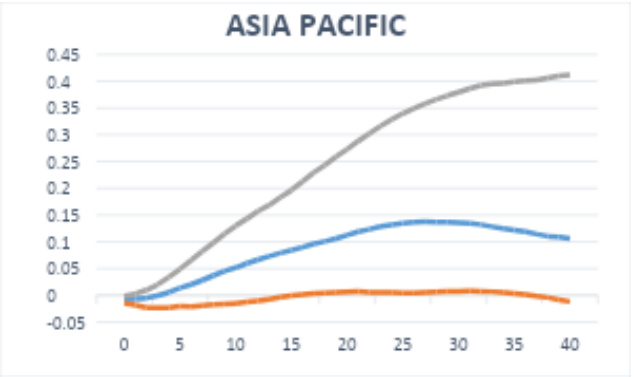


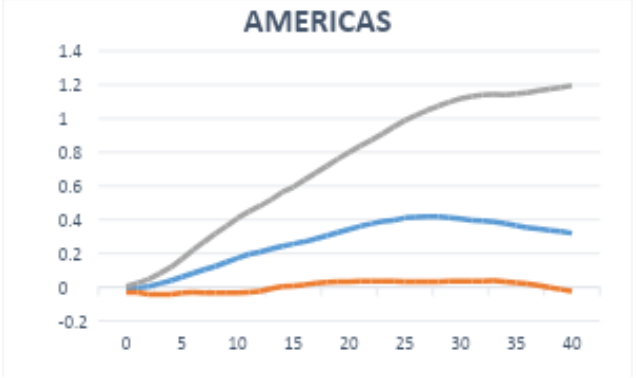
Note: These charts present the impulse responses of the simulated effects of the Carbon Border Adjustment Mechanism (measured by a one per cent increase in the disaggregated EU import prices. These measure the direct impacts of the CBAM (from the log of EU industry import prices) on the countries' real exchange rates (measured by the log of real exchange rates).

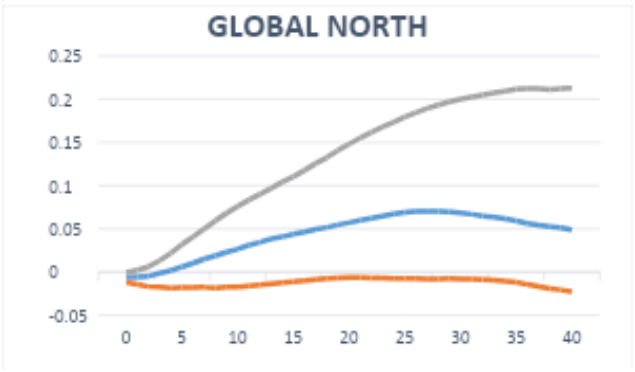
Figure 20: *Simulated impacts of the CBAM on real exchange rates [via EU manufacturing import prices]*

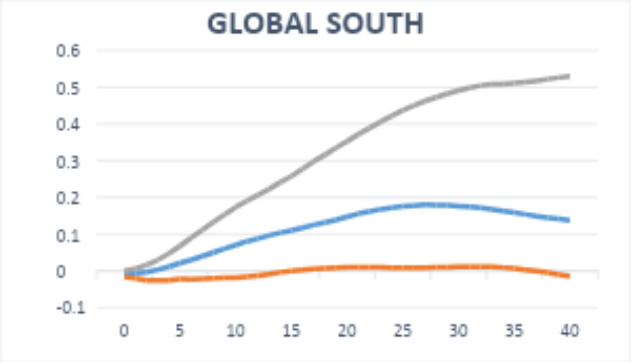


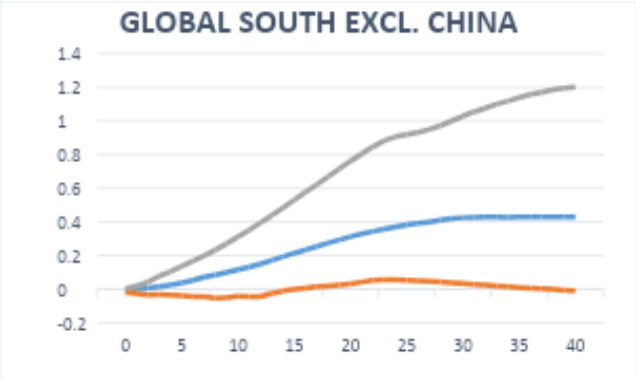


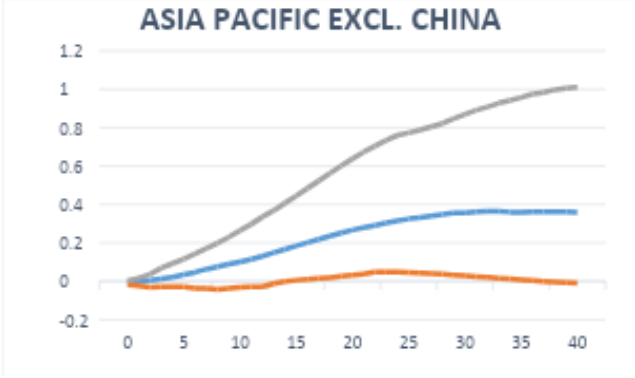






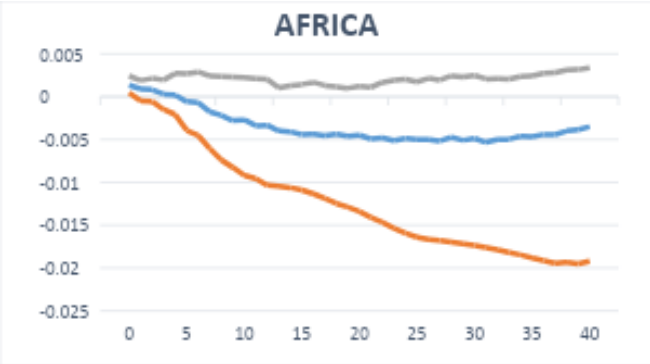


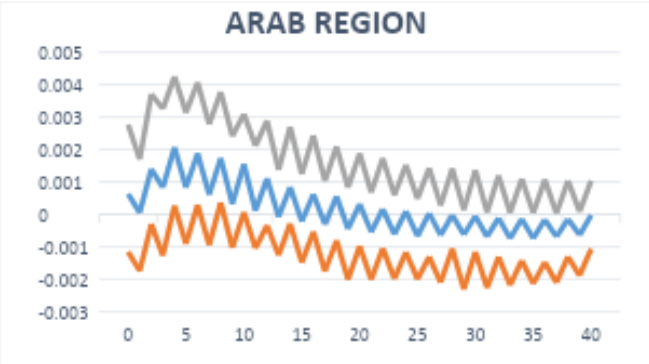


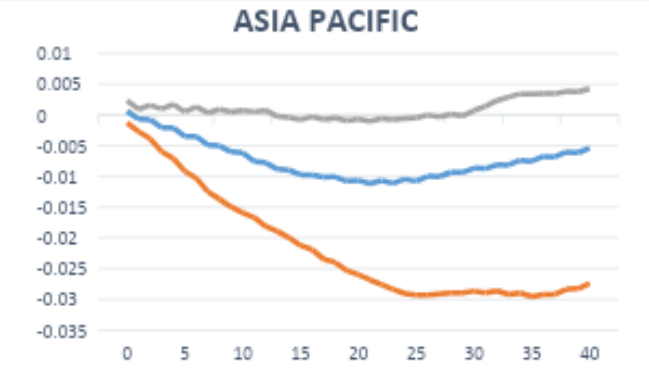


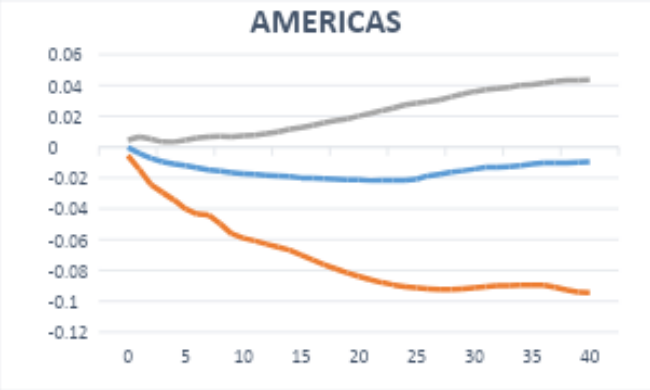
Note: These charts present the impulse responses of the simulated effects of the Carbon Border Adjustment Mechanism (measured by a one per cent increase in the EU import prices. These measure the direct impacts of the CBAM (from the log of EU manufacturing import prices) on the countries' real exchange rates (measured by the log of real exchange rates).

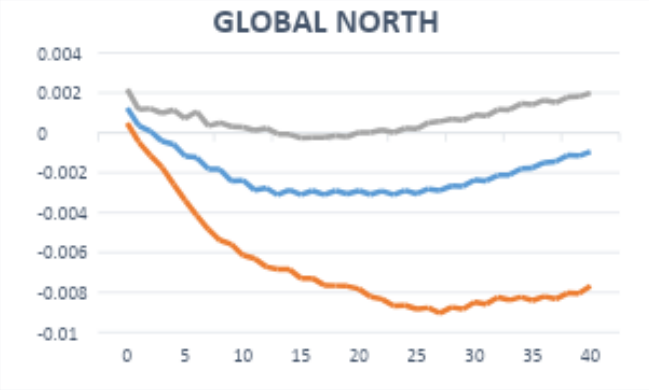
Figure 21*: Simulated impacts of the CBAM on inflation rates [via EU industry import prices]*

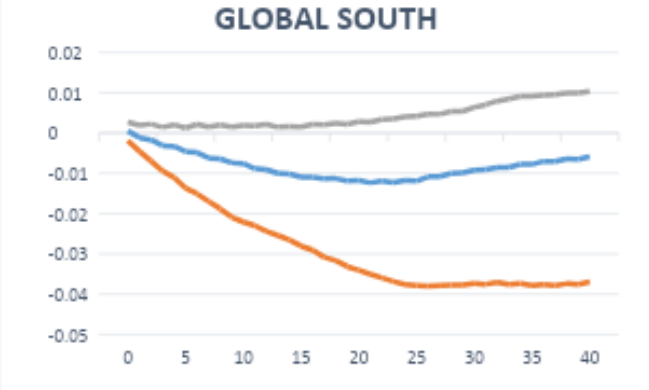


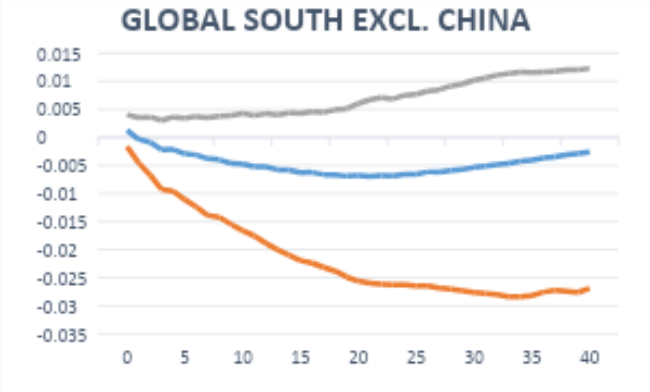


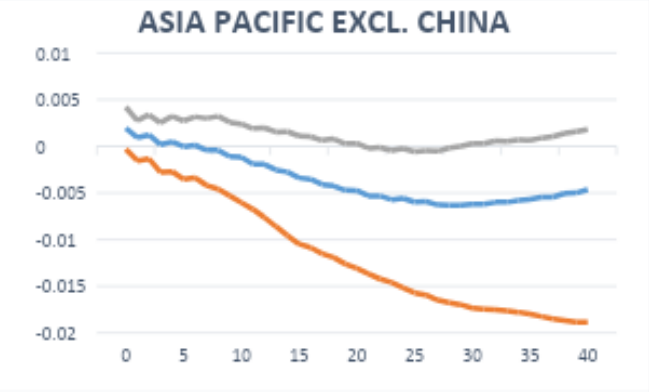






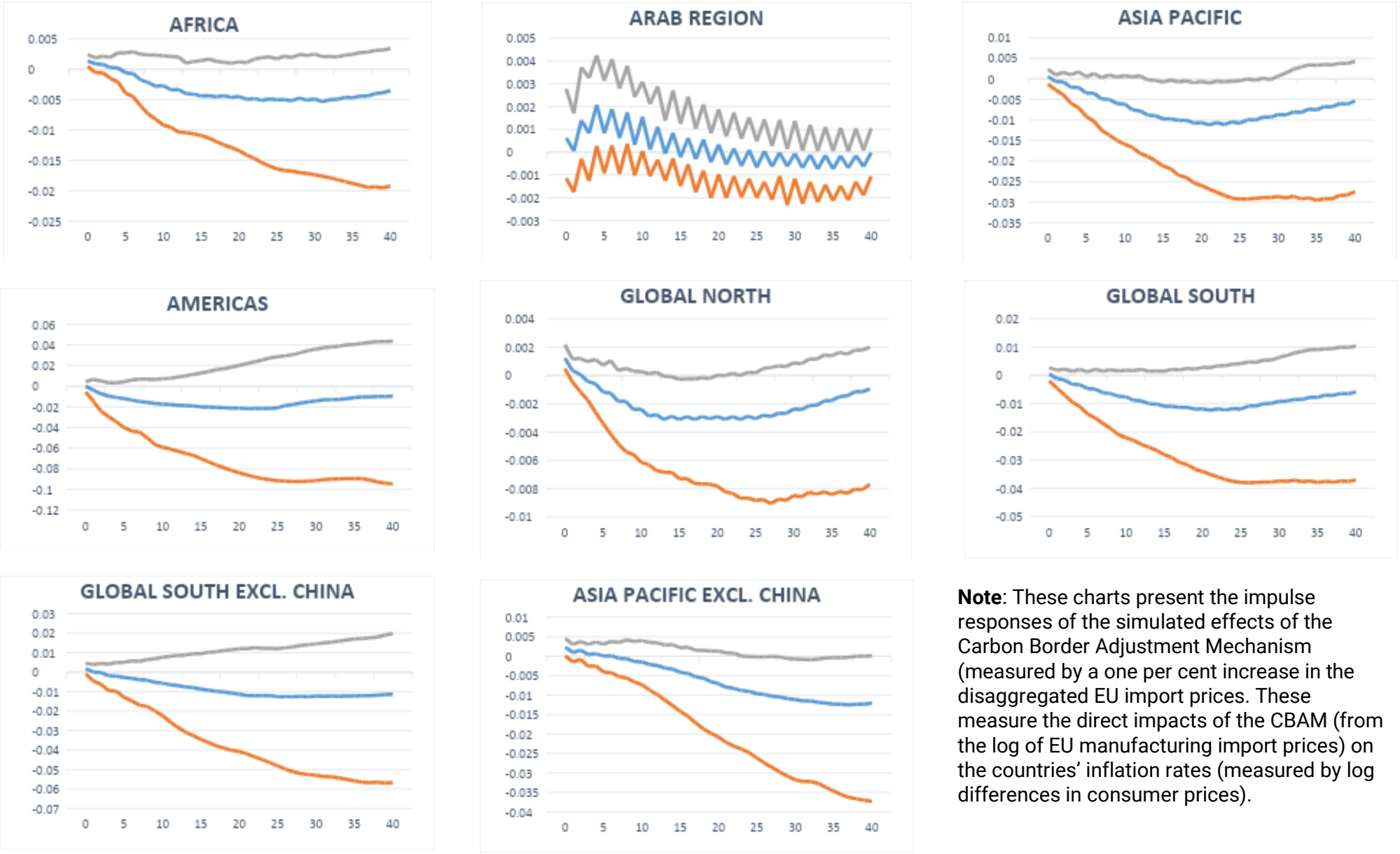






Note: These charts present the impulse responses of the simulated effects of the Carbon Border Adjustment Mechanism (measured by a one per cent increase in the disaggregated EU import prices. These measure the direct impacts of the CBAM (from the log of EU industry import prices) on the countries' inflation rates (measured by log differences in consumer prices).

Figure 22: *Simulated impacts of the CBAM on inflation rates [via EU manufacturing import prices]*



Note: These charts present the impulse responses of the simulated effects of the Carbon Border Adjustment Mechanism (measured by a one per cent increase in the disaggregated EU import prices. These measure the direct impacts of the CBAM (from the log of EU manufacturing import prices) on the countries' inflation rates (measured by log differences in consumer prices).

6. Conclusions

This study is motivated from a number of fronts. This policy paper seeks to understand how the Carbon Border Adjustment Mechanism policy aimed at imposing a carbon tax on imported goods in the European Union would affect the economies of the EU's trading partners, particularly those in the Global South divide. This has implications for the pursuance of global inclusiveness since the economies of the Global South are more susceptible to shocks, unlike their advanced economies counterparts in the Global North. Thus, when a large open economic unit like the EU pushes out the energy policy and international macroeconomic policy shock indicated in the CBAM, it could trigger energy/environmental policy responses as well as trade and macroeconomic responses in the trading partner's economies consequent upon the impacts received. This study, therefore, examines the potential welfare gains or losses in terms of the anticipated impacts of the policy on salient macroeconomic fundamentals (real output, real exchange rate, and inflation) in the Global South.

The macroeconomic impacts are therefore simulated with the aid of the GVAR technique that operationalizes the transmission of the energy policy shock through the international trade flows since the policy indicates a carbon tax on imports. The GVAR constructs individual country VAR models for each of the 33 advanced and emerging economies (inclusive of fourteen Global South countries grouped across four regions: Africa, Asia Pacific, Arab region, and the Americas) and connected through bilateral trade flows and relative economic size (i.e. GDP purchasing power parity). We trace the indirect macroeconomic effects of the shock through the demand-side (unexpected decline in the global economic conditions index) if the carbon tax policy significantly discourages consumption and exports from the countries to the EU, the supply-side (unanticipated spike in the global supply pressure index) if the policy result to trade wars and disruption to the global supply chain. The direct impacts are traced from the disaggregated EU import prices measured by the EU manufacturing import price index and the EU industry import price index, limited to those two due to data availability.

We find that demand-side shock triggered by CBAM leads to greater negative consequences on the real GDP of the Global Southern countries and the other EU's trading partners than the negative effects observed from supply-side shock triggered by CBAM. These findings are established via counterfactuals when the global demand- and supply-side variables are assessed with and without the inclusion of disaggregated EU import prices as control variables. When the direct impacts of CBAM are examined by shocking the disaggregated EU import prices directly, we also find evidence of significant negative effects on real GDP but of lower magnitudes, and evidence of exchange rate depreciation excluding Saudi Arabia (Arab region). However, the policy could not be described as inflationary, given that the impacts on inflation are sparsely statistically significant. In all, we highlight that the CBAM policy could have far-reaching negative welfare consequences especially because of its adverse potentials to disrupt global macroeconomic conditions (e.g. affecting supply chains & aggregate demand) and spiral into trade wars. The EU is therefore advised to consider the adoption of relevant mitigation measures to moderate the negative effects of the policy on global welfare outcomes. Such strategies could include exemption of poor and vulnerable countries particularly those with low emission levels (in addition to the prosed exclusion of low-carbon sectors) from the scheme as well as yielding to the call to set aside large chunk of the revenues accrued from the CBAM to finance climate action programs in countries that are not only poor but

are also adversely affected by the policy to fund their activities aimed at implementing the Paris agreement[18].

This study could have even been more extensive than it currently is, but for data limitation that permits only disaggregated analyses of EU industry and manufacturing import prices. It fails to cover the EU import prices of specific products targeted in the CBAM. Nonetheless, the depth of the analyses is far-reaching, and we reckon that the approach to studying the aggregate industry and manufacturing EU import prices is more practical to reflect inter-sectoral linkages and the multiplier effects of the CBAM policy to be assessed alongside other aggregate/macro variables.

[18] See the document: Declaration: Calling on the EU to direct revenues from the CBAM towards international climate finance – ERCST

References

Adediran, I. A., and Swaray, R. (2023). Carbon trading amidst global uncertainty: The role of policy and geopolitical uncertainty. Economic Modelling 123:106279. doi:10.1016/j.econmod.2023.106279.

Andersen, E. V., Shan, Y., Bruckner, B., Cerný, M., Hidiroglu, K., and Hubacek, K. (2024). The vulnerability of shifting towards a greener world: The impact of the EU's green transition on material demand. Sustainable Horizons, 10, 100087. https://doi.org/10.1016/j.horiz.2023.100087.

Antonakakis, N., Gabauer, D., and Gupta, R. (2019). International monetary policy spillovers: evidence from a time-varying parameter vector autoregression. International Review of Financial Analysis, 65, 101382.

Aor, R.L., Salisu, A.A., Okpe, I.J. (2021). The effects of U.S. monetary policy uncertainty shock on international equity markets. Annals of Financial Economics, 16(4), https://doi.org/10.1142/S2010495221500184

Aor, R.L., Salisu, A.A., Okpe, I.J. (2022). A Comparative Assessment of the Global Effects of US Monetary and Fiscal Policy Uncertainty Shocks. Advances in Decision Sciences, 25(4), 89-114.

Ascari, G., Bonam, D., and Smadu, A. (2024). Global supply chain pressures, inflation, and implications for monetary policy. Journal of International Money and Finance, 142, 103029. https://doi.org/10.1016/j.jimonfin.2024.103029.

Auer, R. A., Levchenko, A. A., and Sauré, P. (2019). International inflation spillovers through input linkages. Rev. Econ. Stat. 101 (3), 507–521.

Beaufils, T., Ward, H., Jakob, M., and Wenz, L. (2023). Assessing different European Carbon Border Adjustment Mechanism implementations and their impact on trade partners. Communications Earth & Environment, 4(131). https://doi.org/10.1038/s43247-023-00788-4.

Bellora, C., and Fontagné, L. (2023). EU in search of a Carbon Border Adjustment Mechanism. Energy Economics, 123, 106673. https://doi.org/10.1016/j.eneco.2023.106673.

Bernanke, B. S., Boivin, J., and Eliasz, P. S. (2005). Measuring the effects of monetary policy: A factor augmented vector autoregressive (FAVAR) approach. The Quarterly Journal of Economics, 120(1), 387-422. https://doi.org/10.1162/0033553053327452.

Bertoldi, M., Eriksgård, A., Orsini, K., and Pfeiffer, P. (2023). Where is the EU economy headed? The international dimension. Journal of Policy Modeling, 45, 817-832. https://doi.org/10.1016/j.jpolmod.2023.07.005.

Boivin, j., and Ng, S. (2006). Are more data always better for factor analysis? Journal of Econometrics, 132(1), 169-194. https://doi.org/10.1016/j.jeconom.2005.01.027.

Boto-García, D., Albert, J. F., and Gómez-Fernández, N. (2024). Carbon price shocks and tourism demand. Annals of Tourism Research, 108, 103813. https://doi.org/10.1016/j.annals.2024.103813.

Casoli, C., Manera, M., and Valenti, D. (2024). Energy shocks in the Euro area: Disentangling the pass-through from oil and gas prices to inflation. Journal of International Money and Finance, 147, 103154. https://doi.org/10.1016/j.jimonfin.2024.103154.

Chu, L., Do, T. N., Le, T. H. L., Ho, Q. A., and Dang, K. (2024). Carbon border adjustment mechanism, carbon pricing, and within-sector shifts: A partial equilibrium approach to Vietnam's steel sector. Energy Policy, 193, 114293. https://doi.org/10.1016/j.enpol.2024.114293.

Chudik, A. and Pesaran, M. H. (2016). Theory and practice of GVAR modelling. Journal of Economic Surveys, 30(1), 165-197. doi:10.1111/joes.12095.

Chudik, A., and Smith, V. (2013). The GVAR approach and the dominance of the US economy. Federal Reserve Bank of Dallas Working Paper No. 136. Available at https://www.dallasfed.org/~/media/documents/institute/wpapers/2013/0136.pdf.

Chudik, A., Grossman, V., and Pesaran, M. H. (2016). A multi-country approach to forecasting output growth using PMIs. Journal of Econometrics 192 (2):349–65. doi:10.1016/j.jeconom.2016.02.003.

Claeys, P., and Vasícek, B. (2019). Transmission of uncertainty shocks: Learning from heterogeneous responses on a panel of EU countries. International Review of Economics and Finance, 64, 62–83. https://doi.org/10.1016/j.iref.2019.05.012.

Cleary, S., and Willcott, N. (2024). Carbon pricing: Necessary but not sufficient. Finance Research Letters, 68, 106017. https://doi.org/10.1016/j.frl.2024.106017.

Cuestas, J. C., Monfort, M., and Ordonez, J. (2024). Gas price shocks, the current account, and the real exchange rate: An empirical analysis for the EU. Finance Research Letters, 60, 104840. https://doi.org/10.1016/j.frl.2023.104840.

di Mauro, F. and Pesaran, M.H. (2013), The GVAR Handbook: Structure and Applications of a Macro Model of the Global Economy for Policy Analysis, Oxford University Press, Oxford.

Diaz, E. M., Cunado, J., and Perez de Gracia, F. (2024). Global drivers of inflation: The role of supply chain disruptions and commodity price shocks. Economic Modelling, 140, 106860. https://doi.org/10.1016/j.econmod.2024.106860.

Feindt, S., Kornek, U., Labeaga, J. M., Sterner, T., and Ward, H. (2021). Understanding regressivity: Challenges and opportunities of European carbon pricing. Energy Economics, 103, 105550.

Fields, M., and Lindequist, D. (2024). Global spillovers of US climate policy risk: Evidence from EU carbon emissions futures. Energy Economics, 139, 107931. https://doi.org/10.1016/j.eneco.2024.107931.

Hensel, J., Mangiante, G., & Moretti, L. (2024). Carbon pricing and inflation expectations: Evidence from France. Journal of Monetary Economics, In Press. https://doi.org/10.1016/j.jmoneco.2024.103593.

Hinterlang, N. (2024). Different effects of carbon pricing and border adjustment in Germany and Spain. Economic Modelling, 141, 106840. https://doi.org/10.1016/j.econmod.2024.106840.

Jensen, L. (2024). The economic and fiscal transition costs of global climate mitigation in fossil fuel export dependent economies. Resources Policy, 96, 105234. https://doi.org/10.1016/j.resourpol.2024.105234.

Lin, B., and Zhao, H. (2024). Threatening the Poor? The economic impacts of carbon border adjustment mechanism on developing countries. Structural Change and Economic Dynamics, 71, 582-593.

Maeno, K. (2023). Identifying critical sectors in the restructuring of low-carbon global supply chains. Energy Economics, 127, 107025. https://doi.org/10.1016/j.eneco.2023.107025.

Mohaddes, K. and M. Raissi (2024). Compilation, Revision and Updating of the Global VAR (GVAR) Database, 1979Q2-2023Q3. University of Cambridge: Judge Business School (mimeo). https://www.econ.cam.ac.uk/people-files/faculty/km418/GVAR%20Database%20(1979Q2-2023Q3).pdf.

Mohaddes, K., and Raissi, M. (2020). Compilation, revision and updating of the Global VAR (GVAR) database, 1979Q2– 2019Q4. University of Cambridge: Judge Business School (mimeo).

Nguyen, D. B., Nong, D., Simshauser, P., and Pham, H. (2024). Economic and supply chain impacts from energy price shocks in Southeast Asia. Economic Analysis and Policy, 84, 929–940. https://doi.org/10.1016/j.eap.2024.09.025.

Pan, X., and Liu, S. (2024). The development, changes and responses of the European Union carbon border adjustment mechanism in the context of global energy transition. World Development Sustainability, 4, 100148. https://doi.org/10.1016/j.wds.2024.100148.

Perdana, S., and Vielle, M. (2022). Making the EU Carbon Border Adjustment Mechanism acceptable and climate friendly for least developed countries. Energy Policy, 170, 113245. https://doi.org/10.1016/j.enpol.2022.113245.

Pesaran, H., Schuermann, T., and Weiner, S. M. (2004). Modeling regional interdependencies using a global error-correcting macroeconometric model. Journal of Business and Economic Statistics, 22(2), 129–162.

Salisu, A. A., Adediran, I. A., and Gupta, R. (2021): A Note on the COVID-19 Shock and Real GDP in Emerging Economies, Emerging Markets Finance and Trade, https://doi.org/10.1080/1540496X.2021.1981854.

Salisu, A. A., Gupta, R., & Demirer, R. (2022). The financial US uncertainty spillover multiplier: Evidence from a GVAR model. International Finance, 25(3), 313-340. https://doi.org/10.1111/infi.12414.

Salisu, A. A., Gupta, R., & Olaniran, A. (2023a). The effect of oil uncertainty shock on real GDP of 33 countries: a global VAR approach. Applied Economics Letters, 30(3), 269-274. https://doi.org/10.1080/13504851.2021.1983134.

Salisu, A. A., Gupta, R., Ntyikwe, S., & Demirer, R. (2023b). Gold and the global financial cycle. Quantitative Finance and Economics, 7(3), 475–490. https://doi.org/10.3934/qfe.2023024.

Salisu, A.A. (2024). India and the Rest of the World: Analyses of International Monetary Policy Spillovers. Bulletin of Monetary Economics and Banking, 27(3), https://doi.org/10.59091/2460-9196.2280.

Salisu, A.A., Ayinde, T.O., Gupta, R., Wohar, M.E. (2022b) Global Evidence of the COVID-19 Shock on Real Equity Prices and Real Exchange Rates: A Counterfactual Analysis with a Threshold-Augmented GVAR Model. Finance Research Letters, 47, https://doi.org/10.1016/j.frl.2021.102519.

Samuelson, P. A. (1948). Economics, an Introductory Analysis. McGraw-Hill Company.

Sikiru, A. A., & Salisu, A. A. (2024). A global VAR analysis of global and regional shock spillovers to West African countries. The Singapore Economic Review, 69(02), 543-566. https://doi.org/10.1142/S0217590821410034.

Sikiru, A. A., and Salisu, A. A. (2020). A global VAR analysis of global and regional shock spillovers to West African countries, Singap. Econ. Rev. (2020), doi: 10.1142/ S0217590821410034.

Simis, C. A., (1992). Interpreting the macroeconomic time series facts: The effect of monetary policy. European Economic Review, 36(5), 975-1000. https://doi.org/10.1016/0014-2921(92)90041-T.

Smith, L.V. and Galesi, A. (2014), "GVAR toolbox 2.0", available at: https://sites.google.com/site/gvarmodelling/gvar-toolbox.

Sun, X., Mi, Z., Cheng, L., Coffman, D., and Liu, Y. (2024). The carbon border adjustment mechanism is inefficient in addressing carbon leakage and results in unfair welfare losses. Fundamental Research, 4, 660–670. https://doi.org/10.1016/j.fmre.2023.02.026.

Tarr, D.G., Kuznetsov, D. E., Overland, I. and Vakulchuk, R. (2023). Why carbon border adjustment mechanisms will not save the planet but a climate club and subsidies for transformative green technologies. Energy Economics, 122, 106695. https://doi.org/10.1016/j.eneco.2023.106695.

Timilsina, G. R. (2022). Carbon taxes. Journal of Economic Literature, 60 (4), 1456–1502.

Tumala, M. M., Salisu, A. A., Atoi, N. V., and Yaaba, B. N. (2021). International monetary policy spillovers to emerging economies in Sub-Saharan Africa: A global VAR analysis. Scientific African, 14, e00976. https://doi.org/10.1016/j.sciaf.2021.e00976.

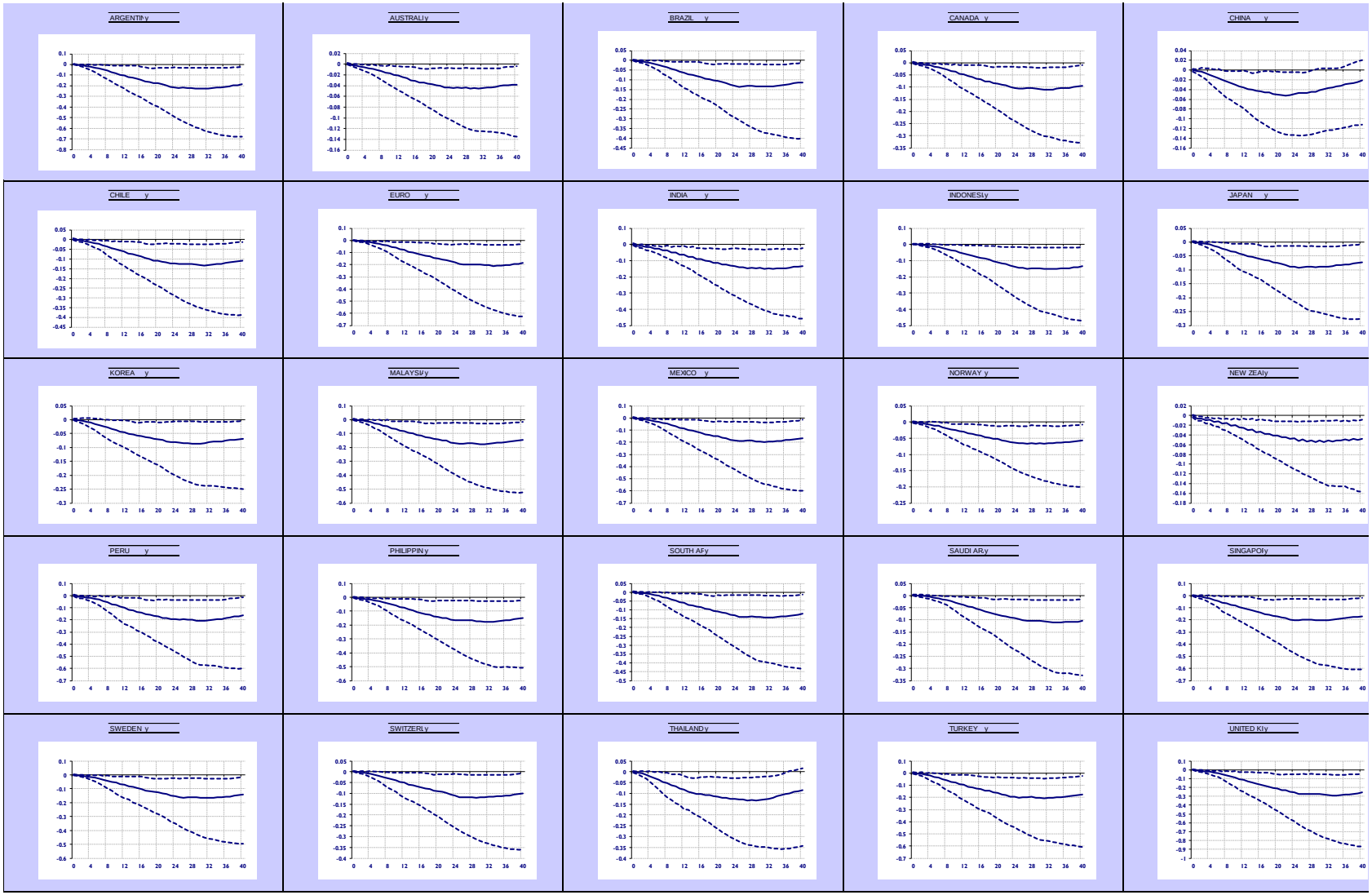
Wu, J., Pan, Y. and Zhu, Q. (2014). The conditions and potential of RMB as an international reserve currency. China Finance Review International, 4(2), 103-123. https://doi.org/10.1108/CFRI-07-2012-0077.

Zhang, K., Yao, Y., Qian, X., Zhang, Y., Liang, Q., and Wei, Y. (2024). Could the EU carbon border adjustment mechanism promote climate mitigation? An economy-wide analysis. Advances in Climate Change Research, 15, 557e571. https://doi.org/10.1016/j.accre.2024.05.002.

SPES Sustainability performances, evidence & scenarios

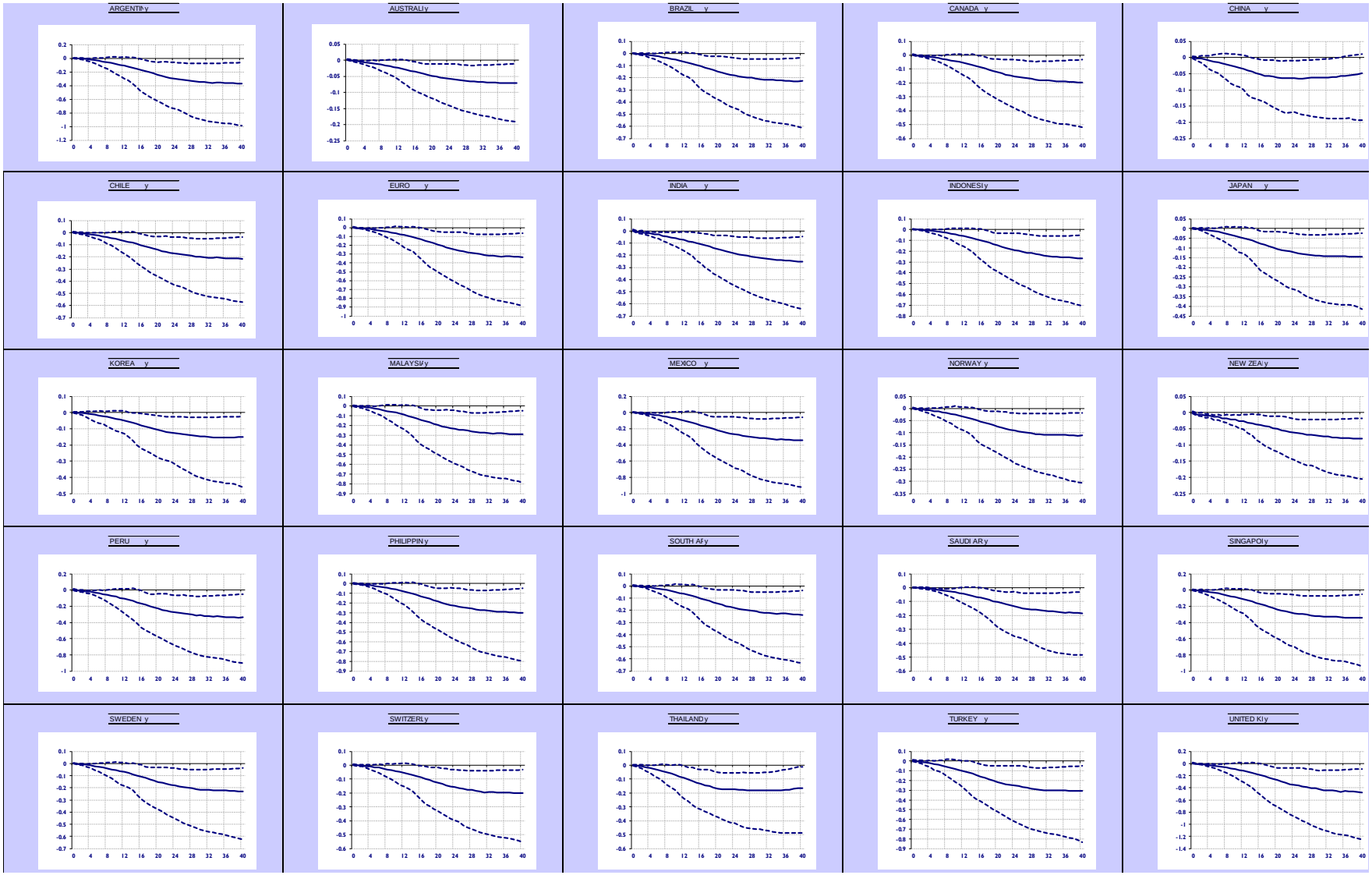
Appendix A1

Simulated impacts of the CBAM on real outputs [via EU industry import prices]



Appendix A2

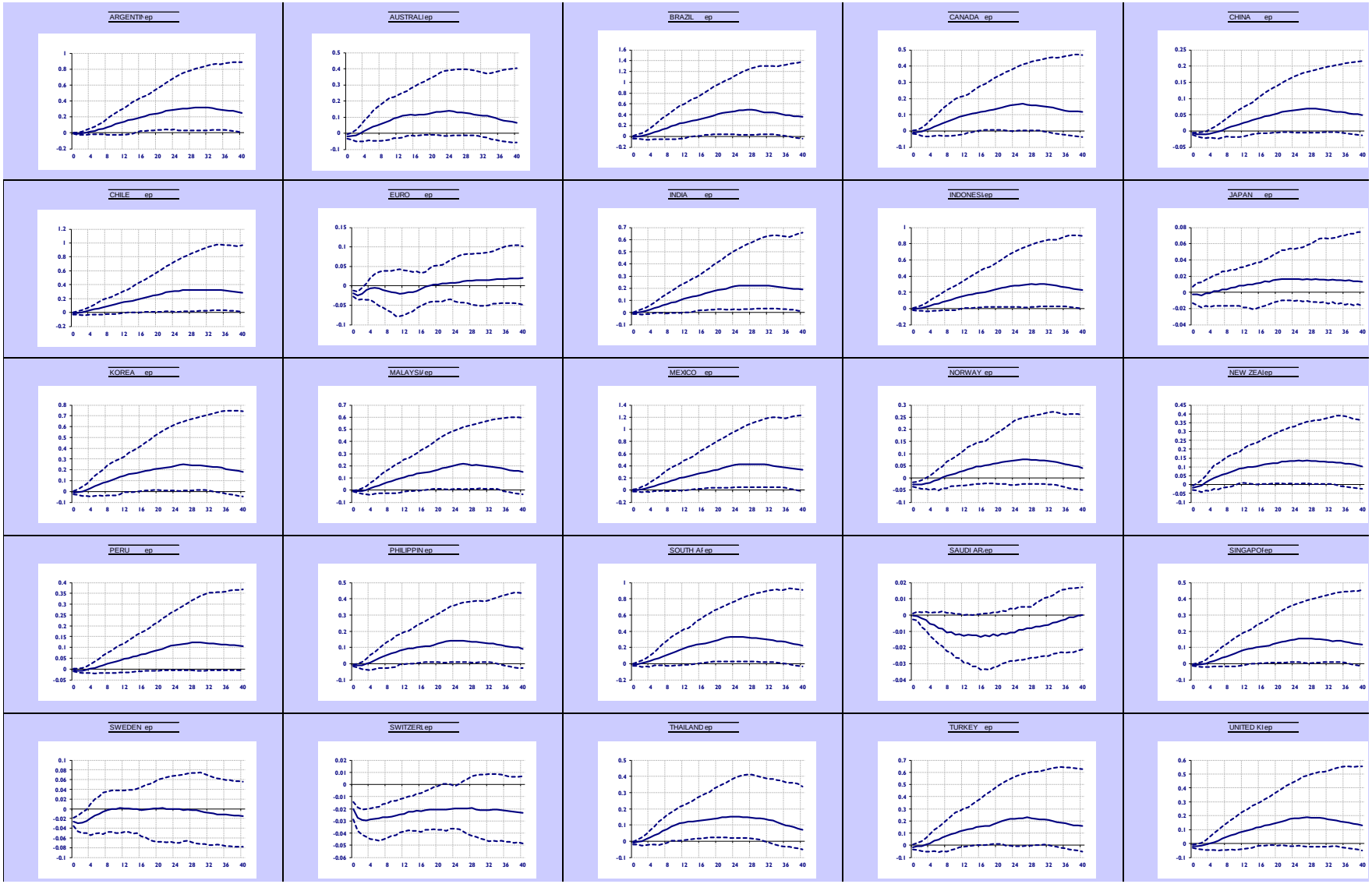
Simulated impacts of the CBAM on real outputs [via EU manufacturing import prices]



SPES Sustainability performances, evidence & scenarios

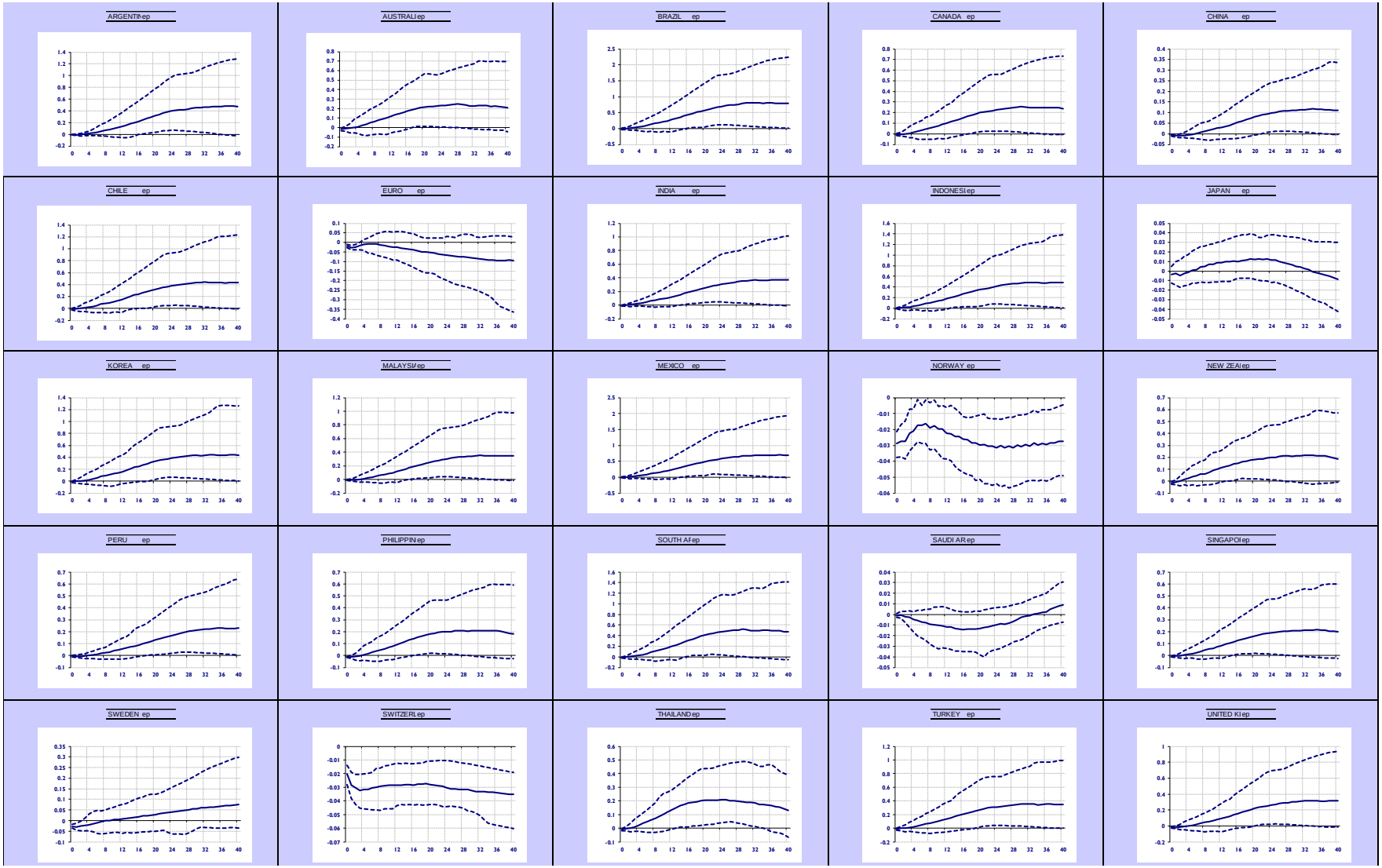
Appendix B1

Simulated impacts of the CBAM on real exchange rates [via EU industry import prices]



Appendix B2

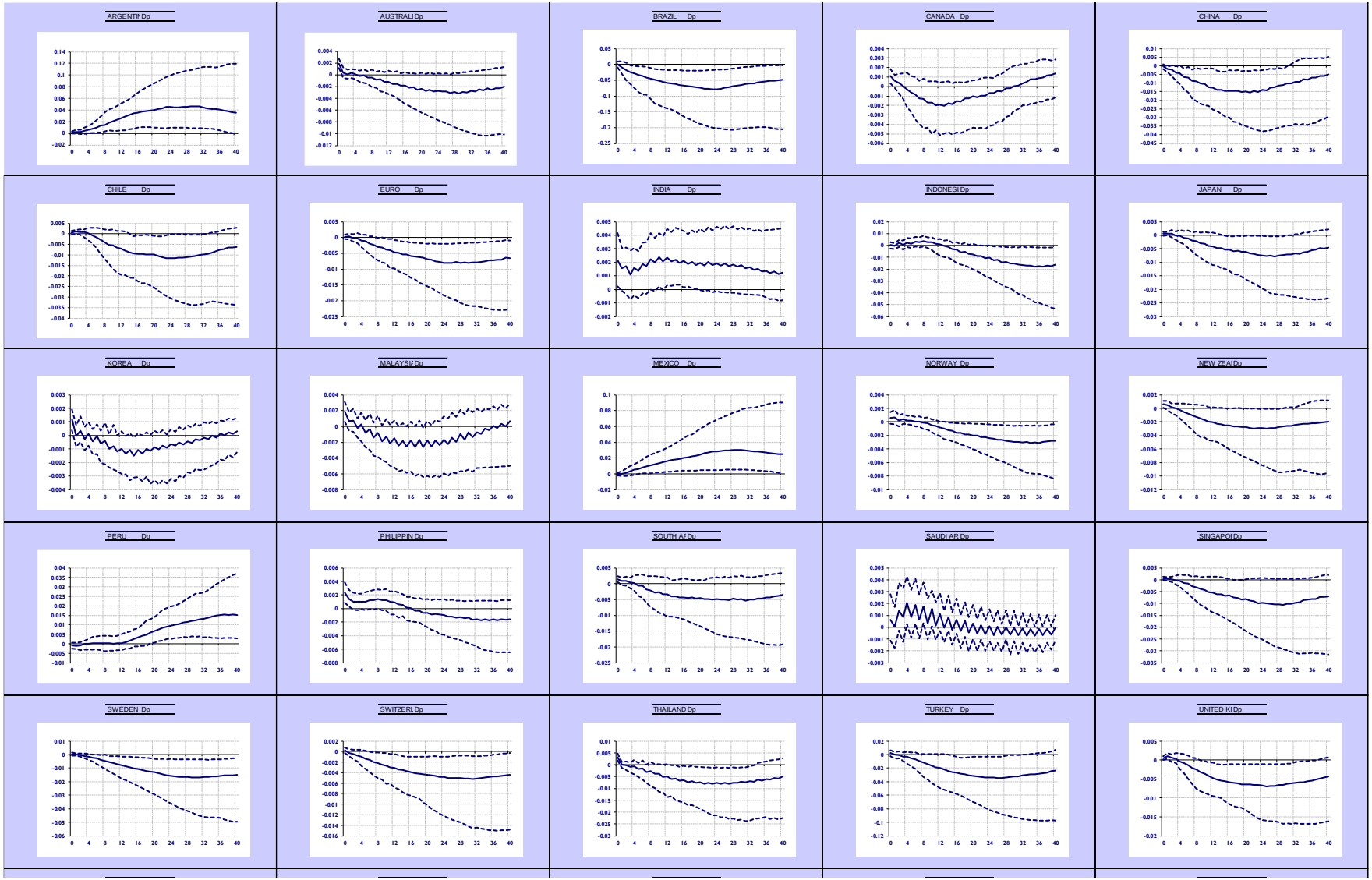
Simulated impacts of the CBAM on real exchange rates [via EU manufacturing import prices]



SPES Sustainability performances, evidence & scenarios

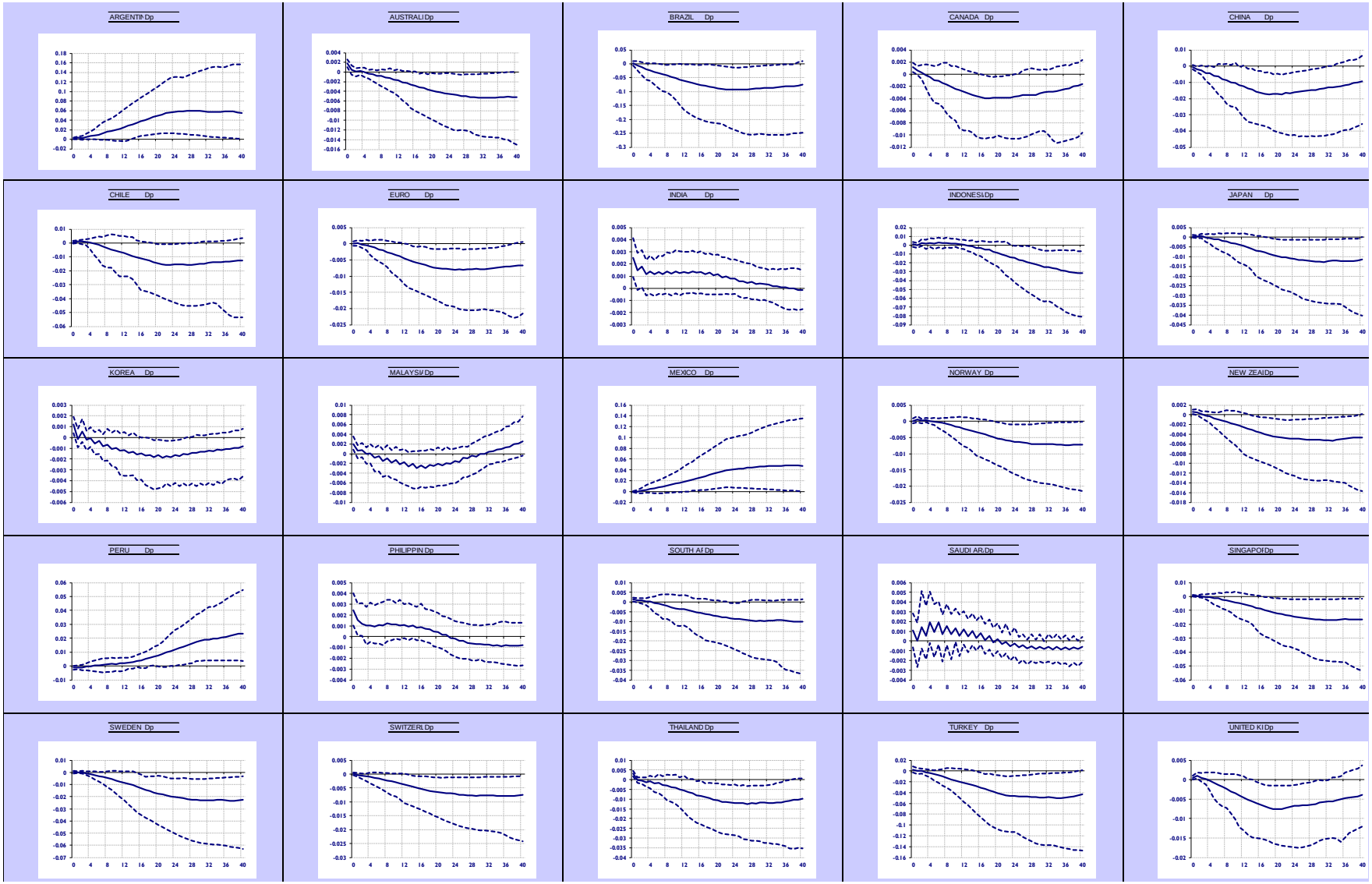
Appendix C1

Simulated impacts of the CBAM on inflation rate [via EU industry import prices]



Appendix C2

Simulated impacts of the CBAM on inflation rate [via EU manufacturing import prices]



SPES

Sustainability
performances,
evidence & scenarios

www.sustainabilityperformances.eu