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Climate Uncertainty and Financial Subordination: Evidence From a Two-Country Stock-Flow Consistent Model

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ABSTRACT

In the face of climate change, uncertainty is deep, systemic, and does not propagate amid an institutional vacuum, contrary to assumptions often underlying existing macroeconomic climate models. The paper presents a macroeconomic Stock-Flow Consistent model to examine the impact of climate-related financial pressures under fundamental uncertainty within a hierarchical international monetary and financial system. It demonstrates how climate uncertainty induces asymmetric cross-country interactions, highlighting the potential for the climate catastrophe to exacerbate regional economic disparities. These findings call for a more structural approach to a just transition in which financial governance is geared towards global equity and long-term sustainability.

JEL Classification: E12, F32, G15, Q56

1 | Introduction

The mounting climate crisis increasingly necessitates the integration of environmental factors in economic analysis and the exploration of their effects on macro-financial trajectories. Yet, this task cannot depart from an adequate account of the structural imbalances entrenched in the current international monetary and financial system (IMFS) and the systemic uncertainty associated with climate change.

Numerous scholars have long emphasised the hierarchical nature of the IMFS, pointing to the subordinated position of different currencies as reflected in their low liquidity premia, that is, the return differentials reflecting a currency's degree of international acceptability and safety under uncertainty. These differentials determine each currency's position within a structured ranking known as the currency hierarchy, shaping countries' ability to autonomously pursue domestic policies and achieve economic development (e.g. de Paula et al. 2017; Kaltenbrunner and Painceira 2015).

In parallel, research has shown that, in the face of climate change, uncertainty is deep and systemic, highlighting the limitations of classical decision-making models based on expected utility and probabilistic risk (Heal and Millner 2014). The fragilities that emerge at the intersection of the IMFS and ecological degradation have led a growing body of literature to conceptualise an ecological currency hierarchy to expose the convergence of environmental and financial asymmetries (e.g. Althouse and Svartzman 2022; Löscher and Kaltenbrunner 2023; Salah and Ament 2025).

'Just transition' is often reduced to the adoption of climate policies towards lower carbon intensity, but leaves out the institutional architecture through which climate risks propagate (see also Wang and Lo 2021). By failing to recognise the climate catastrophe as an

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endogenous force interacting with foundational macro-financial structures, the significant danger remains that proposed solutions will fail to take into account the pervasive nature of climate uncertainty and its compounding effects on pre-existing vulnerabilities embedded within the IMFS.

Unlike environmental economics, the ecological economics tradition has often eschewed a supply-side focus in its incorporation of climate variables, instead emphasising money and finance 'in the course of time', a theme frequently highlighted in heterodox economics (e.g. Fontana and Sawyer 2013; Fontana and Sawyer 2016). With their inherent ability to trace balance sheet dynamics in terms of stocks and flows over time without imposing the condition of convergence towards optimal equilibrium, stock-flow consistent (SFC) models have established themselves in the field as a prominent tool for capturing the impact of evolving monetary and financial variables.

In particular, a seminal way of addressing climate issues has been that of extending prototype SFC models originally developed by Godley and Lavoie (2012) to include the flow-fund model proposed by Georgescu-Roegen (1971, 1979, 1984). This approach fundamentally rests on modelling the macroeconomy as part of the ecosystem, emphasising feedback interactions between the two. However, despite the undeniable advancements, integrating environmental variables *ex post* into previously defined economic systems overlooks the potential for climate-related phenomena to affect internal macro-financial rules and regulating mechanisms at a foundational level.

This paper proposes a novel approach, showing how climate change can shape key economic behaviours through its interaction with monetary and financial structures. In doing so, the present study conducts a more holistic and realistic analysis that explicitly incorporates financial subordination and the heightened uncertainty induced by the climate crisis. By drawing attention to the vulnerabilities that emerge at the intersection of the ecological and financial domains, the analysis shows how climatically induced fragilities intensify volatility and shape underlying markets where expectations are formed. The resulting macro-financial patterns help define uneven development trajectories, exacerbating regional economic disparities. Significantly, these effects can be captured regardless of an explicit integration of resource and energy variables or damage functions. While such an omission inevitably entails overlooking additional feedback mechanisms (see, e.g., Nalin et al. 2024), this paper opts for preserving the original core structure of the benchmark model by Godley and Lavoie (2012) to ensure comparability and to bring the implications of climate uncertainty for the internal macro-financial mechanisms underpinning the IMFS to the fore.

In exploring the macro-financial nexus of monetary subordination and climate change within a self-contained SFC model, the paper contributes to the existing literature in multiple ways. First, by critically engaging with the benchmark SFC two-country framework with flexible exchange rates (OPENFLEX) of Godley and Lavoie (2012, Chapter 12), we make explicit underlying model assumptions concerning financial and climate uncertainty that the model's increased liquidity preference scenario brings to the surface. Second, marrying the concern for monetary subordination of developing and emerging economies (DEEs) with their exposure to climate change, we propose an augmented version of OPENFLEX that formally assesses the macro-financial dynamics arising in financially subordinated contexts under climate uncertainty, pointing to the risk that the climate catastrophe exacerbates regional economic disparities. Third, drawing on these results, we sketch out policy implications for a just transition, highlighting the need for structural institutional reforms in monetary and financial governance as a precondition.

The remainder of this paper is organised as follows. Section 2 critically assesses the effects of an exogenous shock to liquidity preference within the benchmark OPENFLEX framework and moves to conceptually explore how climate-related macro-financial considerations in the context of monetary and financial hierarchies may be accounted for. Section 3 draws on these propositions to derive alternative analytical solutions and integrates them into OPENFLEX via the redefinition of key behavioural equations according to a higher sensitivity to climate-related financial pressures within a financially subordinated context. Section 4 takes the new version of the model through a series of simulations under assumptions increasingly aligning with a climatically uncertain and hierarchical financial regime, showing how the larger the number of conditions incorporated, the more the resulting dynamics gravitate towards hysteresis. All in all, these findings are generalised across the international spectrum, pointing to the risk that the climate catastrophe may contribute to exacerbating regional economic disparities unless structural reforms in monetary and financial governance that prioritise long-term environmental and economic sustainability are introduced. Section 5 summarises and concludes.

2 | Climate Uncertainty Within a Stock-Flow Consistent Two-Country Model

2.1 | The Traditional Approach to (Climate) Uncertainty in Stock-Flow Consistent Modelling

An influential way of addressing climate issues in ecological economics research has been that of extending prototype SFC models originally developed by Godley and Lavoie (2012) to include the flow-fund model proposed by Georgescu-Roegen (1971, 1979, 1984). Significant contributions to this field include Dafermos et al. (2017), who developed a benchmark ecological SFC model to investigate the trajectories of key environmental, macroeconomic, and financial variables; and Dafermos et al. (2018), who extended this analysis to examine the interplay between climate change and financial stability. However, these models have been developed by assuming a single-area economy calibrated using global data. Carnevali et al. (2021) address this limitation by analysing the impact of cross-area financial flows on the economy, enhancing the analysis drawn in single-area ecological SFC models to account for open-economy dynamics.

Despite these advancements, integrating environmental variables *ex post* implies that climate-related considerations are added to pre-existing macro-financial systems without fundamentally affecting their internal behavioural rules and regulating mechanisms. For instance, Carnevali et al. (2021) utilise

the two-area SFC model by Godley and Lavoie (2012) as a starting point and expand it to account for the environmental side effects of cross-border financial flows, but do not transform the underlying macro-financial system originally formulated by Godley and Lavoie (2012). This appears particularly problematic in the way financial uncertainty is treated in such models, which is not altered by the introduction of environmental variables.[1]

While resource and energy variables do not feature in the benchmark SFC two-country model by Godley and Lavoie (2012, Chapters 6 and 12), the macro-financial implications of climatically augmented financial uncertainty can still be captured by accounting for certain empirical features that the model allows to reproduce under its original formulation. Particularly in a globally financialised world, climate change shocks propagate through international financial markets (R. Ahmed et al. 2024), feeding into investors' appetite for safety and risk. A rich empirical literature has shown how international investment decisions are driven by such global risk-appetite swings, as evidenced by capital flow dynamics (S. Ahmed and Zlate 2014; Ananchotikul and Zhang 2014; Ebeke and Kyobe 2015; Forbes and Warnock 2012; Fratzscher 2012). Whenever global financial conditions worsen and lead to an increase in liquidity preference, capital flows rebalance in search of safe assets (Choi and Furceri 2019), particularly towards the issuer of the international reserve currency (Caballero and Krishnamurthy 2009). These dynamics risk being amplified in the face of the climate catastrophe, insofar as the latter heightens the risk of financial crises and commodity price swings (Batten et al. 2020; Dafermos et al. 2018; Dufrénot et al. 2026; Löscher and Kaltenbrunner 2023; Porter et al. 2014), exposing agents to the permanent threat of sudden depreciations and intensifying the volatility of self-fulfilling assessments of prospective returns on peripheral assets. Unlike conventional financial shocks, the climate catastrophe produces irreversible, non-probabilistic outcomes that cannot be insured against via standard risk management (Heal and Millner 2014), amplifying the subjective weight of argument in agents' decision-making (Fontana and Gerrard 1999, 2004) and intensifying during bust phases the drive towards liquidity as the safe store of value under radical uncertainty.

Building on these empirical regularities and under the assumption that climate change leads to an increase in global liquidity preference, we employ the OPENFLEX model to explore the impact of a heightened preference for holding assets issued by one economy over another. Figure 1 illustrates the results of an exogenous portfolio shock as in Godley and Lavoie (2012, pp. 484–487) by displaying the impact on the domestic exchange rate and the trade balance for the economy that experiences the capital flight, as well as the dynamics in domestic and foreign real output.

One can infer that, in the OPENFLEX model, a shock such as a climatically induced hike in financial uncertainty and the resulting portfolio-driven exchange rate depreciation would produce immediate positive domestic effects (Godley 1999). Here, the current account would benefit from the downward pressure on the exchange rate, and both variables would stabilise close to their pre-shock levels over time rather than spiralling out of control. Such dynamics fundamentally reflect a 'weak' version of the imperfect asset substitutability assumption underlying the model (see also Lavoie 2022, pp. 534–536), where investors do respond to changing financial uncertainty by trading government securities (since assets are not perfect substitutes), but their portfolios progressively stabilise. In its current specification, the model hence allows for a new portfolio configuration to emerge and gradually absorb financial uncertainty pressures in a way that enables the economy to regain balance. Connecting this result to the climate catastrophe and its accompanying financial processes, insofar as climate uncertainty is confined to one-off shocks in international financial markets, the resulting economic adjustments do not degenerate into persistent disruptions and deteriorating macro-financial trajectories.

2.2 | New Analytical Premises: Climate Uncertainty Amid Monetary and Financial Hierarchies

In the face of climate change, uncertainty is deep and systemic (Heal and Millner 2014) and does not propagate amid an institutional vacuum, contrary to assumptions often underlying existing macroeconomic climate models. As emphasised by a number of scholars from multiple fields of research ranging from International Political Economy to monetary economics (e.g. Andrade and Prates 2013; Cohen and Benney 2014; Mehrling 2015; Murau et al. 2023; Terzi 2006), the fundamental feature of today's IMFS lies in its hierarchical configuration. In particular, within the Post-Keynesian monetary economics tradition, some authors note that while money may stand as liquidity in pure form domestically (Keynes 1936, Chapter 17), in the international context, it is denominated in various currencies that structurally carry different liquidity premia (Kregel 1982). The currency associated with the highest liquidity premium serves as global money in a way that the 'return' and safety of all other currencies are assessed against it.

Following the conceptualisation of an international hierarchy of currencies, a number of economic scholars have investigated its macro-financial implications (e.g. Bonizzi 2017; de Paula et al. 2017; Kaltenbrunner 2015; Ramos 2019). These works suggest that, during phases of increased liquidity preference, investors tend to deleverage their positions vis-à-vis currencies associated with low liquidity premia without tying their portfolio decisions to specific macroeconomic fundamentals of the investment destination (Bonizzi 2017; Kaltenbrunner 2015, 2020). Through these mechanisms, shocks in global financial markets can thus substantially disrupt exchange rates and asset prices, producing persistent effects on cross-country development trajectories (Kaltenbrunner and

[1] From a Keynesian perspective, uncertainty cannot be reduced to calculable risk (Knight 1921). Following Keynes' two-dimensional probability-credence framework (Fontana and Gerrard 1999, 2004), agents' behaviour under fundamental uncertainty depends on the relation between the probability of a proposition and the 'weight of argument', which is a measure of the evidence on which that proposition rests, based on a subjective and inherently dynamic component. As it shall be seen, in contrast to assumptions underlying standard SFC modelling, climate uncertainty shapes agents' financial decisions via the weight-of-argument channel. Consequently, procyclical behaviours are more likely to gain momentum in the presence of climate-related financial pressures (see also Löscher and Kaltenbrunner 2023).

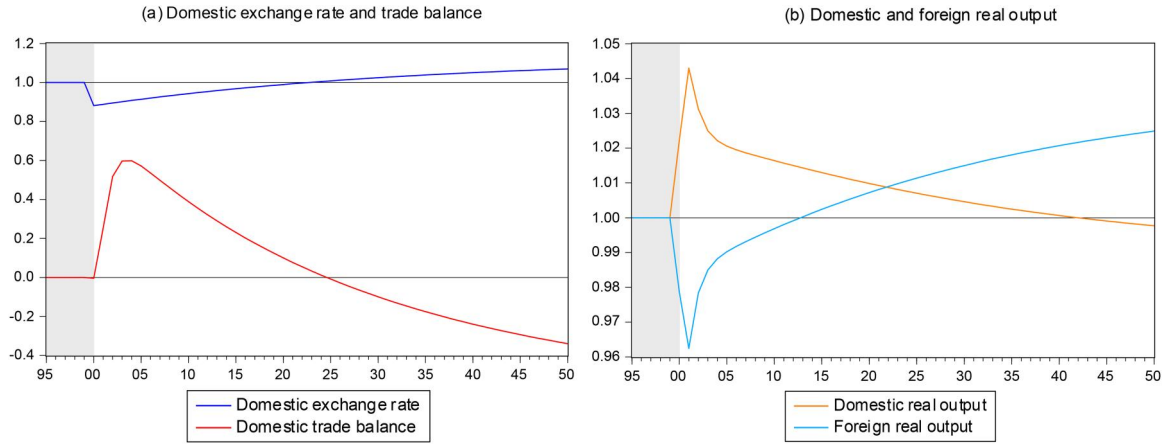


FIGURE 1 | Domestic and foreign macro-financial dynamics following a capital flight within the benchmark OPENFLEX model. *Note:* In graph (a), exchange rate and trade balance refer to the country experiencing the capital flight. Exchange rate values below 1 indicate depreciation; positive trade balance values indicate a surplus. All variables are expressed relative to the baseline.

Painceira 2015). Overall, these descriptions appear to point to a 'strong' form of imperfect asset substitutability in which, no matter the domestic macroeconomic conditions or policies in place, investors will want to get rid of or acquire assets that are perceived as fragile or remunerative under that particular liquidity phase (Biancarelli 2009).

Building on this framework, recent scholarship has introduced the concept of an ecological currency hierarchy (e.g. Althouse and Svartzman 2022; Löscher and Kaltenbrunner 2023; Salah and Ament 2025) to show how socioeconomic disruptions and environmental degradation converge unevenly across countries, increasing the risk of commodity price swings (Batten et al. 2020; Dufrénot et al. 2026; Porter et al. 2014) and financial crises (Dafermos et al. 2018). In marrying the concern for climate change with the hierarchical configuration of the IMFS, this study contributes to this debate by assessing the proposition that, by exacerbating volatility and shaping underlying markets where expectations are formed under fundamental uncertainty, climatically induced vulnerabilities unevenly affect macro-financial patterns of contemporary economic development. The currency hierarchy approach emphasises liquidity preference as the major force driving financial subordination and shaping macro-financial outcomes. When global financial conditions shift, liquidity preference pressures arise and affect the economic decisions of actors running financial operations that involve assets denominated in different currencies (D'Orsi 2024). As different currencies are structurally associated with different levels of liquidity, these pressures are qualified in terms of these assets' relative liquidity-provision capacity. Accordingly, Equation (1) defines them in terms of a time-and-space-dense liquidity pressure index π_{λ_i} as the positive product of two variables—$\Delta\lambda_T$ and $\Delta\lambda_S$—weighted by coefficient χ.

$$\pi_{\lambda_i} = \chi \cdot \Delta\lambda_T \cdot \Delta\lambda_S \tag{1}$$

$\Delta\lambda_T$ can be interpreted as a measure of the 'temporal' component of the underlying liquidity preference pressures which arise from cyclical global financial conditions. From a Keynesian perspective, this component reflects the inherent ebb-and-flow nature of the state of confidence under a capitalist economic system (Minsky 1978), a dynamic closely associated with what is commonly termed the financial cycle (Borio 2014; Rey 2015). U.S. monetary policy plays a key role in directing these cyclical fluctuations (Rey 2015). Accordingly, Equation (2) expresses $\Delta\lambda_T$ as a positive function of the cyclical component of global expectations γ weighted by coefficient κ, and a negative function of changes in the monetary policy of the core economy dr^A weighted by coefficient o.

$$\Delta\lambda_T = \kappa \cdot \gamma - o \cdot dr^A \tag{2}$$

The second dimension of Equation (1) posits that the sensitivity of agents' expectations to fundamental uncertainty also reacts to specific spatial conditions—the reason being that the institutions that emerge to mitigate 'risk' perceptions and cope with fundamental uncertainty by providing liquidity are embedded within space (Kregel 1982). $\Delta\lambda_S$ can hence be understood as a positional argument referring to the relative structural liquidity function performed by assets issued across different geographical units.[2] Accordingly, Equation (3) defines $\Delta\lambda_S$ by subtracting the structural liquidity premium of the rest of the world ($\lambda_{S_{RoW}}$) from that of the country in question (λ_{S_i}).

$$\Delta\lambda_S = \lambda_{S_i} - \lambda_{S_{RoW}} \tag{3}$$

All in all, the π_{λ_i} index conveys information about the pressures that arise from the impact of changing global financial conditions on the economic decision-making process of actors running financial operations that involve assets associated with a distinct structural liquidity premium. In exploring the interplay between climate change accompanying financial processes with the hierarchical configuration of the IMFS, a case is made that climatically induced financial vulnerabilities exacerbate volatility and shape underlying markets where expectations are formed, crucially interacting with both the temporal and spatial determinants of liquidity preference pressures (Löscher and Kaltenbrunner 2023).

[2]While dollar-denominated assets are also created offshore, the central nodes of clearing and settlement remain with the Federal Reserve, thereby maintaining onshore-based currency hierarchies (Murau et al. 2023).

In the first instance, the overall growth of climatically induced fragilities, namely the increased risk of financial crises (Dafermos et al. 2018) and commodity price swings (Batten et al. 2020; Dufrénot et al. 2026; Porter et al. 2014), heightens investors' sense of fundamental uncertainty. These processes expose agents to the permanent threat of sudden, sharp depreciations, which translates into more volatile, self-fulfilling assessments of their prospective returns on peripheral assets (Löscher and Kaltenbrunner 2023). Once the hierarchical nature of the IMFS in the presence of climate-related financial pressures is acknowledged, procyclical behaviours thereby gain momentum. In this context, the subjective 'weight of argument' plays a growing role in decision formation (Fontana and Gerrard 1999, 2004), particularly when peripheral countries asymmetrically exposed to climate risks are involved. Accordingly, persistent procyclical liquidity preference considerations in reaction to changes in financial conditions may come into play through exacerbating pressures related to the temporal dimension of liquidity premia.

In parallel, structural pressures on liquidity premia of currencies issued by countries in financially subordinated positions may grow due to climatically induced repercussions in financial and commodity markets (Löscher and Kaltenbrunner 2023). Being characterised by higher sensitivity to demand fluctuations (see, e.g., UNCTAD 2020, p. 5) and greater co-movement with domestic currencies (Kaltenbrunner 2018, p. 19) compared to manufactured goods, commodity prices tend to experience steeper declines during periods of elevated risk perception (Löscher and Kaltenbrunner 2023, p. 126). Consequently, the external position of DEEs—traditionally heavily reliant on commodity export—will tend to deteriorate under climate uncertainty (see also Nalin et al. 2024).[3] Where climate uncertainty, high commodity dependence, and a low position in the currency hierarchy collude, external financing will increasingly need to be satisfied by turning to international capital markets, reinforcing financial subordination (Löscher and Kaltenbrunner 2023).

$$\pi_{\lambda_i} = \chi \cdot \Delta\lambda_T \cdot \Delta\lambda_S \cdot (1 + \phi) \tag{4}$$

All in all, climatically induced fragilities against the background of a hierarchical IMFS compound domestic liquidity pressures as global financial conditions shift. This happens for two reasons, as underscored by Equation (4). First, an increase in climate uncertainty pressures ϕ implies that, through a heightened risk of financial crises and commodity price swings, as well as a generally risen perception of fundamental uncertainty, climatically induced instabilities exacerbate the volatility and amplitude of cyclical expectations under capitalism. Second, a growing ϕ causes a deepening polarisation of the IMFS itself as a consequence of climate vulnerability.

Crucially, the liquidity pressure channel does not exhaust the effects of climate uncertainty in a hierarchical IMFS, which directly emerge in the productive structure of the economy. Scholars have highlighted that the overwhelming share of world trade is invoiced in very few currencies, typically the U.S. dollar, reflecting the central role their issuers play within the IMFS (Goldberg and Tille 2009; Gopinath 2015; Ito and Chinn 2014). Building on this consideration and following a currency hierarchy perspective, the capacity to invoice trade flows in one's own currency and thus benefit from domestic depreciation may be explained in terms of the structural liquidity premium differential $\Delta\lambda_S$. This relationship is compounded by climate uncertainty, which hinders DEEs' external financial positions in the ways discussed above, deepening financial subordination and exacerbating pressures that arise from structural liquidity premia differentials (Löscher and Kaltenbrunner 2023). With that in mind, following a currency hierarchy perspective in the presence of climate-related financial pressures, the capacity for the trade balance to benefit from one's own currency depreciation may be made dependent on the structural liquidity premium differential $\Delta\lambda_S$ and the climate uncertainty index ϕ.

One first way through which these considerations can be incorporated is by making the exchange rate pass-through coefficients to export and import prices (υ_1 and ν_1 in OPENFLEX) endogenous and linking them to the structural liquidity premium differential $\Delta\lambda_S$ and the climate uncertainty index ϕ in the way Equations (5) and (6) suggest:

$$\upsilon_1 \rightarrow \upsilon_{10} = \upsilon_1 + \upsilon \cdot \Delta\lambda_S \cdot (1 + \phi) \tag{5}$$

$$\nu_1 \rightarrow \nu_{10} = \nu_1 + \eta \cdot \Delta\lambda_S \cdot (1 + \phi) \tag{6}$$

While υ_1 and ν_1 remain exogenous, the pass-through coefficients to export and import prices are made responsive to $\Delta\lambda_S$ and further compounded by ϕ. The final resultants are governed by the weighting parameters υ and η, respectively. Overall, when the structural liquidity differential is nil, the new coefficients remain unchanged compared to their benchmark counterparts. Things will change as $\Delta\lambda_S$ takes a value other than zero.

A second channel through which climate uncertainty in the context of monetary and financial hierarchies affects the productive structure of the economy is that of the firms' exporting and importing behaviours in response to exchange rate fluctuations. Accordingly, Equations (7) and (8) rewrite the exchange rate pass-through coefficients to export and import quantities (ε_1 and μ_1 in OPENFLEX) so that export and import tendencies in a peripheral economy are made sensitive to the country's position within the IMFS—as reproduced by $\Delta\lambda_S$—and compounded by climate-related financial pressures captured by ϕ. Parameters φ and ξ regulate the respective resultants.

$$\varepsilon_1 \rightarrow \varepsilon_{10} = \varepsilon_1 + \varphi \cdot \Delta\lambda_S \cdot (1 + \phi) \tag{7}$$

$$\mu_1 \rightarrow \mu_{10} = \mu_1 + \xi \cdot \Delta\lambda_S \cdot (1 + \phi) \tag{8}$$

In the remainder of the paper, the benchmark OPENFLEX model is modified to accommodate these insights and explore the implications of the corollaries derived above. Ultimately, this augmented model will enable testing whether a stronger form of imperfect asset substitutability arises as climate-related financial pressures in the context of international monetary and

[3]This is especially true when considering the physical impacts of climate change, where the agricultural sector faces severe harm (Porter et al. 2014). Nonetheless, the focus of this paper primarily lies on the financial and monetary side of climatically induced vulnerabilities.

financial hierarchies are introduced. This is done fundamentally at two levels, discussed sequentially in Section 3. The rest of the baseline coefficients and initial values are not amended. Sectoral balance sheets and the transaction-flow matrix are reported below in Tables 1 and 2, where A and B stand for the core and peripheral economies, respectively. A key to symbols is provided in Appendix A, while the complete model is available in Appendix B.

3 | New Analytical Solutions

3.1 | Condition 1: Relationship Between Exchange Rate and Trade Balance

Open-economy macroeconomics models usually assume that a currency depreciation(appreciation) improves(worsens) the trade balance.[4] We here show that this relationship is called into question in the case of financially subordinated countries. Most models assume the validity of the Marshall–Lerner condition (MLC), holding that the sum of the absolute values of the price elasticities of import and export must be greater than one (Robinson 1937). Carnevali et al. (2020) show through Equation (9) that the positive impact of an exchange rate depreciation on the trade balance is defined by a condition implicit in OPENFLEX:

$$DTB < 0 \quad \text{iff} \quad \varepsilon_1 \cdot (1 - \upsilon_1) + \mu_1 \cdot \nu_1 > \nu_1 - \upsilon_1 \tag{9}$$

where $\varepsilon_1 \cdot (1 - \upsilon_1)$, representing the price elasticity of export multiplied by the exchange rate pass-through of the other country's import prices, and $\mu_1 \cdot \nu_1$, representing the price elasticity of import multiplied by the exchange rate pass-through of import prices, are named weighted price elasticities of export and import, respectively. Plugging the values defined in benchmark OPENFLEX ($\nu_1 = 0.7$, $\upsilon_1 = 0.5$, $\varepsilon_1 = 0.7$, $\mu_1 = 0.7$) into Equation (9), the condition for a trade balance improvement following a nominal exchange rate depreciation is verified (see Carnevali et al. 2020). This setup allows for the exchange rate to affect the trade balance in the way expected under the MLC. However, it also lays the basis for second-round feedback effects through stock-flow linkages, whereby changes in the current account lead to adjustments in the exchange rate opposite to the initial movement. The result is that, under the benchmark OPENFLEX framework, an initial depreciation that improves the trade balance is followed by an appreciation, while an initial appreciation that worsens the trade balance is followed by a depreciation.

As discussed in Section 2.2, financial subordination and climate uncertainty may collude to engender fragilities which directly pan out in the productive structure of the economy. With that in mind, Equations (5–8) have made the parameters featured in Equation (9) sensitive to financial subordination and climate uncertainty. From a currency hierarchy perspective, since a portfolio shock gives rise to procyclical dynamics compounded by climate-related financial pressures wherein climate uncertainty operates, one may conclude that Equation (9) does not hold and that the sum of the weighted price elasticities of export and import is lower than the difference between the pass-through coefficients of import and export prices, as Equation (10) suggests. This way, the feedback mechanism linking exchange rates to the trade balance at the centre of OPENFLEX should break down under Condition 1.

$$\begin{aligned} &[\varepsilon_1 + \varphi \cdot \Delta\lambda_S \cdot (1 + \phi)] \cdot \{1 - [\upsilon_1 + \upsilon \cdot \Delta\lambda_S \cdot (1 + \phi)]\} \\ &\quad + [\mu_1 + \xi \cdot \Delta\lambda_S \cdot (1 + \phi)] \\ &\quad \cdot [\nu_1 + \eta \cdot \Delta\lambda_S \cdot (1 + \phi)] \\ &< [\nu_1 + \eta \cdot \Delta\lambda_S \cdot (1 + \phi)] - [\upsilon_1 + \upsilon \cdot \Delta\lambda_S \cdot (1 + \phi)] \end{aligned} \tag{10}$$

$$\Longrightarrow \varepsilon_{10} \cdot (1 - \upsilon_{10}) + \mu_{10} \cdot \nu_{10} < \nu_{10} - \upsilon_{10}$$

One can further make sense of Equation (10) within OPENFLEX in consideration of the following observations. Assuming that Country A stands for the core economy, import prices would be denominated in A currency (Gopinath 2015). Additionally, the fact that exporting firms in the peripheral Country B typically owe liabilities in foreign currency A exposes them to the necessity of raising revenues denominated in the same way (Bruno and Shin 2023; Kearns and Patel 2016). On top of that, domestic depreciation against the background of currency mismatches may expose exporting firms in the peripheral Country B that have accumulated foreign debt to the risk of bankruptcy (Chui et al. 2016; Kearns and Patel 2016). This suggests that a significant contraction of the exporting sector may arise even before it can fully capitalise on the increased price competitiveness resulting from domestic depreciations (see also Chui et al. 2016). With these considerations in mind, newly added parameters in Equations (5) and (6) can be calibrated so that the pass-through coefficients to import and export ν_{10} and υ_{10} are made equal to, respectively, one and zero as Condition 1 is introduced, to incorporate insights from the currency hierarchy tradition within a climate uncertainty regime while matching the formulation of the MLC by Joan Robinson (1937).

In parallel, considerations reflecting financial subordination within a climatically uncertain regime in relation to Equation (7) can be captured by calibrating ε_{10} so that an extremely low value is obtained for the elasticity of export, reflecting a tiny fraction of exporting firms.[5] Similarly, in relation to Equation (8), it is also reasonable to assume import tendencies in a peripheral economy are sensitive to the country's position within the IMFS, and the latter's impact is compounded by climate-related financial pressures. Nevertheless, a component of the demand for import will be insensitive to changes in prices due to the production needs of firms in Country B.[6] Overall, these considerations can be reproduced by assigning a middle-ground value to the elasticity of import.[7]

[4]This is the case in the Mundell–Fleming model (Fleming 1962; Mundell 1963), but heterodox open-economy models also usually assume this condition to hold in some form (Blecker and Setterfield 2019).

[5]In the model simulations presented in this paper, the parameter φ is calibrated in such a way that $\varepsilon_{10} = 0.05$ as Condition 1 is introduced.

[6]This point represents the core result of what is known as the 'technical dependency' argument, that is, the inelastic demand for imported inputs in peripheral economies (Prebisch 1950; Singer 1950).

[7]In the model simulations presented in this paper, the parameter ξ is calibrated in a manner such that $\mu_{10} = 0.5$ as Condition 1 is introduced.

3.2 | Condition 2: Liquidity Preference Pressures

The second way in which the model is augmented to account for financial subordination in the context of climatically induced financial fragilities involves the incorporation of variable π_{λ_i} across multiple macro-financial dimensions. As already discussed, this index captures liquidity preference pressures that, following changing global financial conditions within a climate uncertainty regime, shape the economic decisions of the actors who run financial operations that involve assets denominated in a specific currency. It is assumed that agents' response behaviour to such liquidity pressures is mediated by variable δ, which is defined by Equation (11) in a way that the adoption of restrictive policies from the monetary authority of Country B exacerbates the agents' reaction to worsening global financial conditions (Coimbra and Rey 2024). The net effect, weighted by coefficient ω, is proportional to the size of the monetary consolidation dr^B.

$$\delta = \begin{cases} \pi_{\lambda_B} \cdot (1 + \omega \cdot dr^B), & dr^B > 0 \\ \pi_{\lambda_B}, & dr^B \leq 0 \end{cases} \tag{11}$$

Equation (11) is defined to capture how, under climate uncertainty amid global financial stress, restrictive monetary policies in financially subordinated contexts amplify domestic liquidity pressures as risk-averse agents adjust their portfolio expectations.[8] The consequence is that, during a period of panic, assets associated with high liquidity premia may be demanded regardless of domestic macroeconomic conditions (Caballero and Krishnamurthy 2009). On the other hand, investors may try to get rid of assets perceived as fragile as a result of changing liquidity preference, whatever the measure put in place by the authority that issues the currency denominating them (S. Ahmed and Zlate 2014). Equation (11) will be incorporated within the structure of the benchmark OPENFLEX model under Condition 2 as discussed in detail in the remainder of this section.

To capture the liquidity pressures resulting from financial subordination and climate-induced fragilities, a key amendment to the benchmark OPENFLEX model must involve the set of conditions that govern capital flow interactions between the two economies. In the OPENFLEX model, such flows are described by the portfolio Equations (12–15).

$$B^B_{Bd} = V^B \cdot [\lambda_{10} + \lambda_{11} \cdot r^B - \lambda_{12} \cdot (r^A + dxre^A)] \tag{12}$$

$$B^A_{Bd} = V^B \cdot [\lambda_{20} - \lambda_{21} \cdot r^B + \lambda_{22} \cdot (r^A + dxre^A)] \tag{13}$$

$$B^A_{Ad} = V^A \cdot [\lambda_{40} + \lambda_{41} \cdot r^A - \lambda_{42} \cdot (r^B + dxre^B)] \tag{14}$$

$$B^B_{Ad} = V^A \cdot [\lambda_{50} - \lambda_{51} \cdot r^A + \lambda_{52} \cdot (r^B + dxre^B)] \tag{15}$$

The first amendment to the behavioural portfolio equations consists of defining the parameters capturing the structural conditions of portfolio allocation λ_{10-50} in a way that reproduces a tendency by investors to seek safe or remunerative assets as global liquidity pressures shift (Caballero and Krishnamurthy 2009; Choi and Furceri 2019), overriding their standard home-biased configuration (see Babilis and Fitzgerald 2005). As the response to changing global financial conditions is described by variable δ, it is possible to write:

$$\lambda_{10} \rightarrow \lambda_{100} = \lambda_{10} \cdot (1 - \lambda \cdot \delta \cdot \lambda_1) \tag{16}$$

$$\text{If } \delta > 0 \Longrightarrow \lambda_{100} < \lambda_{200}$$

$$\lambda_{20} \rightarrow \lambda_{200} = \lambda_{20} \cdot (1 + \lambda \cdot \delta \cdot \lambda_2) \tag{17}$$

$$\lambda_{40} \rightarrow \lambda_{400} = \lambda_{40} \cdot (1 + \lambda \cdot \delta \cdot \lambda_4) \tag{18}$$

$$\text{If } \delta < 0 \Longrightarrow \lambda_{400} < \lambda_{500}$$

$$\lambda_{50} \rightarrow \lambda_{500} = \lambda_{50} \cdot (1 - \lambda \cdot \delta \cdot \lambda_5) \tag{19}$$

The parameters λ_{10-50} within the benchmark OPENFLEX framework are defined in order to establish a structural tendency amongst investors to prioritise investment in domestic assets over foreign ones. Building upon this feature, Equations (16), (17), (18), and (19) replace them with parameters $\lambda_{100-500}$ endogenous to the response to changing global financial conditions under a hierarchical, climatically uncertain regime. Accordingly, three possible scenarios open up as the response variable to global liquidity pressures takes different values weighted by parameters λ and λ_{1-5}. If $\delta > 0$, investors will tend to prefer investing in safe assets issued by Country A over risky ones. Alternatively, if $\delta < 0$, assets that are in prospect more remunerative, as those issued by Country B would be, will be preferred. Lastly, should the response variable be nil ($\delta = 0$), portfolio liquidity preference conditions will stick to their original configuration adopted in the benchmark OPENFLEX model, aligning with the home-bias assumption (Lewis 1999).

The second amendment to portfolio equations has to do with their component that defines volatile flows λ_{12-52}. Equations (12), (13), (14), and (15) in their traditional form entail a positive relationship between domestic interest rates and portfolio flows. This can be a realistic representation under certain conditions, but when a global financial uncertainty shock kicks in and liquidity pressures arise in the context of financial subordination and climate-related fragilities, investors may adjust their behaviour (see also Ramos and Prates 2021).

In the augmented OPENFLEX framework, the volatile component of the portfolio equations is defined by a series of new endogenous coefficients $\lambda_{110-520}$ described by Equations (20), (21), (22), and (23). While retaining the positive correlation with the rate of interest characterising the standard OPENFLEX configuration, these coefficients combine that with an opposite relationship driven by the sign of the response variable δ and regulated by parameters λ and λ_{6-9}.

$$\lambda_{11} \cdot r^B \rightarrow \lambda_{110} = \lambda_{11} \cdot (r^B - \lambda \cdot \lambda_6 \cdot \delta \cdot dr^B) \tag{20}$$

$$\lambda_{21} \cdot r^B \rightarrow \lambda_{210} = \lambda_{21} \cdot (r^B - \lambda \cdot \lambda_7 \cdot \delta \cdot dr^B) \tag{21}$$

$$\lambda_{42} \cdot r^B \rightarrow \lambda_{420} = \lambda_{42} \cdot (r^B - \lambda \cdot \lambda_8 \cdot \delta \cdot dr^B) \tag{22}$$

$$\lambda_{52} \cdot r^B \rightarrow \lambda_{520} = \lambda_{52} \cdot (r^B - \lambda \cdot \lambda_9 \cdot \delta \cdot dr^B) \tag{23}$$

While these coefficients keep their original values when the response variable is nil ($\delta = 0$) so that the normal mechanics of

[8] Coimbra and Rey (2024) show within a model with financial frictions that a decrease in the domestic interest rate when interest rates are generally high has the effect of decreasing aggregate risk. As a corollary, one may infer that increases in the interest rate under the same circumstances may heighten risk perceptions.

TABLE 1 | Balance-sheet matrix of the two countries.

	Country A				Country B				$\sum$
	Households	**Firms**	**Government**	**Central bank**	**Households**	**Firms**	**Government**	**Central bank**	
Money (cash)	$+H^A$			$-H^A$	$+H^B$			$-H^B$	0
A government bills	$+B^A_A$		$-B^A$	$+B^A_{cbA}$	$+B^A_B \cdot xr^A$			$+B^A_{cbB} \cdot xr^A$	0
B government bills	$+B^B_A \cdot xr^B$				$+B^B_B$		$-B^B$	$+B^B_{cbB}$	0
Gold				$+or^A \cdot p^A_g$				$+or^B \cdot p^B_g$	$+\sum or \cdot p^A_g$
Balance (net worth)	$-V^A$		$-NW^A_g$		$-V^B$		$-NW^B_g$	$-NW^B_{cb}$	$-\sum or \cdot p^A_g$
Σ	0		0	0	0		0	0	0

Note: '+' before a magnitude denotes an asset, whereas '−' denotes a liability. *Source:* Author's elaboration.

portfolio flows are not altered, as global liquidity pressures arise in a climatically uncertain, currency hierarchy context ($\delta \neq 0$), the cyclical component of portfolio flows adjusts. Specifically, if $\delta > 0$, the relation is defined so that positive liquidity preference pressures arise, making increases in the peripheral interest rate counterproductive for domestic assets' attractiveness in the eyes of investors (Coimbra and Rey 2024). Inversely, should $\delta < 0$, global liquidity pressures reflecting a general inclination towards the search for future gains would take shape and magnify the effect obtained within the benchmark OPENFLEX framework under an increase in the peripheral interest rate (Ananchotikul and Zhang 2014).

Another amendment to the structure of the model involves interest rates. The benchmark OPENFLEX model treats interest rates as exogenous variables set by the central bank and does not differentiate across assets and maturities (Godley and Lavoie 2012). On the contrary, a currency hierarchy perspective would emphasise additional pressures involved in the determination process of key macro prices, including interest rates (Kaltenbrunner 2020). More specifically, as economic agents' liquidity preference considerations enter the formation process of interest rates, interest setting would face impediments to different degrees depending on context-specific financial pressures (see Kaltenbrunner 2020, p. 20). Such pressures are compounded by climate-related fragilities, which would exacerbate the existing perception of fundamental uncertainty by investors as they formulate their expectations (Löscher and Kaltenbrunner 2023).

Recent empirical findings document that central banks in emerging markets follow Taylor-type rules and lower their policy rates even when economic activity decelerates (e.g. De Leo et al. 2022), despite the risk that doing so may trigger capital flight and exchange rate pressures in a hierarchical IMFS (de Paula et al. 2017). It follows that, similarly to advanced economies, peripheral countries would seem to officially retain independence in the conduct of monetary policy (Angrick 2017; De Leo et al. 2022). This stylised fact would seem to support the characterisation presented by the benchmark OPENFLEX model, where the policy rate is set exogenously (Lavoie 2006).

Nevertheless, it has been acknowledged that when emerging economies conduct anticyclical monetary policy, the effective transmission to short-term market rates may break down as a result (De Leo et al. 2022; Rey 2016). This breakdown is not incidental but reflects the structural impossibility of genuine monetary independence at the periphery, where financial subordination systematically constrains the efficacy of domestic policy (Andrade and Prates 2013). In other words, the central bank may still set the interest target it desires, but at the cost of the efficacy of that very policy, suggesting that pressures stemming from financial subordination have merely shifted form. As a corollary, should central banks in financially subordinated contexts insist on following Taylor-type rules, the sensitivity of interest rates to changes in the policy rate may diminish across assets and maturities (De Leo et al. 2022, pp. 19–20), reflecting a different mode in which global financial conditions constrain policy space in the periphery.

TABLE 2 | Transaction-flow matrix of the two countries.

	Country A					Country B				
	Households	**Firms**	**Government**	**Central bank**		**Households**	**Firms**	**Government**	**Central bank**	∑
Consumption	$-C^A$	$+C^A$				$-C^B$	$+C^B$			0
Government spending		$+G^A$	$-G^A$				$+G^B$	$-G^B$		0
A exports to B		$+X^A$			$\cdot xr^B$		$-IM^B$			0
B exports to A		$-IM^A$			$\cdot xr^B$		$+X^B$			0
Gross domestic product	$+Y^A$	$-Y^A$				$+Y^B$	$-Y^B$			0
Taxes	$-T^A$		$+T^A$			$-T^B$		$+T^B$		0
Interests on A bills	$+r^A \cdot B^A_A$		$-r^A \cdot B^A$	$+r^A \cdot B^A_{cbA}$	$\cdot xr^B$	$+r^A \cdot B^A_B \cdot xr^A$			$+r^A \cdot B^A_{cbB} \cdot xr^A$	0
Interests on B bills	$+r^B \cdot B^B_A \cdot xr^B$				$\cdot xr^B$	$+r^B \cdot B^B_B$		$-r^B \cdot B^B$	$+r^B \cdot B^B_{cbB}$	0
CB profits			$+F^A_{cb}$	$-F^A_{cb}$				$+F^B_{cb}$	$-F^B_{cb}$	0
Δ in cash	$-\Delta H^A$			$+\Delta H^A$		$-\Delta H^B$			$+\Delta H^B$	0
Δ in A bills	$-\Delta B^A_A$		$+\Delta B^A$	$-\Delta B^A_{cbA}$	$\cdot xr^B$	$-\Delta B^A_B \cdot xr^A$			$-\Delta B^A_{cbB} \cdot xr^A$	0
Δ in B bills	$-\Delta B^B_A \cdot xr^B$				$\cdot xr^B$	$-\Delta B^B_B$		$+\Delta B^B$	$-\Delta B^B_{cbB}$	0
Δ in gold				$-\Delta or^A \cdot p^A_g$	$\cdot xr^B$				$-\Delta or^B \cdot p^B_g$	0
Σ	0	0	0	0		0	0	0	0	0

Note: '+' before a magnitude denotes a receipt or a source of funds, whereas '−' denotes a payment or a use of funds. *Source:* Author's elaboration.

Starting from the assumption that the central bank prioritises successful control over interest rates and thus wants to ensure monetary policy transmission, it seems reasonable to simply argue that its interest rate targeting policy shall reflect such an objective. Within a hierarchical financial regime shaped by climate uncertainty, deteriorating global liquidity conditions pressure peripheral central banks to respond restrictively, partly reflecting developments in the foreign exchange market. Accordingly, it is possible to rewrite the peripheral interest rate in the model as suggested by Equation (24):

$$r^B = r^A + \psi \cdot \delta \cdot \log\left(\frac{1}{xr^B_{-1}}\right) \tag{24}$$

While the core economy sets the interest rate r^A exogenously, the monetary authority in the periphery targets the core interest rate plus a mark-up. Such a mark-up is influenced by the response to global liquidity pressures δ and a non-linear response[9] to the inverse of the exchange rate in the previous period, regulated by parameter ψ.

Lastly, the currency hierarchy perspective stresses that expectations as to whether the prevailing state of money and credit in the economy is perceived as sustainable play an important role in the spot exchange rate determination process (Kaltenbrunner 2015, 2020). In OPENFLEX, future monetary conditions are captured by changes in the expected exchange rate, but the variables $dxre^A$ and $dxre^B$ are derived in a way that ensures they are *de facto* set to zero, which is tantamount to assuming that expectations about the probability of appreciation and of depreciation are balanced (Lavoie and Daigle 2011, p. 438).

Following a currency hierarchy approach in a climate uncertainty regime, expected future monetary conditions of Countries A and B can be linked, respectively, positively and negatively, to the response variable δ. The expected exchange rate can thus be considered a proxy for the forward exchange market in which traders operate following their expectations of future monetary conditions (Kaltenbrunner 2020), moulded by global liquidity pressures.[10] Changes in the expected exchange rate in Country B, formed according to a reinforcing process that depends on the international liquidity pressure response δ and parameter β, are described by Equation (25):

$$dxre^B = \beta \cdot (-\delta) \tag{25}$$

4 | Simulation Results and Discussion

4.1 | Simulation Results

Table 3 summarises the effects of a shock to global financial uncertainty on selected variables under distinct scenarios that increasingly account for climate-related financial pressures in the context of monetary and financial hierarchies through the progressive incorporation of Conditions 1 and 2. The exogenous change in global financial conditions is set in a way that matches the liquidity preference shock simulated in Chapter 12 of Godley and Lavoie (2012, pp. 484–487) and presented in Section 2, where international and domestic investors increase their desire to hold bills of Country A. In the proposed augmented representation, changing global financial conditions are ultimately linked to the temporal liquidity premium differential $\Delta\lambda_T$ via a negative shock to γ, against the background of a negative structural liquidity premium differential $\Delta\lambda_S$ and a positive climate uncertainty index ϕ. Overall, these assumptions allow for reproducing a portfolio shift from the periphery to the core that reflects an increase in the preference to hold liquid assets under a climate uncertainty regime from a currency hierarchy perspective. Effects under different scenarios are summarised in Table 3 for selected variables, revealing that the higher the number of conditions from Sections 3.1 and 3.2 incorporated, the more the shock produces hysteretic and path-dependent responses.[11] The key underlying macro-financial dynamics are discussed in the remainder of this section in a step-by-step manner.

The scenarios reported in Table 3 are derived under a one-off increase in financial uncertainty that prompts a heightened general desire to hold bills of Country A denominated in domestic currency. To replicate this effect, the same liquidity shock simulated in Chapter 12 of Godley and Lavoie (2012) is introduced by increasing λ_{20} and λ_{40} to 0.3 and 0.75, respectively.

The effects within the benchmark OPENFLEX model have already been discussed and are represented here by the blue lines under Scenario 1. As a result of the positive shock to global financial uncertainty, the peripheral exchange rate depreciates (Figure 2a). However, the rebound effect caused by feedback pressures from the trade balance only takes place within the benchmark OPENFLEX model (Figure 2d).

From Scenario 2 onwards, the elasticities in trade equations and the parameters defining the degree of pass-through to import and export prices are made endogenous to $\Delta\lambda_S \cdot (1 + \phi)$, so that, as the structural liquidity premium differential and the climate uncertainty index change, the general condition for a trade balance improvement following a depreciation is no longer satisfied. As expected, against the backdrop of a climatically uncertain regime where ϕ is positive and $\Delta\lambda_S$ is calibrated so as to reproduce the higher position of Country A within the IMFS, the feedback loop between the trade balance and the exchange rate breaks down. Specifically, as opposed to Scenario 1, neither the exchange rate depreciation nor the real trade balance improvement in the periphery changes course in the medium run under Scenario 2.

[9] Given that, following an increase in global financial uncertainty, the inverse function of the domestic exchange rate will tend to infinity, the interest rate response is assumed to be non-linear to ingrain stabilising properties in the system.

[10] This approach shares some similarities with Lavoie and Daigle (2011), where speculative expectations are introduced by means of a 'chartist' trend-following component in the expected exchange rate determination. However, in the equation presented, it is the intensity of the reaction variable δ rather than the last observed exchange rate value that governs the process. For the sake of simplicity, only expected monetary conditions of Country B are modelled in this exercise; $dxre^A$ is retained at zero as in the benchmark.

[11] Crucially, these hysteretic properties arise endogenously from the stock-flow linkages within the model rather than from any externally imposed condition, as it happens with standard computable general equilibrium approaches (see, e.g., Acar et al. 2018), highlighting the relevance of this framework for capturing real-world macro-financial persistence under climate uncertainty.

TABLE 3 | Effects of a one-off increase of global financial uncertainty on selected variables within an OPENFLEX model under different conditions.

	Conditions[a]		Short-run[b] and medium-run[c] responses[d] of selected variables following the shock							
Scenarios	**Condition 1**	**Condition 2**	**Peripheral *xr***		**Peripheral *r***		**Peripheral real *Y***		**Peripheral real *TB***	
Scenario 1			−	+	=	=	+	+	+	−
Scenario 2	✓		−, <	−, <<	=	=	−, <	−, <<	+, >	+, >>
Scenario 3	✓	✓	−, <	−, <<	+, >	+, >>	−, <	−, <<	+, >	+, >>

Source: Author's elaboration.
[a]The conditions are those discussed in Sections 3.1 and 3.2, specifically, Condition 1 on the relationship between the exchange rate and the trade balance, and Condition 2 on liquidity preference pressures.
[b]Short-run responses reported on the left-hand column for each variable 10 periods after the shocks.
[c]Medium-run responses reported on the right-hand column for each variable 30 periods after the shocks.
[d]Final results following the shock being neutral ('='), positive ('+'), or negative ('−'); short-run responses (left-hand column) reported in relation to the previous scenario n_{-1} (left-hand column, row above) with a positive ('>') or negative ('<') sign; medium-run responses (right-hand column) reported as positive ('>>') or negative ('<<') in relation to short-run responses (left-hand column, same row).

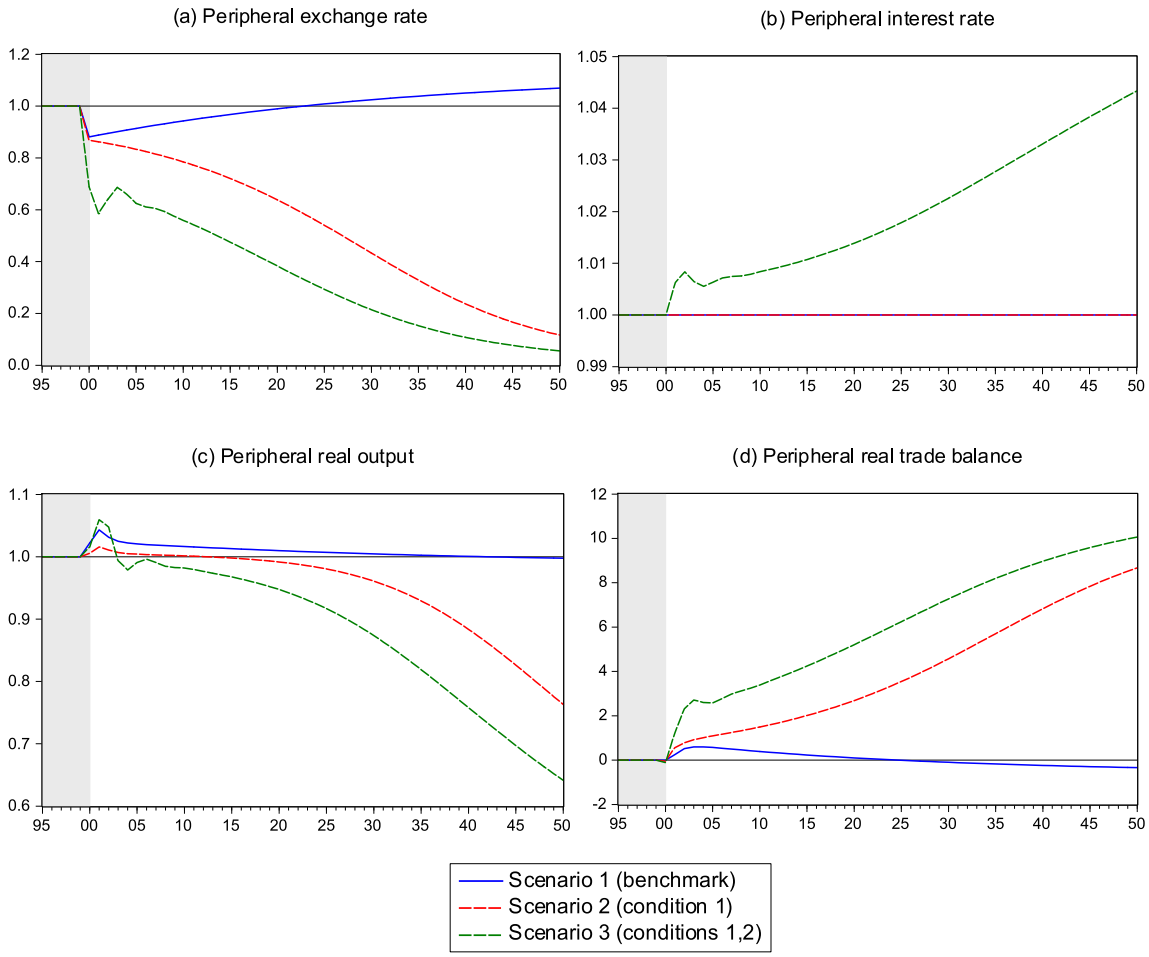


FIGURE 2 | Key selected responses in the periphery following an increase in global financial uncertainty under different conditions. *Note:* All the variables refer to Country B and are expressed relative to the baseline. Scenarios are obtained from OPENFLEX benchmark by cumulatively incorporating Conditions 1 and 2. Exchange rate values below 1 indicate depreciation; positive trade balance values indicate a surplus.

Building on the previous amendments, Scenario 3 is obtained by introducing the additional assumption that the increase in the preference for A bills reflects a deterioration of global financial conditions within a climate uncertainty regime and heightened liquidity pressures in the periphery. To achieve that, the same increase in the preference for A bills is combined with a negative shock to γ. Accordingly, the determinants of the global liquidity pressure index π_{λ_B} and its response variable δ are calibrated to allow both these resultants to take a positive value.

As portfolio allocation parameters are made endogenous to the reaction variable δ under Scenario 3, the responses of peripheral

exchange rates further intensify in the same direction as in previous scenarios following the initial shock (Figure 2a). That happens because global pressures override the standard home-biased configuration of portfolio equations so that investors will prioritise safe assets.

Additionally, as the peripheral interest rate is endogenised, the central bank intervenes by targeting the interest rate of the core economy plus a mark-up dependent on liquidity pressures and changes in the domestic exchange rate. Following the shock, the peripheral interest rate thus gradually increases beyond the 3% threshold (Figure 2b). This process feeds into the reaction variable δ and intensifies agents' response to deteriorating global financial conditions. Specifically, as the reaction variable is directly proportional to the domestic interest rate and inversely proportional to capital inflows, investors will stop viewing increases in peripheral interest rates following the shock favourably, and intensify the flight to quality to country A. Accordingly, rising interest rates have the effect of exacerbating depreciating exchange rate pressures further (Figure 2a).

Finally, the addition of self-feeding expected exchange rates strengthens the hysteretic properties of the system. By integrating expectations of future monetary conditions, exchange and interest rate dynamics are accentuated due to trend-following speculators in the spot foreign exchange market that increase the underlying volumes of cross-border portfolio flows in line with anticipated global financial trends. This translates into a steadier depreciation of the peripheral exchange rate against the background of domestic interest rates increasing at a faster pace than in Scenario 2 (Figure 2a and Figure 2b).

Unsurprisingly, the dynamics undergone by interest and exchange rates affect real output. Figure 2c reveals that the more hysteretic the response of such macro prices becomes as Scenario 3 approaches, the greater the decline in real output. Decomposition into output components, reported in Figure 3, reveals that this process is primarily driven by declining consumption. Although the real trade balance improves (refer back to Figure 2d), its individual components show that this trend is more due to declining real import than increasing export (Figure 3b,c). Real export growth is initially driven by increasing demand from country A following the flight to safety, but over time, this effect fades.

To delve into the drivers of output deterioration, trends in changing prices in country B are reported in Figure 4. Altogether, these help make sense of the recessionary effects owed to the domestic depreciation evidenced in Figure 2a. The plunging peripheral exchange rate fuels inflationary dynamics in the periphery (Figure 4a) primarily through increasing import prices, whose growth rate pace overtakes that of other price components (Figure 4b). Declining consumption and the progressive slowdown in real export growth in the periphery (refer back to Figure 3a,c) are to be understood in light of the interactions produced by such inflationary forces playing out in the background.

4.2 | General Discussion of the Results

This section assesses the results produced under the augmented version of OPENFLEX. While Scenario 1 aligns with benchmark simulations, Scenarios 2 and 3 have been obtained by calibrating the model to reflect two differentiated regions in their monetary and financial subordination within a climate uncertainty regime. Accordingly, the structural liquidity component of country A has been defined so as to be greater than that of country B ($\lambda_S^A > \lambda_S^B$) against the backdrop of a positive climate uncertainty index ϕ. Additionally, in Scenario 3, the increase in preference for assets issued by country A has been framed to reflect a more general tendency for liquidity premia to fall as a result of deteriorating global financial conditions ($\gamma < 0$). As a general trend, the simulations presented indicate that the more OPENFLEX is structured and calibrated according to a climate-uncertainty-augmented currency hierarchy perspective, the greater the hysteretic properties of the system, reflecting a stronger version of imperfect asset substitutability associated with the emerging scenarios.

Figure 5 makes this point by means of a hyperbolic paraboloid representation which connects the liquidity premia differentials $\Delta\lambda_S$ and $\Delta\lambda_T$ with the climate uncertainty index ϕ, providing insight into the resulting hysteretic properties of the system.

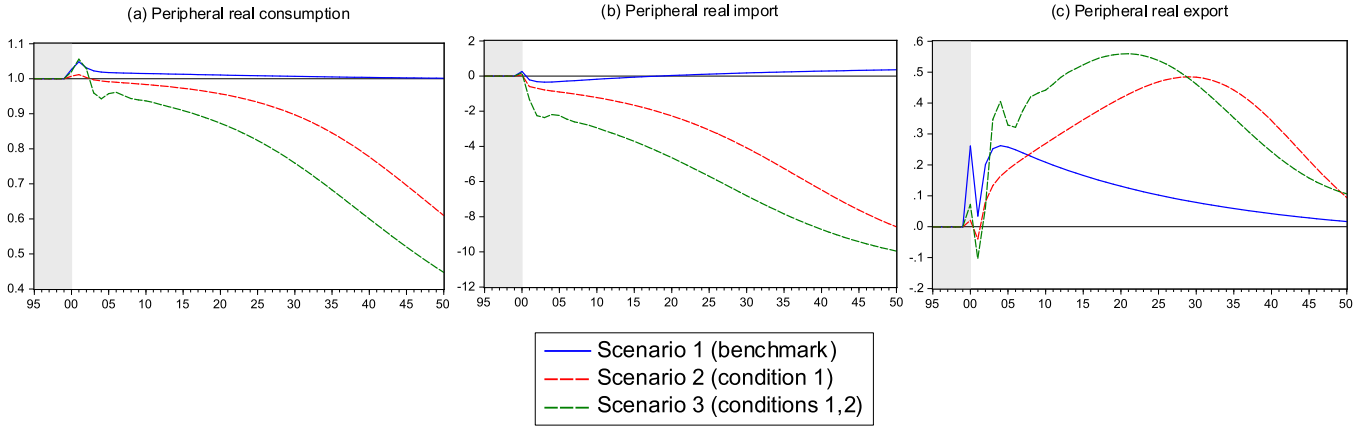


FIGURE 3 | Responses of selected output components in the periphery following an increase in global financial uncertainty under different conditions. *Note:* All the variables refer to Country B and are expressed relative to the baseline. Scenarios are obtained from OPENFLEX benchmark by cumulatively incorporating Conditions 1 and 2.

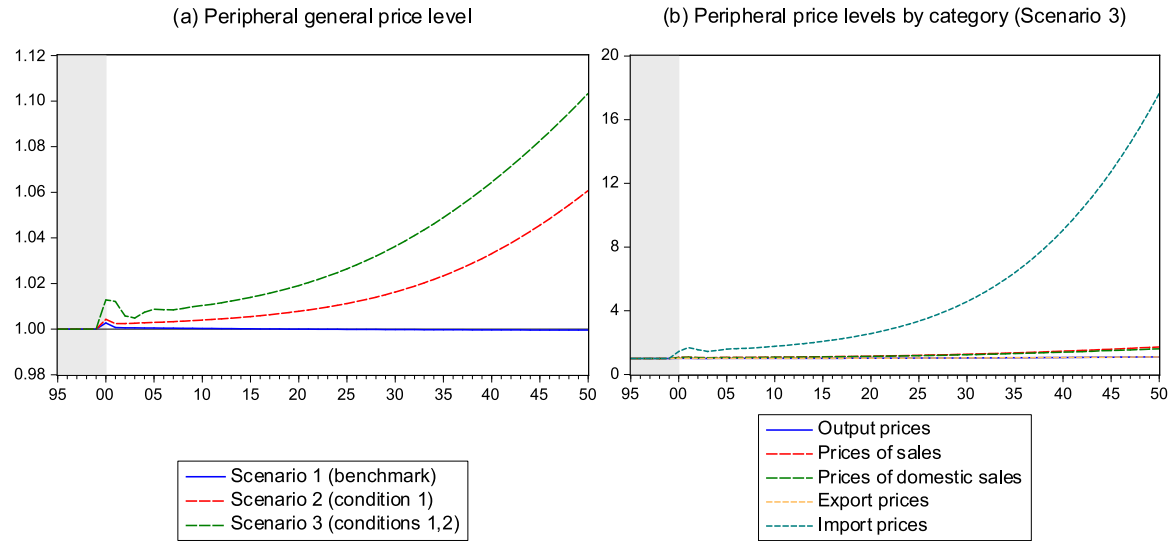


FIGURE 4 | Price responses in the periphery to an increase in global financial uncertainty under different conditions. *Note:* All the variables refer to Country *B* and are expressed relative to the baseline. Scenarios are obtained from OPENFLEX benchmark by cumulatively incorporating Conditions 1 and 2.

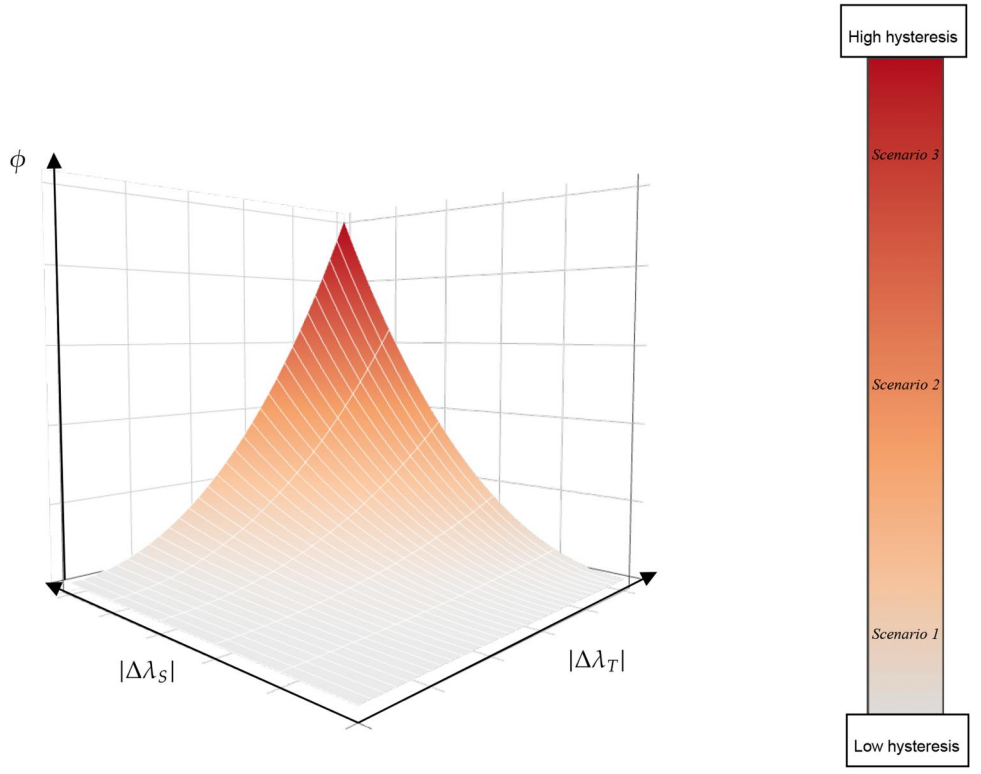


FIGURE 5 | Hysteretic properties of an SFC two-country model and their determinants. *Note:* z-axis associated with the climate uncertainty index ϕ; x-axis associated with the structural liquidity differential $\Delta\lambda_S$ related to the two economies that the model wants to reproduce; y-axis associated with the temporal liquidity differential $\Delta\lambda_T$ related to global financial conditions. Right-hand bar reflecting the intensity of the hysteretic properties and imperfect asset substitutability that characterise the resulting scenarios. *Source:* Author's elaboration.

Scenario 1 situates itself at the origin of the x, y, and z axes, which is associated with low hysteresis. As the climate uncertainty index increases, for positive values on the x and y axes, the resulting scenario converges to highly hysteretic properties. Scenarios 2 and 3 increasingly tend to this outcome. Although, for simplicity, only simulations with the aim of reproducing a bust phase from the perspective of the periphery have been reported, the absolute values $\Delta\lambda_S$ and $\Delta\lambda_T$ underscore that results can be generalised to any temporal and spatial configurations.

These findings provide formal support for a currency hierarchy perspective in the open economy, reinforcing it in the context of climate-related financial pressures. Within a hierarchical IMFS

where climate uncertainty exists, capital flows exerting sustained extrapolative pressures over time define cross-border relations across economies associated with different liquidity features. Accordingly, the domestic macroeconomic conditions of a financially subordinated economy may be destabilised by forces embedded in international monetary and financial structures throughout their adjustment process (Kaltenbrunner and Painceira 2015), with climate change reinforcing its subjugation and external vulnerability (Löscher and Kaltenbrunner 2023). These results point to the uneven impact of the macro-financial disruptions induced by climate change accompanying financial processes, which do not affect all countries evenly.

Beyond that, the augmented version of OPENFLEX also enables the examination of alternative scenarios, from which key policy implications for a just transition can be drawn. In particular, where either the structural or temporal liquidity premium differential is null, Equation (9) would hold, and Equation (1) would dictate that the overall resultant π_{λ_i} is zero. Accordingly, agents would not manifest a strong inclination towards safety or risk, meaning that the model would reproduce the same scenarios consistent with a 'weak' version of imperfect asset substitutability as within its benchmark version (Godley 1999). Importantly, should climate-related financial pressures be introduced under such instances via $\phi > 0$, no significant macro-financial deviation from benchmark OPENFLEX in the resulting scenarios would ensue.

4.3 | Lessons for a Just Transition

While acknowledging the significance of mitigating climate-related financial pressures, the augmented OPENFLEX framework draws emphasis on the importance of a more structural approach to a just transition in which monetary and financial institutions are geared towards global equity and long-term environmental and economic sustainability. With that in mind, while policies operating on ϕ such as green bond issuance (Mohammed et al. 2024; Zhang et al. 2023) may serve to reduce the climate-related financial fragilities highlighted in Scenarios 2 and 3, institutional reforms that address global equity and economic vulnerabilities at a deeper level are needed (see also Bortz and Toftum 2023).[12] Specifically, addressing climate change and achieving a just transition in a more fundamental sense would involve filling 'liquidity loopholes' and addressing the structural gaps in international liquidity provision by designing financial architectures whose resilience to global financial uncertainty shocks is not confined to core countries.

This would entail addressing the disruptive repercussions of structural liquidity premia differentials $\Delta\lambda_S$ that are emblematic of monetary and financial hierarchies, mitigating external vulnerabilities of subordinated economies. One first step could involve a more selective approach to financial integration, which could see the adoption of capital controls as a permanent and preventive feature of DEEs' policy array (Gallagher et al. 2012; Ocampo and Palma 2008; Palma 2002) along with reinforcements and extensions of institutional prudential arrangements at the international level (e.g. BIS 2011).

Against this background, addressing the periodic dimension of liquidity premia differentials $\Delta\lambda_T$ would demand acting countercyclically on the drivers of the global financial cycle, notably on the monetary policy of the issuer of the international reserve currency (Borio 2014; Rey 2015). Monetary policy in systemically important countries may structurally factor an international dimension, insofar as domestic policy choices generate significant spillovers to the rest of the world (Rey 2015, p. 22). Against this background, issuers of key currencies may consider preventive interventions to limit the build-up of financial imbalances as a way to mitigate adjustment costs during contractionary liquidity phases amongst peripheral economies and to contain potential spillbacks (Feroli et al. 2014; Stein 2014).

At a more structural level, addressing the hysteretic properties of the IMFS would require global coordination aligned with the principles of international climate justice to reimagine financial architectures that prioritise long-term environmental and economic sustainability. While exploring specific institutional arrangements extensively goes beyond the goals of this paper, it is nevertheless timely to at least point to indicative avenues of transformation. One such example could involve the IMFS gravitating towards Keynes' proposal for an international clearing union (Keynes [1943] 1973), with a global special purpose money which may combine balance of payment criteria with environmental considerations, allowing to restructure external debt obligations to account for climate vulnerability, particularly for peripheral countries (Aguila et al. 2024).

5 | Conclusion

In marrying the concern for DEEs' monetary and financial subordination with their exposure to climate-related financial pressures, this paper investigates the asymmetric macro-financial trajectories resulting from the hierarchical configuration of the IMFS within a climatically uncertain regime. After discussing the effects of a shock to liquidity preference within the benchmark OPENFLEX framework, the analysis moves to lay out how climate uncertainty considerations may be accounted for in the context of monetary and financial hierarchies. Drawing on these new analytical premises, the paper derives two conditions which it then integrates within OPENFLEX via the redefinition of key behavioural equations according to a higher sensitivity to climate-related financial pressures within a financially subordinated context. Model simulations show that the more the scenarios accounted for climate uncertainty against the backdrop of a hierarchical IMFS, the more the cross-country interactions resulting from a global shift in liquidity preference diverge, burdening peripheral economies. Even without explicitly modelling resource and energy variables or damage functions, the analysis highlights that the climate catastrophe and its accompanying financial processes exacerbate regional economic disparities and reinforce DEEs' subjugation under global financial cycles rooted in international monetary and financial

[12]Similar considerations can be extended to include other green-oriented policy frameworks which aim at encouraging firms to accelerate the transition to low-carbon activities by targeting physical and transition risks, incidentally acting on ϕ by reducing climate uncertainty and its associated vulnerabilities (e.g. Dafermos 2022; Dafermos et al. 2021; Dafermos and Nikolaidi 2021).

hierarchies. These findings suggest that for the just transition to be meaningful, addressing the inherently uneven properties of the IMFS is ultimately needed, reimagining financial architectures that prioritise generalised access to liquidity. An incorporation of ecosystem dynamics and physical climate channels might extend the present framework, enabling a more granular assessment of transition and environmental risks across centre–periphery relations.

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Conflicts of Interest

The author declares no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Appendix A

Key to Symbols

I. Endogenous variables	
Y^A	Nominal income in country A
Y^B	Nominal income in country B
y^A	Real income in country A
y^B	Real income in country B
YD^A	Disposable income in country A
YD^B	Disposable income in country B
YD^A_{hs}	Nominal Haig–Simons disposable income of households in country A
YD^B_{hs}	Nominal Haig–Simons disposable income of households in country B
yd^A_{hs}	Real Haig–Simons disposable income of households in country A
yd^B_{hs}	Real Haig–Simons disposable income of households in country B
yd^A_{hse}	Expected Haig–Simons disposable income of households in country A
yd^B_{hse}	Expected Haig–Simons disposable income of households in country B
C^A	Nominal consumption in country A
C^B	Nominal consumption in country B
c^A	Real consumption in country A
c^B	Real consumption in country B

(Continues)

T^A	Value of tax revenues in country A
T^B	Value of tax revenues in country B
G^A	Nominal government expenditure of country A
G^B	Nominal government expenditure of country B
S^A	Nominal sales in country A
S^B	Nominal sales in country B
s^A	Real sales in country A
s^B	Real sales in country B
DS^A	Nominal domestic sales in country A
DS^B	Nominal domestic sales in country B
ds^A	Real domestic sales in country A
ds^B	Real domestic sales in country B
V^A	Nominal private wealth in country A
V^B	Nominal private wealth in country B
v^A	Real private wealth in country A
v^B	Real private wealth in country B
CAB^A	Current account balance of country A
CAB^B	Current account balance of country B
TB^A	Trade balance of country A
TB^B	Trade balance of country B
X^A	Nominal exports of country A
X^B	Nominal exports of country B
x^A	Real exports of country A
x^B	Real exports of country B
IM^A	Nominal imports of country A
IM^B	Nominal imports of country B
im^A	Real imports of country A
im^B	Real imports of country B
KAB^A	Financial account balance of country A
KAB^B	Financial account balance of country B
B^A_{As}	Bills issued by country A held by households of country A
B^B_{As}	Bills issued by country B held by households of country A
B^B_{Bs}	Bills issued by country B held by households of country B
B^A_{Bs}	Bills issued by country A held by households of country B
B^A_{Ad}	Bills issued by country A demanded by households of country A
B^B_{Ad}	Bills issued by country B demanded by households of country A
B^B_{Bd}	Bills issued by country B demanded by households of country B
B^A_{Bd}	Bills issued by country A demanded by households of country B
B^A_{cbAs}	Bills issued by country A held by the central bank of country A
B^B_{cbBs}	Bills issued by country B held by the central bank of country B
B^A_{cbAd}	Bills issued by country A demanded by the central bank of country A
B^B_{cbBd}	Bills issued by country B demanded by the central bank of country B
B^A_{cbBd}	Bills issued by country A demanded by the central bank of country B
B^A_s	Public debt of country A
B^B_s	Public debt of country B
H^A_s	Money supplied by country A
H^B_s	Money supplied by country B
H^A_h	Money demanded by households of country A
H^B_h	Money demanded by households of country B
F^A_{cb}	Profits of the central bank of country A
F^B_{cb}	Profits of the central bank of country B
N^A	Employment level of country A
N^B	Employment level of country B
DEF^A	Government deficit of country A
DEF^B	Government deficit of country B
$NAFA^A$	Net financial asset accumulation of country A
$NAFA^B$	Net financial asset accumulation of country B
xr^A	Exchange rate of country A
xr^B	Exchange rate of country B
p^B_g	Price of gold in country B
p^A_m	Price of import in country A
p^B_m	Price of import in country B
p^A_x	Price of export in country A
p^B_x	Price of export in country B
p^A_{ds}	Price of domestic sales in country A
p^B_{ds}	Price of domestic sales in country B
p^A_s	Price of sales in country A
p^B_s	Price of sales in country B
p^A_y	Output deflator in country A
p^B_y	Output deflator in country B
r^B	Interest rate on B bills*
$dxre^B$	Change in the expected exchange rate of country B*
$\Delta\lambda_S$	Structural liquidity premium differential*
$\Delta\lambda_T$	Temporal liquidity premium differential*
π_{λ_B}	Liquidity pressure index in country B*
δ	Liquidity pressure response*
λ_{100}	Structural portfolio equation variable regulating demand for B bills in B*
λ_{200}	Structural portfolio equation variable regulating demand for A bills in B*

(Continues)

λ_{400}	Structural portfolio equation variable regulating demand for A bills in A*
λ_{500}	Structural portfolio equation variable regulating demand for B bills in A*
λ_{110}	Cyclical portfolio equation variable regulating demand for B bills in B*
λ_{210}	Cyclical portfolio equation variable regulating demand for A bills in B*
λ_{420}	Cyclical portfolio equation variable regulating demand for A bills in A*
λ_{520}	Cyclical portfolio equation variable regulating demand for B bills in A*
ν_{10}	Pass-through to B import prices*
υ_{10}	Pass-through to B export prices*
ε_{10}	Elasticity determining real export in country B*
μ_{10}	Elasticity determining real import in country B*
II. Exogenous variables	
B^{A}_{cbBs}	Bills issued by country A held by the central bank of country B
g^{A}	Real government expenditure of country A
g^{B}	Real government expenditure of country B
p^{A}_{g}	Price of gold in country A
or^{A}	Gold reserves of country A
or^{B}	Gold reserves of country B
pr^{A}	Productivity in country A
pr^{B}	Productivity in country B
W^{A}	Wage rate in country A
W^{B}	Wage rate in country B
$dxre^{A}$	Change in the expected exchange rate of country A
r^{A}	Interest rate on A bills
γ	Global financial conditions*
λ^{B}_{S}	Structural liquidity conditions in country B*
λ^{A}_{S}	Structural liquidity conditions in country A*
ϕ	Climate uncertainty index*
III. Model parameters	
θ^{A}	Tax rate in country A
θ^{B}	Tax rate in country B
α^{A}_{1}	Propensity to consume out of income in country A
α^{B}_{1}	Propensity to consume out of income in country B
α^{A}_{2}	Propensity to consume out of wealth in country A
α^{B}_{2}	Propensity to consume out of wealth in country B
φ^{A}	Mark-up on unit cost in country A
φ^{B}	Mark-up on unit cost in country B
ν_{0}	First parameter of B import prices
ν_{1}	Parameter in pass-through to B import prices
υ_{0}	First parameter of B export prices
υ_{1}	Parameter in pass-through to B export prices
ε_{2}	Elasticity with respect to A output determining real export in country B
μ_{2}	Elasticity with respect to B output determining real export in country A
μ_{0}	Constant real import in country B
μ_{1}	Parameter in elasticity determining real import in country B*
ε_{0}	Constant real export in country B
ε_{1}	Parameter in elasticity determining real export in country B*
$\lambda_{1\text{-}5}$	Weighting parameters in structural portfolio equation variables*
$\lambda_{6\text{-}9}$	Weighting parameters in cyclical portfolio equation variables*
$\lambda_{10\text{-}50}$	Parameters in structural portfolio equation variables*
$\lambda_{11\text{-}52}$	Parameters in cyclical portfolio equation variables*
λ	Weighting parameter in portfolio equation variables*
κ	Weighting parameter in temporal liquidity premium differential of global financial conditions*
o	Weighting parameter in temporal liquidity premium differential of the change in A monetary policy*
ω	Weighting parameter in the liquidity pressure response*
ξ	Weighting parameter in the elasticity determining real import in country B*
φ	Weighting parameter in the elasticity determining real export in country B*
χ	Weighting parameter in liquidity pressure index*
ψ	Weighting parameter in the interest rate mark-up in country B*
β	Weighting parameter in the expected exchange rate of country B*
υ	Weighting parameter in the pass-through to B export prices*
η	Weighting parameter in the pass-through to B import prices*

*Note:** Key amendments or additions to the original model by Godley and Lavoie ([2007] 2012).

(Continues)

Appendix B

Model Equations

I. Accounting identities

$$YD^A = Y^A + r^A_{-1}\cdot B^A_{As-1} + r^B_{-1}\cdot B^B_{As-1}\cdot xr^B - T^A \quad \text{(B.1)}$$

$$YD^A_{hs} = YD^A + \Delta xr^B\cdot B^B_{As-1} \quad \text{(B.2)}$$

$$\Delta V^A = \left(YD^A - C^A\right) + \Delta xr^B\cdot B^B_{As-1} \quad \text{(B.3)}$$

$$YD^B = Y^B + r^B_{-1}\cdot B^B_{Bs-1} + r^A_{-1}\cdot B^A_{Bs-1}\cdot xr^A - T^B \quad \text{(B.4)}$$

$$YD^B_{hs} = YD^B + \Delta xr^A\cdot B^A_{Bs-1} \quad \text{(B.5)}$$

$$\Delta V^B = \left(YD^B - C^B\right) + \Delta xr^A\cdot B^A_{Bs-1} \quad \text{(B.6)}$$

$$T^A = \theta^A\left(Y^A + r^A_{-1}\cdot B^A_{As-1} + r^B_{-1}\cdot B^B_{As-1}\cdot xr^B\right) \quad \text{(B.7)}$$

$$T^B = \theta^B\left(Y^B + r^B_{-1}\cdot B^B_{Bs-1} + r^A_{-1}\cdot B^A_{Bs-1}\cdot xr^A\right) \quad \text{(B.8)}$$

$$Y^A = C^A + G^A + X^A - IM^A \quad \text{(B.9)}$$

$$Y^B = C^B + G^B + X^B - IM^B \quad \text{(B.10)}$$

$$F^B_{cb} = r^B_{-1}\cdot B^B_{cbBs-1} + r^A_{-1}\cdot B^A_{cbBs-1}\cdot xr^A \quad \text{(B.11)}$$

$$F^A_{cb} = r^A_{-1}\cdot B^A_{cbAs-1} \quad \text{(B.12)}$$

$$\Delta B^A_s = G^A - T^A + r^A_{-1}\cdot B^A_{s-1} - F^A_{cb} \quad \text{(B.13)}$$

$$\Delta B^B_s = G^B - T^B + r^B_{-1}\cdot B^B_{s-1} - F^B_{cb} \quad \text{(B.14)}$$

$$TB^A = X^A - IM^A \quad \text{(B.15)}$$

$$TB^B = X^B - IM^B \quad \text{(B.16)}$$

$$CAB^A = TB^A + r^B_{-1}\cdot B^B_{As-1}\cdot xr^B - r^A_{-1}\cdot B^A_{Bs-1} - r^A_{-1}\cdot B^A_{cbBs-1} \quad \text{(B.17)}$$

$$CAB^B = TB^B + r^A_{-1}\cdot B^A_{Bs-1}\cdot xr^A - r^B_{-1}\cdot B^B_{As-1} + r^A_{-1}\cdot B^A_{cbBs-1}\cdot xr^A \quad \text{(B.18)}$$

$$KAB^A = \Delta B^A_{Bs} + \Delta B^A_{cbBs} - \Delta B^B_{As}\cdot xr^B - \Delta or^A\cdot p^A_g \quad \text{(B.19)}$$

$$KAB^B = \Delta B^B_{As} - \Delta B^A_{Bs}\cdot xr^A - \Delta B^A_{cbBs}\cdot xr^A - \Delta or^B\cdot p^B_g \quad \text{(B.20)}$$

II. International trade equations

$$\log\left(p^B_m\right) = \nu_0 - \nu_{10}\cdot\log\left(xr^B\right) + (1-\nu_{10})\cdot\log\left(p^B_y\right) + \nu_{10}\cdot\log\left(p^A_y\right) \quad \text{(B.21)*}$$

$$\log\left(p^B_x\right) = \upsilon_0 - \upsilon_{10}\cdot\log\left(xr^B\right) + (1-\upsilon_{10})\cdot\log\left(p^B_y\right) + \upsilon_{10}\cdot\log\left(p^A_y\right) \quad \text{(B.22)*}$$

$$\log\left(x^B\right) = \varepsilon_0 - \varepsilon_{10}\cdot\left[\log\left(p^A_{m-1}\right) - \log\left(p^A_{y-1}\right)\right] + \varepsilon_2\cdot\log\left(y^A\right) \quad \text{(B.23)*}$$

$$\log\left(im^B\right) = \mu_0 - \mu_{10}\cdot\left[\log\left(p^B_{m-1}\right) - \log\left(p^B_{y-1}\right)\right] + \mu_2\cdot\log\left(y^B\right) \quad \text{(B.24)*}$$

$$p^A_x = p^B_m\cdot xr^B \quad \text{(B.25)}$$

$$p^A_m = p^B_x\cdot xr^B \quad \text{(B.26)}$$

$$x^B = im^A \quad \text{(B.27)}$$

$$im^B = x^A \quad \text{(B.28)}$$

$$X^A = x^A\cdot p^A_x \quad \text{(B.29)}$$

$$X^B = x^B\cdot p^B_x \quad \text{(B.30)}$$

$$IM^A = im^A\cdot p^A_m \quad \text{(B.31)}$$

$$IM^B = im^B\cdot p^B_m \quad \text{(B.32)}$$

$$\upsilon_{10} = \upsilon_1 + \upsilon\cdot\Delta\lambda_S\cdot(1+\phi) \quad \text{(B.33)*}$$

$$\nu_{10} = \nu_1 + \eta\cdot\Delta\lambda_S\cdot(1+\phi) \quad \text{(B.34)*}$$

$$\varepsilon_{10} = \varepsilon_1 + \varphi\cdot\Delta\lambda_S\cdot(1+\phi) \quad \text{(B.35)*}$$

$$\mu_{10} = \mu_1 + \xi\cdot\Delta\lambda_S\cdot(1+\phi) \quad \text{(B.36)*}$$

(Continues)

III. Income and expenditure

$$v^B = \frac{V^B}{p_{ds}^B} \tag{B.37}$$

$$v^A = \frac{V^A}{p_{ds}^A} \tag{B.38}$$

$$c^A = \alpha_1^A \cdot yd_{hse}^A + \alpha_2^A \cdot v_{-1}^A \tag{B.39}$$

$$c^B = \alpha_1^B \cdot yd_{hse}^B + \alpha_2^B \cdot v_{-1}^B \tag{B.40}$$

$$yd_{hs}^A = \frac{YD_{hs}^A}{p_{ds}^A} - v_{-1}^A \cdot \frac{\Delta p_{ds}^A}{p_{ds}^A} \tag{B.41}$$

$$yd_{hs}^B = \frac{YD_{hs}^B}{p_{ds}^B} - v_{-1}^B \cdot \frac{\Delta p_{ds}^B}{p_{ds}^B} \tag{B.42}$$

$$yd_{hse}^A = \frac{\left(yd_{hs}^A + yd_{hs-1}^A\right)}{2} \tag{B.43}$$

$$yd_{hse}^B = \frac{\left(yd_{hs}^B + yd_{hs-1}^B\right)}{2} \tag{B.44}$$

$$s^A = c^A + g^A + x^A \tag{B.45}$$

$$s^B = c^B + g^B + x^B \tag{B.46}$$

$$S^A = s^A \cdot p_s^A \tag{B.47}$$

$$S^B = s^B \cdot p_s^B \tag{B.48}$$

$$p_s^A = \frac{(1+\varphi^A)\cdot(W^A \cdot N^A + IM^A)}{s^A} \tag{B.49}$$

$$p_s^B = \frac{(1+\varphi^B)\cdot(W^B \cdot N^B + IM^B)}{s^B} \tag{B.50}$$

$$p_{ds}^A = \frac{S^A - X^A}{s^A - x^A} \tag{B.51}$$

$$p_{ds}^B = \frac{S^B - X^B}{s^B - x^B} \tag{B.52}$$

$$DS^A = S^A - X^A \tag{B.53}$$

$$DS^B = S^B - X^B \tag{B.54}$$

$$ds^A = s^A - x^A \tag{B.55}$$

$$ds^B = s^B - x^B \tag{B.56}$$

$$Y^A = S^A - IM^A \tag{B.57}$$

$$Y^B = S^B - IM^B \tag{B.58}$$

$$y^A = s^A - im^A \tag{B.59}$$

$$y^B = s^B - im^B \tag{B.60}$$

$$p_y^A = \frac{Y^A}{y^A} \tag{B.61}$$

$$p_y^B = \frac{Y^B}{y^B} \tag{B.62}$$

$$C^A = c^A \cdot p_{ds}^A \tag{B.63}$$

$$C^B = c^B \cdot p_{ds}^B \tag{B.64}$$

$$G^A = g^A \cdot p_{ds}^A \tag{B.65}$$

$$G^B = g^B \cdot p_{ds}^B \tag{B.66}$$

$$N^A = \frac{y^A}{pr^A} \tag{B.67}$$

$$N^B = \frac{y^B}{pr^B} \tag{B.68}$$

$$r^B = r^A + \psi \cdot \delta \cdot \log\left(\frac{1}{xr_{-1}^B}\right) \tag{B.69}*$$

$$dxre^B = \beta \cdot (-\delta) \tag{B.70}*$$

IV. Demands for financial assets

$$B_{Bd}^B = V^B \cdot [\lambda_{100} + \lambda_{110} - \lambda_{12} \cdot (r^A + dxre^A)] \tag{B.71}*$$

(Continues)

$$B^A_{Bd} = V^B \cdot [\lambda_{200} - \lambda_{210} + \lambda_{22} \cdot (r^A + dxre^A)] \quad \text{(B.72)*}$$

$$B^A_{Ad} = V^A \cdot [\lambda_{400} + \lambda_{41} \cdot r^A - \lambda_{420} - \lambda_{42} \cdot dxre^B] \quad \text{(B.73)*}$$

$$B^B_{Ad} = V^A \cdot [\lambda_{500} - \lambda_{51} \cdot r^A + \lambda_{520} + \lambda_{52} \cdot dxre^B] \quad \text{(B.74)*}$$

$$H^A_h = V^A - B^A_{Ad} - B^B_{Ad} \quad \text{(B.75)}$$

$$H^B_h = V^B - B^B_{Bd} - B^A_{Bd} \quad \text{(B.76)}$$

$$\lambda_{100} = \lambda_{10} \cdot (1 - \lambda \cdot \delta \cdot \lambda_1) \quad \text{(B.77)*}$$

$$\text{If } \delta > 0 \Longrightarrow \lambda_{100} < \lambda_{200}$$

$$\lambda_{200} = \lambda_{20} \cdot (1 + \lambda \cdot \delta \cdot \lambda_2) \quad \text{(B.78)*}$$

$$\lambda_{400} = \lambda_{40} \cdot (1 + \lambda \cdot \delta \cdot \lambda_4) \quad \text{(B.79)*}$$

$$\text{If } \delta < 0 \Longrightarrow \lambda_{400} < \lambda_{500}$$

$$\lambda_{500} = \lambda_{50} \cdot (1 - \lambda \cdot \delta \cdot \lambda_5) \quad \text{(B.80)*}$$

$$\lambda_{110} = \lambda_{11} \cdot (r^B - \lambda \cdot \lambda_6 \cdot \delta \cdot dr^B) \quad \text{(B.81)*}$$

$$\lambda_{210} = \lambda_{21} \cdot (r^B - \lambda \cdot \lambda_7 \cdot \delta \cdot dr^B) \quad \text{(B.82)*}$$

$$\lambda_{420} = \lambda_{42} \cdot (r^B - \lambda \cdot \lambda_8 \cdot \delta \cdot dr^B) \quad \text{(B.83)*}$$

$$\lambda_{520} = \lambda_{52} \cdot (r^B - \lambda \cdot \lambda_9 \cdot \delta \cdot dr^B) \quad \text{(B.84)*}$$

$$\Delta\lambda_T = \kappa \cdot \gamma - o \cdot dr^A \quad \text{(B.85)*}$$

$$\Delta\lambda_S = \lambda^B_S - \lambda^A_S \quad \text{(B.86)*}$$

$$\pi_{\lambda_B} = \chi \cdot \Delta\lambda_T \cdot \Delta\lambda_S \cdot (1 + \phi) \quad \text{(B.87)*}$$

$$\delta = \begin{cases} \pi_{\lambda_B} \cdot (1 + \omega \cdot dr^B), dr^B > 0 \\ \pi_{\lambda_B}, dr^B \leq 0 \end{cases} \quad \text{(B.88)*}$$

V. Supplies of financial assets

$$H^A_s = H^A_h \quad \text{(B.89)}$$

$$B^A_{As} = B^A_{Ad} \quad \text{(B.90)}$$

$$B^A_{cbAs} = B^A_{cbAd} \quad \text{(B.91)}$$

$$H^B_s = H^B_h \quad \text{(B.92)}$$

$$B^B_{Bs} = B^B_{Bd} \quad \text{(B.93)}$$

$$B^B_{cbBs} = B^B_{cbBd} \quad \text{(B.94)}$$

$$\Delta B^B_{cbBd} = \Delta H^B_s - \Delta B^A_{cbBs} \cdot xr^A - \Delta or^B \cdot p^B_g \quad \text{(B.95)}$$

$$B^A_{cbAd} = H^A_s - or^A \cdot p^A_g \quad \text{(B.96)}$$

$$p^B_g = p^A_g \cdot xr^A \quad \text{(B.97)}$$

$$xr^B = \frac{B^A_{Bs}}{B^A_{Bd}} \quad \text{(B.98)}$$

$$xr^A = \frac{1}{xr^B} \quad \text{(B.99)}$$

$$B^A_{cbBs} = \overline{B^A_{cbBs}} \quad \text{(B.100)}$$

$$B^A_{cbBd} = B^A_{cbBs} \cdot xr^A \quad \text{(B.101)}$$

$$B^B_{As} = B^B_{Ad} \cdot xr^A \quad \text{(B.102)}$$

$$B^A_{Bs} = B^A_s - B^A_{As} - B^A_{cbAs} - B^A_{cbBs} \quad \text{(B.103)}$$

VI. Additional identities

$$DEF^A = G^A + r^A_{-1} \cdot B^A_{s-1} - T^A - F^A_{cb} \quad \text{(B.104)}$$

$$DEF^B = G^B + r^B_{-1} \cdot B^B_{s-1} - T^B - F^B_{cb} \quad \text{(B.105)}$$

$$NAFA^A = DEF^A + CAB^A \quad \text{(B.106)}$$

$$NAFA^B = DEF^B + CAB^B \quad \text{(B.107)}$$

VII. Redundant equation

$$B^B_{cbBs} = B^B_s - B^B_{Bs} - B^B_{As} \quad \text{(B.108)}$$

Note: * Key amendments or additions to the original model by Godley and Lavoie ([2007] 2012). Variables denoting changes that are not defined by an equation of the model are obtained as first differences with respect to the previous period.