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Can Colombia cope with a Global Low Carbon transition?

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Can Colombia cope with a Global Low Carbon transition?

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Abstract
This paper aims to understand the long-term consequences for the Colombian economy of a global low-carbon transition. The paper proposes an empirical Stock-Flow Consistent model for Colombia, encompassing relevant dynamics for the economy: details regarding the trade balance such as fossil fuel exports or propensities to import out of consumption, intermediate goods or capital goods, dependency to international financial flows to cover a trade balance deficit, and more generally financial feedback loops for all institutional sectors. We envisage different scenarios regarding fossil fuel exports and show the dramatic impacts that Colombia could face in the case of a rapid decline in such exports. We then consider policy responses consisting in industrial policies to diversify the export base and show they can help mitigate the Colombian vulnerabilities but only after a certain period of time indicating the urgency of implementing such policies in Colombia.

Keywords
AFD, Agence française de développement, Research papers, Colombia, low carbon transition, fossil fuel exports

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Résumé
Cet article vise à comprendre les conséquences à long terme pour l'économie colombienne d'une transition bas-carbone mondiale. Nous proposons un modèle empirique Stock-Flux Cohérent pour la Colombie, englobant les dynamiques pertinentes pour l'économie : détails concernant la balance commerciale tels que les exportations de combustibles fossiles ou les propensions à importer hors consommation, biens intermédiaires ou biens d'investissement, la dépendance à l'égard des flux financiers internationaux pour couvrir un déficit de la balance commerciale, et plus généralement les boucles de rétroaction financière pour tous les secteurs institutionnels. Nous envisageons différents scénarios concernant les exportations de combustibles fossiles et montrons les impacts dramatiques que la Colombie pourrait subir en cas de baisse rapide de ces exportations. Nous examinons ensuite les réponses politiques consistant en des politiques industrielles visant à diversifier la base d'exportation et à montrer qu'elles peuvent aider à atténuer les vulnérabilités colombiennes, mais seulement après un certain temps, ce qui indique l'urgence de mettre en œuvre de telles politiques en Colombie.

Mots-clés
Colombie, transition bas-carbone, exportation de combustibles fossiles

1. Introduction

One of the key points for achieving the objectives established in the Paris Agreement is to rapidly initiate a de-carbonisation pathway of global consumption and production patterns, especially in high-income countries. Despite the slow pace of this process due to moderate ambition and political constraints affecting global mitigation actions, the reduction in global demand for fossil fuels will emerge as one of the main outcomes of this forthcoming structural change. While this global low-carbon transition could benefit net fossil fuel-importing countries, other economies with export, financial, productive and/or fiscal dependencies on fossil fuel industries will have to cope with the negative impacts (see e.g. Daumas, 2023; Cahen-Fourot et al., 2021; Van der Ploeg and Rezai, 2020)

An example of such adversely affected countries is Colombia; a middle-income country for which coal and oil exports have accounted for 51% of the export basket of goods for the period 2015-2022. The oil and mining sector has also been an important source of foreign exchange provision for the economy, both via high levels of exports and as the recipient of 24% of foreign direct investment (FDI) during this period. In terms of production, the oil and coal mining industry contributed around 5% to the total value added between 2015 and 2022. Finally, the industry has also been an important source of fiscal revenues, contributing royalties, dividends from Ecopetrol (the majority state-owned oil company) and income tax at an average of 1.4% of GDP per year for the period 2015-2021.

Taking Colombia as a representative case of other developing economies, this paper seeks to analyse some of the implications that the global low-carbon transition may have on its economy during the period 2023-2050. Based on an empirical Stock-Flow Consistent model, reproducing the main regularities of the Colombian economy and calibrated for 2019, we simulate different scenarios of oil and coal export projections and analyse their respective medium- and long-term impacts. Then, we consider the effects of an industrialisation policy that contributes to diversifying the export basket to assess policy alternatives to reduce the vulnerabilities arising from a declining path of fossil fuel exports,

Thus, our paper thus contributes to the literature on macroeconomic and financial vulnerabilities that may emerge in developing economies in the context of the global low-carbon transition. Semieniuk et al. (2021); Bolton et al. (2020); Bernal and Ocampo (2020), among others, have examined the potential effects that moving to a low-carbon economy may have on financial stability from a more qualitative approach and without resorting to modelling tools to explore cross-channel interactions. Magacho et al. (2023) have quantified the macroeconomic exposure of different countries to the global low-carbon transition using input-output analysis and clustering techniques. While this approach allows for a deeper exploration of multi-sectoral issues, its static nature and emphasis on the real side of the economy omit financial dynamics and stock-flow relationships relevant to a more holistic view of vulnerability. Bernal-Ramírez et al. (2022) have estimated the effects of physical and transition risks on a set of macroeconomic and financial variables in Colombia based on the Network for Greening the Financial System's scenarios. Although it is a pioneering study for the country, the use of partial equilibrium methodologies and accounting projections omits interactions and adjustment mechanisms within and between the real and financial spheres

of the economy that may affect the simulated paths.

Hence, unlike these contributions, this paper empirically analyses the consequences of such a structural change using a fully integrated Stock-Flow Consistent approach that simultaneously models the real and financial dynamics of an economy under different scenarios, while allowing for dynamics of disequilibrium and endogenous responses of institutional sectors to changes in their budget constraints and balance sheets. In this way, by capturing the interactions and feedback loops between both spheres over time, we can obtain more accurate and realistic diagnoses of the risks and opportunities that the low-carbon transition may bring forward for developing countries like Colombia.

Our results indicate that a decline in fossil fuel exports would lead Colombia to greater macroeconomic and financial fragility. More precisely, the widening trade deficit and lower FDI inflows induce a sharp depreciation of the Colombian peso, which, depending on the timing of the transition and policy responses, could lead to a currency crisis. In turn, the economy exhibits a lower growth rate, resulting in higher unemployment and higher inflation due to the exchange rate pass-through. Falling oil and coal exports, currency depreciation and higher inflation widen the fiscal deficit and lead to a higher level of public debt, while the deterioration in public finances and the dis-accumulation of international reserves increases the country risk premium. In the long run, the economy's ability to mitigate or reverse these impacts will depend on the magnitude of the favourable response of the trade balance to peso depreciation, on the implementation of industrialisation policies, and on the insertion into global value chains that would diversify the export basket. However, it is a priority to start implementing such policies early because the such structural transformations take time to materialise and to be effective, they require to overcome multiple bottlenecks.

The paper is structured as follows. After this introduction, section 2 presents a brief background of the Colombian economy and the literature on macroeconomic modelling in Colombia to show where we stand. Section 3 describes the structure and main blocks of the empirical SFC model. Then, section 4 presents the data sources, briefly describes the calibration of the model and discusses the scenarios that will be simulated, contrasting the Baseline scenario with some projections of the Colombian Ministry of Finance for the next decade. Section 5 presents the results of the model simulations for some of the scenarios, shows the possibility of a currency crisis and discusses some policy responses. Last but not least, section 6 presents the final reflections of this paper and concludes.

2. Motivation and Context

2.1. Colombia

The Colombian economy is characterized by the so-called "balance-of-payments dominance" that imposes a ceiling on long-term growth and makes external shocks largely determine the short-term behavior of the economy. This can render macroeconomic dynamics procyclical to balance of payments performance and have ambiguous effects on the exchange rate (Prebisch and Cabañas, 1949; Thirlwall et al., 1979; Ocampo, 2016). In essence,

cycles of external financing flows and the procyclical behavior of risk premiums have been the main causes of imbalances and real volatility in Latin American countries (Titelman and Pérez, 2015). The "structural heterogeneity" among productive sectors inhibits the diffusion of intersectoral technical change, slows down productivity growth, and reduces the speed of the convergence processes. (Abeles and Pérez Caldentey, 2022; Pérez Caldentey, 2015). Specialization in natural resources and primary goods creates a "rent-seeking" society and distorts the allocation of resources, further reducing growth prospects. The Dutch disease and income and wealth distribution deterioration are also contributing factors to this process (Botta et al., 2016; Goda and Torres, 2013).

From 2003 to 2014, the Colombian economy experienced a positive growth trend driven by the mining-energy sector during the commodity super-cycle. In this period, the financial Dutch disease resulted in re-primarization, with the mining sector's growth leading to de-industrialization and the rapid growth of non-tradable sectors such as services and construction. Additionally, public sector expenditures were a significant driver of economic growth in this phase. The mining-energy sector suffered negative growth rates from 2014 to 2018 due to falling international commodity prices. Despite this slowdown, economic growth remained positive until the COVID-19 pandemic, but the health crisis led to a 7% fall in production, resulting in the lowest economic growth rate of the last decades.

Colombian exports are heavily dependent on the mining-energy sectors, particularly crude oil production, which accounts for 26.2% of the export basket. Services, mainly tourism and transportation, and agricultural goods, such as coffee, flowers, and bananas, are also vital in generating export revenues. In contrast, the import basket is diversified, with sectors like chemicals and machinery accounting for the largest shares. Compared to its exports, Colombia tends to have a higher value-added content in its imported goods, such as vehicles, electronic products, and capital goods. This trade imbalance partly explains the country's current account deficit, which has steadily increased since 2005. Non-financial firms and the government have contributed most to the current account deficit, while households have remained in surplus due to remittances sent by Colombians living abroad, which accounts for an average of 2.1% of GDP each year since 2015.

The financial account surplus in Colombia between 2000 and 2014 was largely driven by FDI and portfolio investment, which were influenced by the international commodity price boom and the abundance of liquidity in global markets. The oil sector received the highest share of foreign investment, followed by the mining industry and the financial sector. However, foreign direct investment is highly volatile and sensitive to international commodity prices and international liquidity. Both external and domestic flows to finance the private and public sectors are on an upward trend, while the net debt of the Central National Government rose to almost 61% of GDP in 2020 due to the COVID-19 pandemic.

The Colombian central government's revenues increased progressively from 11.4% in 2000 to 16.2% in 2019. The majority of state revenues come from tax collection, with value-added tax, income tax, and the levy on financial transactions representing almost 80% of tax revenues. On the primary expenditure side of the central national government, this also increased from 12.7% of GDP in 2000 to 15.9% of GDP in 2019. Within this category, public investment has been quite pro-cyclical, reaching a peak of 3.1% of GDP in 2013 in the years of highest growth and oil

revenues, before gradually decelerating to 1.8% of GDP in 2019. Precisely, public investment normally acts as an adjustment variable during years of fiscal consolidation. Additionally, the central government budget is subject to a fiscal rule targeting a 55% net debt to GDP ratio and limited by a 71% net debt to GDP ratio. Although the rule was postponed due to the COVID-19 crisis, a transition path in the primary fiscal balance is currently established to reach the target of the rule in 2026 when it will fully enter into force.

The main target of Colombia's monetary policy is to maintain the purchasing power of the currency, while achieving general economic policy objectives such as economic growth and full employment. However, *Banco de la República*, Colombia's central bank, has played a passive role in achieving other objectives apart from controlling inflation. The link between the central bank policy rate and lending rates have been strong, albeit with very high premiums charged by the financial sector. While the average monetary policy rate between 2000 and 2022 was 5.9, the average lending rate for the same period was 13.88%, implying a spread of 798 basis points. The consumer credit rate on the other hand was a staggering 1,310 basis points above the average policy rate in this period.

Colombia's production regime, characterized by a rentier model, has resulted in a highly unequal society, with indicators of income, wealth, and land ownership distribution perpetuating the production regime (Guevara Castañeda, 2015). The economy is also characterized by a labour informality rate of around 50% and a persistent unemployment rate that rarely falls below two digits. While efforts to reduce inequality have not yielded substantial results, taxation has also played a role in perpetuating inequality, with the tax system being highly regressive (Garay and Espitia, 2020). Inequality of income is reinforced by unequal access to land, which has been fueled by institutional characteristics such as the absence of structural agrarian reforms and the presence of illegal actors in the armed conflict (Botero, 2016). Disaggregated by gender, indicators worsen, with women receiving a smaller share of pre-tax labor income and having unequal opportunities to access the labor market due to the burden of care work. The pandemic has also reversed the progress in poverty reduction and increased poverty levels, particularly in rural areas. These characteristics generate tensions in both the social and political arenas in Colombia (Archila et al., 2018).

2.2. Literature review on existing macro models for Colombia

According to Espinoza et al. (2017), the macroeconomic models developed in Colombia to date have two main characteristics. First, most follow an orthodox approach with the utilization of Computable General Equilibrium (CGE) models, Dynamic Stochastic General Equilibrium (DSGE) models and more recently New Keynesian Semi-Structural State-Space models (see e.g. Guarin et al., 2020)). Second, most of them are developed by the technical departments of the Central Bank, the National Planning Department and the Ministry of Finance, as well as by researchers attached to universities, think tanks such as Fedesarrollo and consultancies supported by multilateral organizations.

CGE models have been used extensively since the 1980s (Suescún et al., 2017) and are based on Social Accounting Matrices (SAM), which tend to emphasise real transactions in the economy and exclude financial flows in most studies. The objective of most of these models

has been to analyse the effects of different macroeconomic and policy shocks and scenarios at the national, regional, sectoral and income group levels.

Among the most recent CGE models, Haddad et al. (2022) analyse the regional economic impacts of royalties, Velasco-Martínez and Cárdenas-Hurtado (2015) construct long-run macroeconomic scenarios for the Central Bank and Hernández (2012) analyses the effects of payroll taxes on the labour market. It is worth mentioning that these models have also been used in Colombia to analyse the distributional effects of carbon taxes (Romero et al., 2018), the macroeconomic effects of Colombia's first Nationally Determined Contribution to the Paris Agreement (Álvarez-Espinosa et al., 2017) and the economic impacts of climate change (Tapasco et al., 2015).

Regarding DSGE models, their application in Colombia started to grow in the late 1990s in line with computational advances and developments in the New Keynesian literature regarding the introduction of nominal and real rigidities and other frictions to Real Business Cycle models (Rodríguez Revilla, 2011). These models have been developed mainly by central bank researchers to build scenarios and simulate macroeconomic and policy shocks, calibrated to represent on average the characteristics of the Colombian economy. These include the Policy Analysis Tool Applied to Colombian Needs (PATACON) developed by González et al. (2011) which aims to support monetary policy decisions and the DSGE Fiscal Model for Colombia (FISCO) developed by Rincón et al. (2017) for the analysis of fiscal policy and its interactions with monetary policy.

With this in mind, the empirical SFC model presented here follows a tradition of macroeconomic modelling little explored in Colombia. On the one hand, in contrast to the widely used CGE and DSGE models, we present a model of a monetary and demand-led economy without resorting to micro-foundations, intertemporal optimisation assumptions and mechanical equalization of investment to savings. Here, real and financial spheres of the economy are modeled explicitly and comprehensively as well as the different feedback loops that emerge between them. The role of banks as creators of means of payments is considered beyond being simple intermediaries between borrowers and savers, and financial flows are analysed autonomously rather than being seen as a mirror image of real flows.[1] Last but not least, the continuous-time specification allows for the emergence of disequilibrium dynamics instead of purely equilibrium modelling approaches.[2]

On the other hand, although there have been previous contributions to SFC modelling in Colombia (Escobar, 2016; Guevara Castañeda, 2015), the model presented here differs in several respects. First, it details the main features and interactions of all institutional sectors of the economy, while Guevara Castañeda (2015) analyses a closed economy and Escobar (2016) aggregates households and financial and non-financial corporations into a single private sector. Second, it is an empirical and continuous-time model with a high level of disaggregation and a significant number of real and financial transactions, while aforementioned studies present rather stylised models with a small number of variables and in discrete time. Thirdly, the calibration of the model, the construction of the matrices and the analysis of the results are carried out on the basis of observed data, while in the previous

[1] For more details regarding the SFC literature, see Godley and Lavoie (2006) and Caverzasi and Godin (2015); Nikiforos and Zezza (2017) for recent literature reviews.

[2] See Yilmaz and Godin (2020) for more details on the usage of continuous time stock-flow consistent models.

contributions such exercises are not carried out or not presented.

3. Model

The model derives from the benchmark SFC model of a small open economy developed by Yilmaz and Godin (2020), adapted for the case of Colombia via (among others) the inclusion of FDI flows and public bonds in foreign currency, adaptation of the exports function to represent fossil fuel exports and their connection to royalties generation, a more detailed representation of taxation and pricing and rationing in foreign exchange markets.

Recently, SFC modeling has been utilized to examine the impact of climate change on global macro-financial developments and macroeconomic stability, (Dafermos et al., 2017, 2018; Bovari et al., 2018), as well as the economic implications of rapid energy transition paths (Jacques et al., 2023). Our unique approach combines a multi-sector production structure with the SFC framework and the continuous-time dynamic, macrofoundations approach of the Bielefeld school of macroeconomics (Chiarella and Flaschel, 2006; Flaschel, 2008; Flaschel et al., 2008; Charpe et al., 2011; Chiarella et al., 2012, 2013). We specifically focus on dynamic disequilibrium processes and emphasize the significance of capital inflows for small open economies like Colombia (Frankel, 2010; Borio and Disyatat, 2015). Furthermore, we analyze how these inflows affect the domestic economy through channels like international trade (Blecker, 2016), liquidity (Kaminsky et al., 1997), and balance sheet effects (Bernanke and Gertler, 1995).

The model's stock-flow structure is well-suited for examining external imbalances and a country's susceptibility to financial crises, as well as the macro-environmental channels that can propagate the initial loss in fossil fuel exports. This is due to the fact that the model not only monitors the current account imbalances and the first-round negative effects of a global transition on the trade balance, but also the gross exposure to external financial risks, which is typically overlooked when evaluating external imbalances (Borio and Disyatat, 2011, 2015). The endogenous international investment position and the dynamics of available foreign exchange reserves explicitly monitor the latter. Additionally, the model's structure facilitates a thorough investigation of how such financial risks are distributed within a country through the accumulation of external debt in the balance sheets of all institutional sectors. The model also permits detailed feedback effects such as price effects through the evolution of interest rates and quantity effects such as the quantity rationing in the foreign exchange market and the overall indebtedness of the Colombian economy.

3.1. Structure

Table1 shows the transaction-flow matrix (TFM) that characterizes the Colombian model. Each column represents an institutional agent and each row represents a transaction. There are six institutional agents (one per column): non-financial corporations (NFC), households, financial corporations (FC), the central bank (CB), the government and the rest of the world. Three of them (NFC, FC and CB) are divided, for ease of presentation, into two columns

representing the current and capital accounts of these sectors.

The transactions (i.e. the rows) of the TFM are divided into three main blocks, separated by solid lines. The first part of the TFM presents the non-financial transactions, for which a positive sign (+) represents receipts and a negative sign (-) represents outflows. The second part of the TFM shows the accumulation of non-financial assets, i.e. capital and inventories, represented as memo item (hence within square brackets). The third part of the TFM represents the flow of financial funds for each institutional agent. A positive sign (+) indicating an accumulation of liabilities (i.e. a source of funding) and a negative sign (-) indicating an accumulation of assets (i.e. a use of funds).

As in the System of National Accounts (SNA), the sequence of non-financial transaction are grouped into different accounts, delimited by dotted lines. The first account is the goods and services one, containing the main components of demand and production of goods and services. It is followed by the income generation (consisting mostly wages and profits), and primary income distribution (interests and dividends payments) accounts. The last account is the secondary income distribution one (taxes, social and other types of transfers). The sum of all these transaction by institutional agent leads to the net lending/saving position, represented only for the three agents for which there is an explicit distinction between the current and capital accounts (represented by the retained earnings line). For the three other agents (households, government and rest of the world), the savings/borrowing needs are implicit.

The TFM highlights the tight accounting structure by showing that on the one hand each lines sums up to zero, hence ensuring that each expenditure by an institutional agent is matched by an income for an institutional agent (possibly the same). Note that the only transaction where this rule is not respected refers to the memo items of non-financial assets accumulation (capital and inventories). On the other hand, the sum of each column, including the current and capital ones, is also equal to zero, representing the budget constraints of institutional agents.

Table 2 displays the balance sheet of each institutional sector resulting from the accumulation of financial and non-financial flows shown in the bottom part of the TFM. The first part of the balance sheet shows the stock of capital and inventories, constituting the stock of non-financial assets and resulting from investment decisions, precautionary reasons and unsold merchandise. The second part of the balance sheet presents the stocks of financial assets where each asset (+) is a liability (-) for someone else, the sum of the financial assets for all the sectors is hence equal to zero. Finally, the wealth or net worth is equal to the sum of net financial and non-financial assets for each agent.

3.2. Production and Aggregate Demand

Production[3] decision is based on expected sales and (dis)investment in inventories. Expected sales follow actual demand and includes a trend growth term that is determined by capital accumulation. Investment in inventories aims to attain a specific inventories to

[3]A list of all variables can be found in appendix C and all equations are described in appendix D

expected sales ratio, taking into consideration the current level of inventories. Inventories (dis)accumulate to absorb the disequilibrium between demand and supply of goods.

Total supply is composed of domestic production and imports. Import demand is given by time-varying propensities to import consumption, intermediate and capital goods. Import propensities depend on the real exchange rate, the import tax rate, and the gap between domestic and foreign productivity, following Armington's specification.

Aggregate demand is defined as the sum of intermediate consumption, final consumption, investment and exports.

- Demand for intermediate consumption comes from the NFCs, FCs and the government. It is a fraction of total production in the case of NFCs, while it depends on the level of employment in the sector for FCs and the government.

Variable	Non Financial Corporations		Households	Financial Corporations		Central Bank		Government	RoW	Σ
	Current	Capital		Current	Capital	Current	Capital			
Consumption of NFC Products	$+C$		$-C_H$					$-C_G$		0
Public Services								$+PS_G - PS_G$		0
Consumption of FC Services			$-(INS_H + COM_H)$	$INS_H + COM_H$						0
Interm. Cons. of NFC Products	$+IC$			$-IC_B$				$-IC_G$		0
Interm. Cons. of FC Services	$-(INS_F + COM_F)$			$INS_F + COM_F$						0
Gross Fixed Capital Formation	$+I^K$	$-I^K_F$	$-I^K_H$		$-I^K_B$			$-I^K_G$		0
Change in inventories	$+I^V$	$-I^V$								0
Imports	$-IM$								$+IM$	0
Exports	$+EX$								$-EX$	0
Taxes on Imports	$-T^{IM}$							$+T^{IM}$		0
Value Added Tax	$-T^V$							$+T^V$		0
Other Taxes on Products	$-T^P$							$+T^P$		0
Wages	$-W_F$		$+W$	$-W_B$				$-W_G$		0
Employers Social Contributions	$-SC_F$		$+SC$	$-SC_B$				$-SC_G$		0
Mixed Income Distribution	$-MI_H$		$+MI_H$							0
G.O.S. Redistribution	$-GOS_F$		$+GOS^H_F$					$+GOS^G_F$		0
Net Other Taxes on Production	$-T^Y_F$			$-T^Y_B$				$-T^Y$		0
Int. on Deposits	$+IntD_F$		$+IntD_H$	$-IntD$				$+IntD_G$		0
Int. on Domestic Loans	$-IntL_F$		$-IntL_H$	$+IntL$						0
Int. on Domestic FX Loans	$-IntL^{FX,B}_F$			$+IntL^{FX,B}_F$						0
Int. on RoW FX Loans	$-IntL^{FX,W}_F$			$-IntL^{FX,W}_B$					$+IntL^{FX,W}$	0
Int. on Domestic public Bonds				$+IntBg_B$				$-IntBg$	$+IntBg_W$	0
Int. on FX public Bonds								$-IntBg^{FX}$	$+IntBg^{FX}$	0
Int. on FX public Loans								$-IntLg^{FX}$	$+IntLg^{FX}$	0
Int. on Advances				$-IntA$		$+IntA$				0
Int. on FX Reserves				$+IntR^{FX}_B$		$+IntR^{FX}_{CB}$			$-IntR^{FX}$	0
Firms Dividends	$-Div_F$		$+Div^H_F$					$+Div^G_F$	$+Div^W_F$	0
Banks Dividends			$+Div^H_B$	$-Div_B$					$+Div^W_B$	0
Royalties	$-Roy$							$+Roy$		0
Taxes on Income	$-T^I_F$		$-T^I_H$	$-T^I_B$				$-T^I$		0
Workers Social Contributions			$-WSC$	$+WSC_B$				$+WSC_G$		0
Social Transfers			$+ST$	$-ST_B$				$-ST_G$		0
Remittances			$+Rem \cdot e^N$						$-Rem \cdot e^N$	0
Central Bank Profits						$-F_{CB}$		$+F_{CB}$		0
Other Transfers	$-O_F$		$+O_H$	$-O_B$				$-O_G$	$-O_W$	0
Retained Earnings	$-\dot{RE}_F$	$+\dot{RE}_F$		$-\dot{RE}_B$	$+\dot{RE}_B$					0
[Capital]		$[\dot{K}_F]$	$[\dot{K}_H]$		$[\dot{K}_B]$			$[\dot{K}_G]$		$[\dot{K}]$
[Inventories]		$[\dot{V}]$								$[\dot{V}]$
Foreign Direct Investment		$+F\dot{D}I_F$			$+F\dot{D}I_B$				$-F\dot{D}I$	0
Cash and Deposits		$-\dot{D}_F$	$-\dot{D}_H$		$+\dot{D}$			$-\dot{D}_G$		0
Gov. Deposits at the CB							$+\dot{D}_{CB}$	$-\dot{D}_{CB}$		0
FX Deposits		$-\dot{D}^{FX}_F \cdot e^N$			$-\dot{D}^{FX}_B \cdot e^N$			$-\dot{D}^{FX}_G \cdot e^N$	$+\dot{D}^{FX} \cdot e^N$	0
Domestic Currency Loans		$+\dot{L}_F$	$+\dot{L}_H$		$-\dot{L}$					0
Domestic FX Loans		$+L^{F\dot{X},B}_F \cdot e^N$			$-L^{F\dot{X},B}_F \cdot e^N$					0
RoW FX Loans		$+L^{F\dot{X},W}_F \cdot e^N$			$+L^{F\dot{X},W}_B \cdot e^N$				$-L^{F\dot{X},W} \cdot e^N$	0
Domestic Public Bonds					$-B\dot{g}_B$			$+B\dot{g}$	$-B\dot{g}_W$	0
FX Public Bonds								$+B\dot{g}^{FX} \cdot e^N$	$-B\dot{g}^{FX} \cdot e^N$	0
FX Public Loans								$+\dot{Lg}^{FX} \cdot e^N$	$-\dot{Lg}^{FX} \cdot e^N$	0
Technical insurance Reserves			$-TI\dot{R}_H$		$+TI\dot{R}_H$					0
Domestic Currency Reserves					$-\dot{Rd}$		$+\dot{Rd}$			0
FX Reserves					$-R^{F\dot{X}}_B \cdot e^N$		$-R^{F\dot{X}}_{CB} \cdot e^N$		$+R^{F\dot{X}} \cdot e^N$	0
Advances					$+\dot{A}$		$-\dot{A}$			0
Σ	0	0	0	0	0	0	0	0	0	0

Table 1: Transaction-Flow Matrix of the Colombian Economy.

Variable	NFC	Households	FC	CB	Government	RoW	$+\sum$
Capital stock	$+K_F$	$+K_H$	$+K_B$		$+K_G$		K
Inventories	$+V_F$						V
[Non-Financial Assets]	$+NFA_F$	$+NFA_H$	$+NFA_B$	$+NFA_{CB}$	$+NFA_G$	$+NFA_W$	NFA
Foreign Equity	$-EQ_F^W$		$-EQ_B^W$			$+EQ^F$	0
Cash and Deposits	$+D_F$	$+D_H$	$-D$		$+D_G$		0
Gov. Deposits at the CB				$-D_{CB}$	$+D_{CB}$		0
FX Deposits	$+D_F^{FX} \cdot e^N$		$+D_B^{FX} \cdot e^N$		$+D_G^{FX} \cdot e^N$	$-D^{FX} \cdot e^N$	0
Domestic Currency Loans	$-L_F$	$-L_H$	$+L$				0
Domestic FX Loans	$-L_F^{FX,B} \cdot e^N$		$+L_B^{FX,B} \cdot e^N$				0
RoW FX Loans	$-L_F^{FX,W} \cdot e^N$		$-L_B^{FX,W} \cdot e^N$			$+L^{FX,W} \cdot e^N$	0
Domestic Public Bonds			$+Bg_B$		$-Bg$	$+Bg_W$	0
FX Public Bonds					$-Bg^{FX} \cdot e^N$	$+Bg^{FX} \cdot e^N$	0
FX Public Loans					$-Lg^{FX} \cdot e^N$	$+Lg^{FX} \cdot e^N$	0
Technical Insurance Reserves		$+TIR_H$	$-TIR_H$				0
Domestic Currency Reserves			$+Rd$	$-Rd$			0
FX Reserves			$+R_B^{FX} \cdot e^N$	$+R_{CB}^{FX} \cdot e^N$		$-R^{FX} \cdot e^N$	0
Advances			$-A$	$+A$			0
[Financial Assets]	$+FA_F$	$+FA_H$	$+FA_B$	$+FA_{CB}$	$+FA_G$	$+FA_W$	0

Table 2: Balance Sheet of the Colombian Economy.

- Four institutional sectors invest: NFCs investment depends on an autonomous term and the profit rate. Household investment is a constant share of disposable income. Government's investment is a constant fraction of its capital stock and FCs investment is a constant fraction of its level of production.
- Households and the governments consume the goods and services produced by NFCs. Household consumption depends on time-varying propensities to consume out of disposable income and wealth. The consumption of market goods and services by the government is a constant fraction of the GDP.
- Exports are divided into two components. The first term refers to oil and coal exports which follow an exogenous path. The second term corresponds to non-oil and coal exports which is a fraction of trading partners' GDP. As for imports, export propensity follows Armington specification and depends on the real exchange rate (i.e., price competitiveness) and the gap between domestic and foreign productivity (i.e., non-price competitiveness).

FCs produce on demand two types of financial services: insurance services, and commissions[4]. Insurance services are paid by households and NFCs as a fraction of their capital stock, while commissions are a fraction of their stock of domestic currency loans. The demand for insurance services and commissions is treated as final consumption in the case of households and intermediate consumption in the case of NFCs.

Finally, the government conducts non-market production which refers to the goods and services, such as education and health, provided by the public sector to households free of charge or at a price well below their market value. We follow the SNA approach and compute the value of non-market production at the cost of production which is equal to the sum of wages and employers' social contributions, intermediate consumption and depreciation of public capital stock. Accordingly, the government consumption of non-market goods and

[4]In the National account, a third type of financial service is included: Financial Intimidation Services Indirectly Measured (FISIM). It represents the service provided by banks by either collecting deposits or by lending to other agents in the economy. In the national accounts these FISIM are computed, following the loanable fund theory, by considering the spreads between lending rates (or deposit rates) and a reference rate, typically the policy rate or the interbank rate. Given the endogenous nature of money creation (see McLeay et al., 2014, for example), we decided to abstract from this and have included interest payments in full in the secondary income distribution and did not consider the production of FISIM in our model. As a consequence the value added of the financial sector and of the total economy is slightly lower than in reality. Note that our treatment of FISIM does not change the budget constraints by sector.

services is equal to the value of non-market production, which, although accounted for in GDP, does not affect the net lending/borrowing position because it is paid and received by the government.

3.3. Prices

The model distinguishes between production prices and consumer prices. The first refers to the production price which is modelled as a mark-up over historical unitary cost (Godley and Lavoie, 2006). This mark-up reacts to the gap between the actual and target inventory-to-output ratio in order to generate demand-driven inflation and eliminate the disequilibrium in goods markets. In turn, the historical unitary cost gradually adjusts to the actual unit cost of production, which consists of wages and employers' social contribution, intermediate consumption and taxes on production paid by the NFCs.

There are three domestic consumer prices, one for each component of demand (final consumption, intermediate consumption, and investment), to reflect the different import content of each element. These prices are calculated as a weighted index of import costs (import price plus any import taxes) and the domestic production costs (production price), onto which VAT and other net product taxes are added when applicable. Finally, there are two exogenous export prices: one for fossil fuels and one for the other types of exports.

3.4. Non-Financial Corporations

Gross profits in NFCs are given by the difference between aggregate demand and intermediate consumption, wages and employers' social contributions, distribution of mixed-income and gross operating surplus, net interest payments, royalties, and taxes on imports, on value-added, on products and on production. Then, once corporate income tax is paid, a constant fraction of net profits is saved as retained earnings for internal financing of investment and the remaining is distributed as dividends to households, the government and the rest of the world.

NFCs' financing needs are given by the sum of the nominal value of investment and accumulation of cash and current account deposits in domestic and foreign currency, after deducting retained earnings. These financing needs are covered by borrowing domestic and foreign currency loans from FCs, foreign currency loans directly from banks abroad, and FDI.[5]

3.5. Financial Corporations

Gross profits in FCs result from the difference between revenues and operating outflows. On the one hand, FCs produce financial services and receive interest on household and NFCs loans, public debt holdings and FX reserves. On the other hand, FCs pay for intermediate

[5] More details on how these are treated in section 3.9.

consumption, wages, social transfers, employers' social contributions, taxes on production, and interests on deposits, liquidity advances, and FX loans. Then, once corporate income tax is paid, part of the net profits are saved as retained earnings to comply with capital adequacy regulations while the remainder is distributed as dividends to households and the rest of the world.

Regarding the flow of funds, the variation in FCs' assets is given by loans to households in domestic currency (consumption credit and mortgages), loans to NFCs in domestic and foreign currency, purchase of government bonds in domestic currency, accumulation of FX reserves, and accumulation of domestic currency reserves at the central bank. In turn, the variation in FCs' liabilities is given by FX loans borrowed from abroad, FDI to the financial sector, deposits accumulated by households, NFCs and the government, and the accumulation of technical insurance reserves by households. Finally, FCs borrow liquidity advances from the central bank when they have positive financing needs. On the contrary, if FCs have excess liquidity, they accumulate interest-bearing deposits (excess reserves) at the central bank.

3.6. Central Bank

The assets side of the central bank balance sheet consists of liquidity advances to FCs and FX reserves, while the liability side is composed of domestic currency reserves of FCs and government deposits. Accordingly, the central bank receives interest on FX reserves and liquidity advances, transferring the profits to the government. Last but not least, the central bank follows a simple pure inflation-targeting Taylor rule to steer the policy rate.

3.7. Households

Households' disposable income is composed of wages, mixed-income, gross operating surplus redistributed by the NFCs, dividends, remittances, interest on deposits, and social transfers, less of taxes on income, interest payments on loans and net social contributions paid. Household wealth is made up of capital stock, cash and deposits, and technical insurance reserves.

We model behavioural rules for household's decisions on their assets holding and liability accumulation. First, households take out consumer and mortgage loans with FCs. The former is a fraction of disposable income affected by interest rates and economic growth, while the latter is a fraction of housing investment. Second, households accumulate technical insurance reserves as a fraction of wage income, which are used by FCs as a source of liabilities. Finally, households accumulate all remaining savings in the form of cash and deposits.

3.8. Government

The government block is made up of revenues, expenditures and public debt dynamics. Fiscal revenue is divided into tax and non-tax revenue. Tax revenues includes taxes on imports, on value added, on production, on income (wage and NFC and FC profits), and other taxes on products. Non-tax revenues comprise royalties (related to fossil fuel exports), dividends paid by NFCs (representing public participation in private companies), gross operating surplus redistributed by NFCs (representing the gross operating surplus generated by state-owned enterprises considered as private companies in SNA), workers' social contributions paid by households, profits transferred by the central bank, and interest on domestic currency deposits paid by FCs.

We distinguish between primary and non-primary expenditures of the government. The first includes wages, employers' social contributions, intermediate consumption, final consumption of market goods and services, public investment, and social transfers to households. The second comprises interest payments on domestic and foreign currency (FX) debt to FCs and the rest of the world.

The government deficit is equal to the difference between fiscal expenditures and revenues. The variation in public debt is equal to the fiscal deficit plus the government's accumulation of cash and deposits in domestic and foreign currency. Then, public debt issuance is divided into domestic currency bonds, FX bonds and FX loans.

The interest rate on domestic currency debt depends on the monetary policy rate and a public debt risk premium. Similarly, the interest rate on FX debt depends on an international reference rate, the public debt risk premium and the country risk premium.

3.9. External Sector

We distinguish current account dynamics from financial account ones in the Balance of Payments. In the current account, inflows are equal to the sum of exports, remittances, modelled as a constant share of foreign GDP, and interest paid to the central bank and FCs on FX reserve holdings. On the other hand, current account outflows are equal to the sum of imports, dividends paid by NFCs and FCs to foreign investors, interest paid by NFCs, FCs and the government to foreign banks on FX loans, and interest paid by the government on FX bonds.

Concerning the financial account, inflows are given by FDI to NFCs and FCs, FX loans borrowed by NFCs, FCs and the government, and FX bonds issued by the government. For FDI in NFCs, we distinguish between greenfield FDI (i.e., adding to gross fixed capital accumulation) and non-greenfield FDI (i.e., only as a source of funding), while we consider all FDI in FCs to be non-greenfield. In turn, financial account outflows are given by the accumulation of FX reserves by the central bank and FCs and the accumulation of FX deposits by NFCs, FCs and the government. Lastly, the nominal exchange rate dynamics depends on the demand and supply of foreign currency. In this sense, a currency depreciation reflects a positive excess demand for foreign currency, while a currency appreciation indicates an excess supply.

Source	*Data-set*
Departamento Administrativo Nacional de Estadística (DANE)	Integrated Economic Accounts (IEA), Macroeconomic Aggregates, International Trade, and Labour Market Statistics
Banco de la República	Flow of Funds (FoF), Financial Account (FA), Balance of Payments (BoP), International Investment Position (IIP), Central Bank's Balance Sheet, Exchange Rates, Prices and Interest Rates Statistics
Superintendencia Financiera de Colombia	Household Loans, Non-Financial Corporations Loans, and Aggregate Interest Payments Statistics
Ministerio de Hacienda y Crédito Público	Public Debt, Fiscal Balance, and Royalties Statistics

Table 3: Main datasets used to develop the SFC empirical model

4. Calibration and scenarios

4.1. Data sources

Developing an empirical SFC model is data-intensive and requires integrating multiple data sources and complying with accounting consistency principles. Table 3 presents the main data-sets used along with their respective sources. Appendix A describes the different challenges we had to address when building the empirical TFM and BS of the model.

The Integrated Economic Accounts (IEA) of the SNA provide important information for constructing the real side of the TFM regarding to production, income generation, primary income distribution and secondary income distribution accounts. Also following the SNA guidelines, the Flow of Funds (FoF) and the Financial Account (FA) provide information on the flows and stocks of financial assets and liabilities for the different institutional sectors, respectively, which is a key input for the construction of the financial side of the TFM and the balance sheet.

Although using a different methodology from the SNA, the Balance of Payments (BoP) also contains information on real and financial flows between residents and non-residents while International Investment Position (IIP) presents the stock of financial assets and liabilities of residents and non-residents. Similarly, the *Superintendencia Financiera de Colombia* (Colombia's financial regulator) compiles data on loans, deposits and interest payments between the banking sector and the private sector (i.e., Households and NFCs). Finally, the Ministry of Finance and Public Credit provides detailed information on public debt and the fiscal balance of the general government.

4.2. Calibration

The calibration process of the empirical SFC model consists of determining the values of the initial conditions and parameters in the system of equations. This is done in such a way that the model simulations reproduce, on average, the dynamics of the main macroeco-

nomic variables of the Colombian economy in a way that is consistent with the regularities observed in the data. See Appendix E for more details on the parameters and initial values.

Due to the dynamic nature of the model, the variables that require initial values to carry out the simulations are the stocks of financial and non-financial assets and other state variables whose behaviour is given by a differential equation (e.g., price indexes, wages, the exchange rate). These initial values were determined by taking 2019 as the reference year, based on the information presented in subsection 4.1 and contained in the TFM and the BS.

As for the parameters driving the system of equations, these were also calculated from the data sources presented in subsection 4.1 taking as a reference the period 2014-2019. While a significant number of parameters were calibrated as simple averages in the case of variables that grow at a constant rate (e.g., labour productivity) or that are a ratio between two known variables (e.g., tax rates), others were calculated considering reference values in the literature and in some cases by making use of an algorithm for optimising non-linear continuous-time dynamic systems known as CMA-ES[6]. Finally, the values of some parameters were also determined to be consistent with the assumptions made to build the Baseline scenario.

Then, once the system of equations with their respective parameters and initial conditions are calibrated, the numerical simulations of the different scenarios can be carried out in the statistical software R for a given time horizon. For this purpose, a numerical solution method known as Runge-Kutta of order 4 (RK4) is used. Although RK algorithms do not provide analytical solutions due to the large number of variables and the non-linearity of the system, fourth-order RK generate accurate results in a computationally efficient way. For interested readers, the R codes are available from the authors upon request.

4.3. Scenarios

We assume population to grow at a constant rate of 1%, domestic and world productivity to grow at a constant rate of 2% (hence assuming away any catching-up), world GDP in real terms to grow at constant rate of 3% and world inflation is set at 3%. We assume further that FDI inflows as a share of NFC' investment slow down from their peak value in 2019, falling from 38% of investment (i.e. 4.5% of GDP) to 26% (3% of GDP) by 2050. We also assume a reversal in observed trends of propensity to export non-fossil fuel goods and services and revert it to its average over the last fifteen years by slowly increasing the linear term in the export propensity equation by 20% between 2019 and 2050[7].

We construct three scenarios for oil fossil fuels in Colombia, based on various existing scenarios for petrol and coal exports[8]. (see appendix B).

Apart from any policy responses, which we will describe in section 5, we thus have three scenarios:

[6]Covariance Matrix Adaptation-Evolutionary Strategy, see Hansen and Auger (2011); Auger and Hansen (2012)
[7]See equations 207 and 208 in appendix for the exact specification of the time varying parameters.
[8]q

- A Baseline scenario encompassing all previous assumptions and of the neutral scenario regarding fossil fuel exports (i.e. constant fossil fuel exports from 2023). This scenario is very similar to the baseline scenario of the Finance ministry's medium-term fiscal framework of 2022.
- A Conservative scenario encompassing all previous assumptions and of the Conservative scenario regarding fossil fuel exports (i.e. constant decrease of 3% of fossil fuel exports from 2023).
- A Global Transition scenario encompassing all previous assumptions and of the Conservative scenario regarding fossil fuel exports (i.e. constant decrease of 8.5% of fossil fuel exports from 2023).

We run the model from 2019 to 2050 and present the results starting from 2023 since the model presents some volatility due to the initial point calibration. All scenarios start in 2023 except for the policy response which start in 2024.

4.4. Baseline scenario - medium term outcomes

Before moving to understand the macroeconomic consequences of the Conservative and Global Transition scenarios, we will describe our Baseline scenario and compare it with the baseline scenario of Ministerio de Hacienda y Crédito Público (2022) for the period 2023 to 2033. Figure 1 shows the projections for selected variables for the two scenarios: this paper Baseline (black solid line) and Ministerio de Hacienda y Crédito Público (2022) baseline (red dashed line). Evidently, the two scenarios seem to concur on most variables. Our baseline foresees slightly slower real GDP growth (panel a), similar but more stable unemployment rate (panel b), slightly higher trade deficit (panel c), similar current account deficit (panel d), similar nominal depreciation rate (panel e), slightly higher inflation (panel f), slightly higher foreign reserves (panel g), similar FDI growth rates (panel h), slightly higher fiscal deficit (panel i), slightly higher public debt (panel j) and similar interest rates on domestic (panel k) and foreign (panel l) public debt.

The main reason behind the differences is related to a higher level of imports in our Baseline scenario, leading to lower growth rates and higher trade deficit, leading to all variables expressed as share of GDP to be higher due to a smaller denominator.

As a robustness test, we use the two external scenarios considered in Ministerio de Hacienda y Crédito Público (2022) and compare them with our results. "FDI" assumes a higher levels of FDI inflows entering the economy, while "EXP" assumes an increase in export propensities due to a stronger integration in global value chains, (see Box 4.3 starting on page 132 of Ministerio de Hacienda y Crédito Público, 2022). Figure 2, panel a and b show the two scenarios.

Panel c and d display the dynamics of growth rate and nominal depreciation rates from our model and Ministerio de Hacienda y Crédito Público (2022). The effects in terms of GDP growth are lower for the export scenarios and null for FDI in our simulations, contrary to Ministerio de Hacienda y Crédito Público (2022). This is because in our model only 48% of FDI investment leads to capital accumulation, i.e. are greenfield, and only has a demand

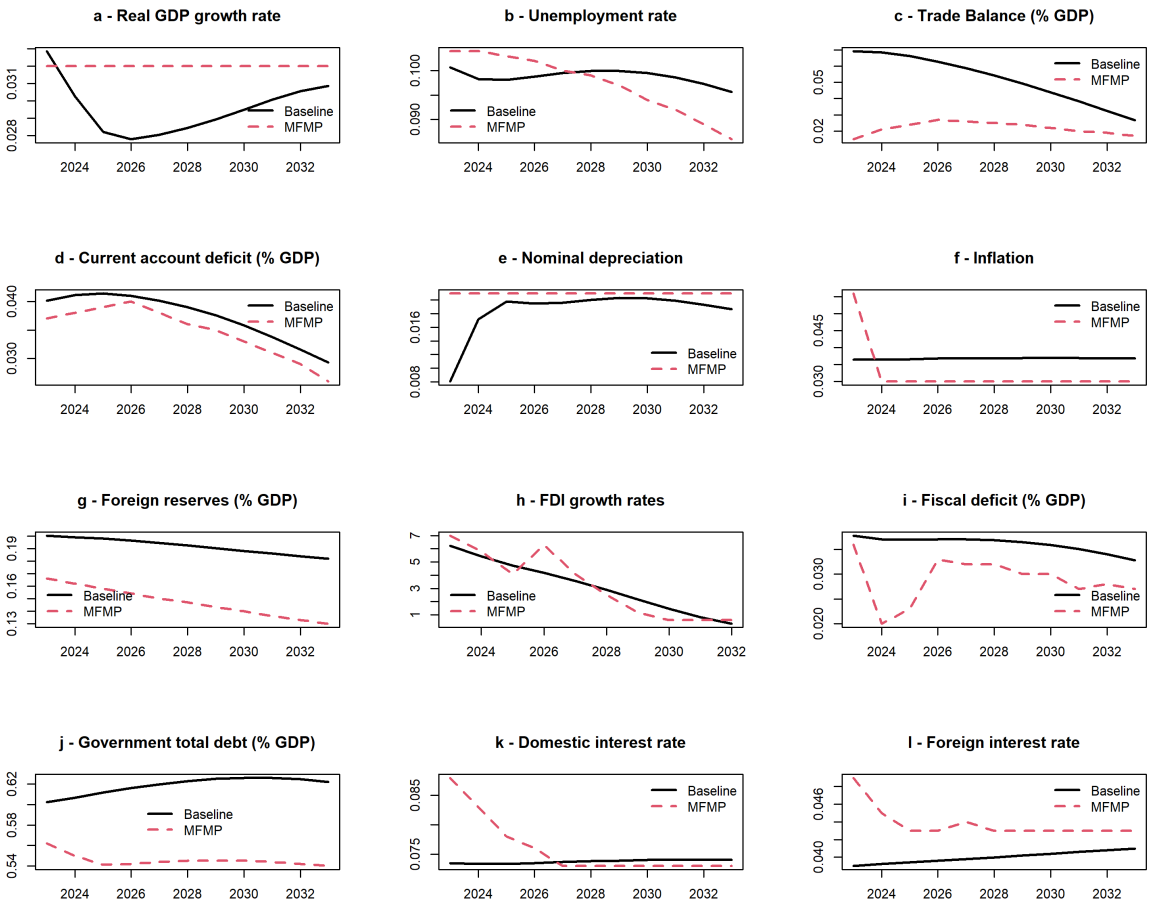

Figure 1: Comparison between Baseline scenario (black solid line) and the baseline scenario (red dashed line) of Ministerio de Hacienda y Crédito Público (2022) for selected variables. Source: Ministerio de Hacienda y Crédito Público (2022) and auhors' computations.

effect, i.e. does not necessarily lead to higher production. On the other hand, the increase in exports leads to a fall in the depreciation rate (panel d) in our model, hence reducing the drop in imports observed in the Baseline scenario and causing lower growth rates in real terms. This highlights the importance of having a fully integrated model with financial feedback loops.

4.5. Baseline scenario - long-term outcomes

Figure 3 presents the long-term outcomes of our Baseline scenario from 2023 to 2050 for selected variables. One can see that the real GDP growth rate settles at 2.8% (panel a). It is important to note that our Baseline scenario encompasses a profound structural change induced by fixed fossil fuel exports, hence leading to a reduction of its share in total exports (panel b). As a result, the economy experiences a strong depreciation of its currency, both in nominal and real terms (panel c). Imports thus decrease as a share of GDP while

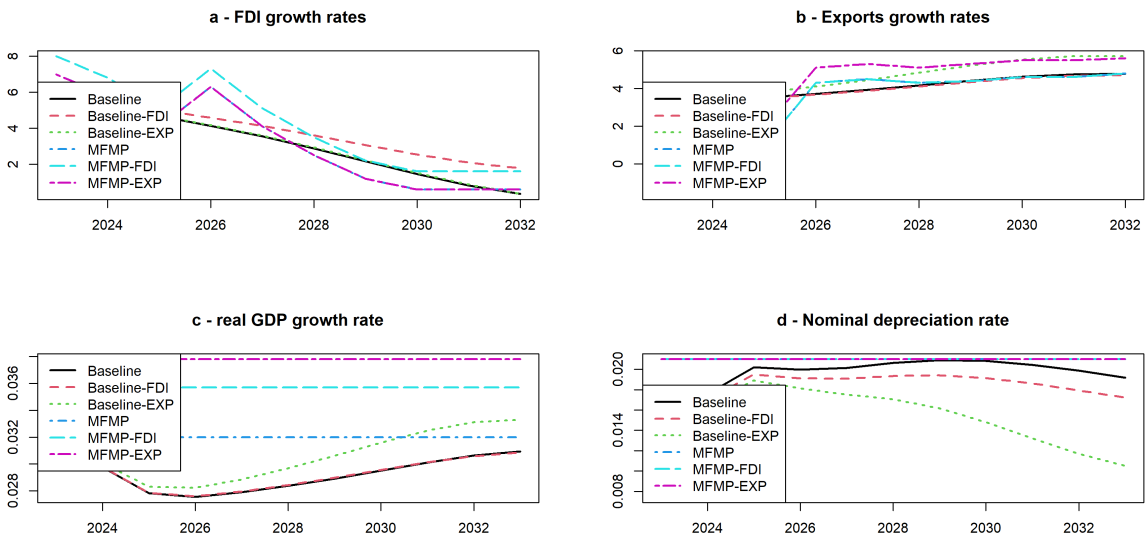

Figure 2: Results of FDI and EXP scenarios: solid black is our Baseline, red dashed is the FDI scenario, green dotted is the EXP scenario, blue dash-dotted is Ministerio de Hacienda y Crédito Público (2022) baseline, cyan long-dashed is their FDI, and pink dash-dashed is their EXP. Source: Ministerio de Hacienda y Crédito Público (2022) and authors' computations.

exports increase.[9] Note that because fossil fuel exports remain constant in real terms, the aggregate growth rate of exports increases less fast that imports fall. As a consequence both consumption and investment see a decrease of their share in real GDP (not shown).

Unemployment (panel e) and inflation (panel f) are relatively stable. The fiscal deficit (panel g) decreases and stabilizes at around 2.5% of GDP. NFC total debt decreases to stabilize at around 27% of GDP while households' debt pursue their historical growth to reach almost 32% of GDP (panel h). On the other hand, public debt, after a slight increase, starts decreasing and reaches around 50% of GDP in 2050, which is in line whit the target set by the government (see section 2).

Panel i shows the different components of the Balance of Payments. As a consequence of the peso depreciation, the trade deficit falls while transfers (mostly remittances) increase. Interests payments to the rest of the world remain relatively constant as a share of GDP because while depreciation increases the domestic currency value of FX debt, the deleveraging of both firms and government compensates for this negative effect. Finally the reduction in financial inflows, partly due to the exogenous reduction in FDI flows and partly due to the general deleveraging, leads to a lower supply of foreign exchange and as a consequence the economy experiences a constant excess demand in foreign exchange markets, maintaining the depreciation of the Colombian peso over the entire simulation. Moreover, FX reserves decline as a share of GDP (panel j), leading to an increase in the country risk premium (panel k).

[9] Although this outcome is standard with Armington specification of trade shares, it should be mitigated by questions regarding the capacity of the country experiencing strong depreciation to expand its export production and substitute for the goods that are imported.

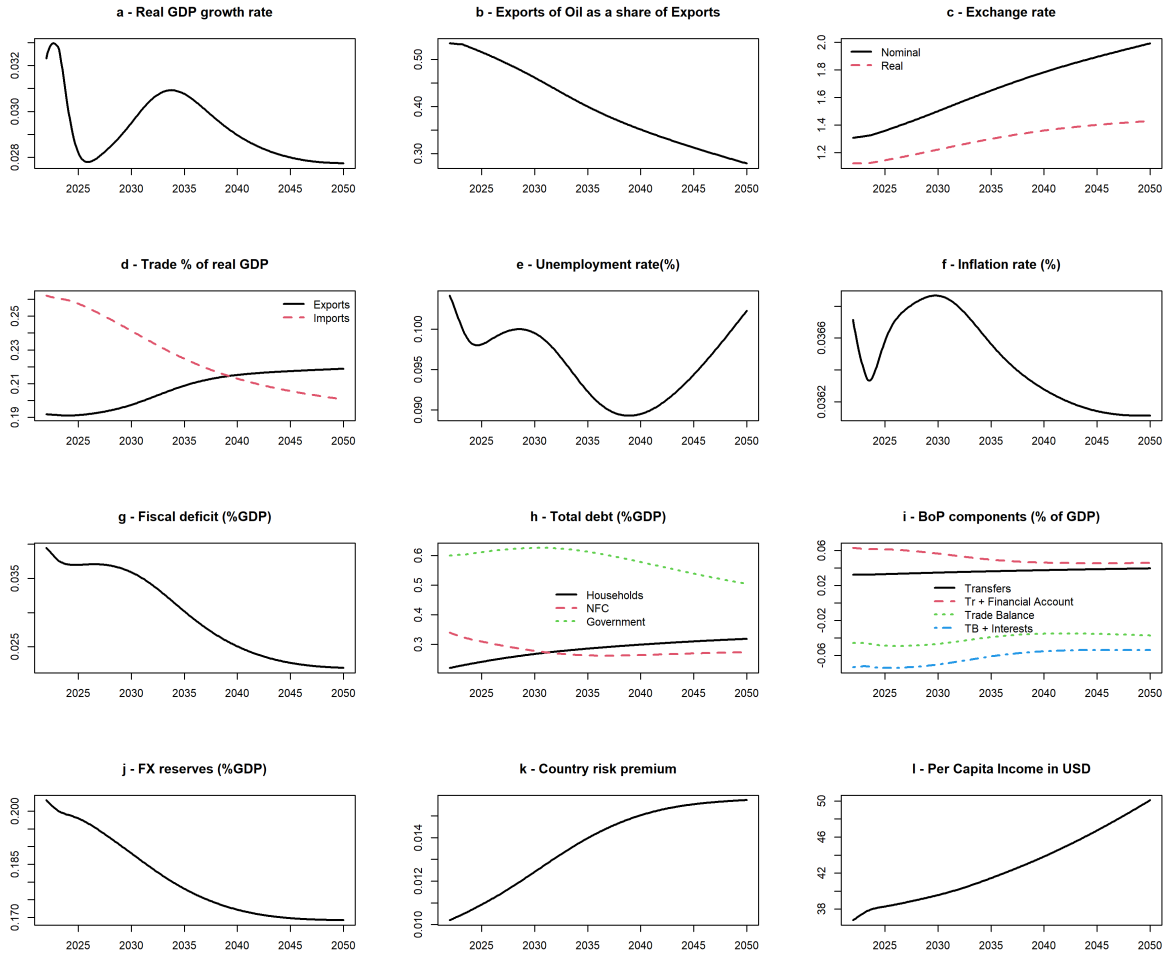

Figure 3: Long-term properties of the Baseline scenario for selected variables. Source: authors' computations.

5. Results

We next move on to analyse the outcome of our two alternative export scenarios with respect to our baseline, before considering the policy responses that could be implemented.

5.1. Loss of fossil fuel exports with no export diversification

Figure 4 displays the simulation results under the three different scenarios we described in detail in Section 4.3 (Baseline, Conservative and Global Transition - GT from now on) where fossil fuel exports start decreasing in 2024. Both scenarios exhibit similar dynamics with larger magnitudes for the GT scenario. While the long-term consequences in terms of real growth seem to converge for all scenarios (panel a), this is not the case for most of the other variables. Furthermore, the model displays the consequences of a non-equilibrium

exchange rate determination. since it is based on an excess demand approach,[10] the exchange rate does not converge to a specific value, which implies that import and export propensities will also not converge to specific values. The different scenarios hence leave the Colombian economy in very different shapes, depending on how much the peso depreciated or not.

As the exports of fossil fuel start falling in real terms, this adds pressure on the trade balance (panel b), on the balance of payments, and on the exchange rate (panel c). The trade balance deterioration exchange rate depreciation is very fast (last than 6 months) and the trade balance quickly starts improving due to the real depreciation impacting the propensities to import and export.

The nominal depreciation of peso leads to inflationary pressures for production prices (panel d) and consumer prices (panel e) due to increases in the domestic currency price of imported goods. This leads to a reduction both in consumption (via the reduction in marginal propensities to consume, panel f) and in investment (due to the reduction of real profit rates, panel g). The fall in consumption, investment and exports is not compensated fully by the fall in imports, leading to a reduction in real growth and an increase in unemployment (panel h).

The increase in unemployment leads to an increase in social transfers while inflationary pressures push up public expenditures (both market and non-market) and investment. On the revenue side, royalties and dividends decline while taxes increase, ensuring a slight increase in total revenues.[11] Overall, the increase in expenditures is larger than the increase in revenues, leading to a worsening of the fiscal deficit (panel i) and an increase in public debt (panel j), further amplifying these dynamics via interests payments.

The balance of payments sees an improvement of the current account in the long run (panel k), as the increase in transfers due to the depreciation of the peso more than compensates for the worsening of the interest payments abroad. Note that in the GT scenario, the current account remains flat for a while, indicating that remittances barely compensate for the increase in interest payments. On the other hand, the financial account surplus (panel l) falls due to two driving forces also observed in the Baseline: the reduction in FDI flows, and deleveraging of firms reducing their demand for FX loans (panel m). The two export scenarios however exacerbate these dynamics via the initial reduction in investment and via stronger depreciation. We thus have three dynamics at hand: a constant reduction in fossil fuel exports, a global reduction in financial inflows and an improvement of the current account. The first two dynamics tends to increase the depreciation of the peso while the last one is not sufficient to overcome the first two ones, at least in the beginning of the simulations. These tensions on the peso slowly disappear as the trade balance improves and as remittances play an increasing role in covering for imports (from 13% in the Baseline to 16% in the GT scenario by 2050). All of these dynamics lead to a reduction in foreign reserves accumulation (panel n) hence leading to an worsening of the country risk (panel o) and increase in interest premiums (panel p) along with higher rationing on international financial

[10] See Yilmaz and Godin (2020) for a long description of the disequilibrium approach proposed in this model.

[11] These results could be modified if taking into consideration the latest tax reform in which the mining and oil sector will pay more taxes. The consequence will be a strong loss in total revenues which would further aggravate the fiscal deficit.

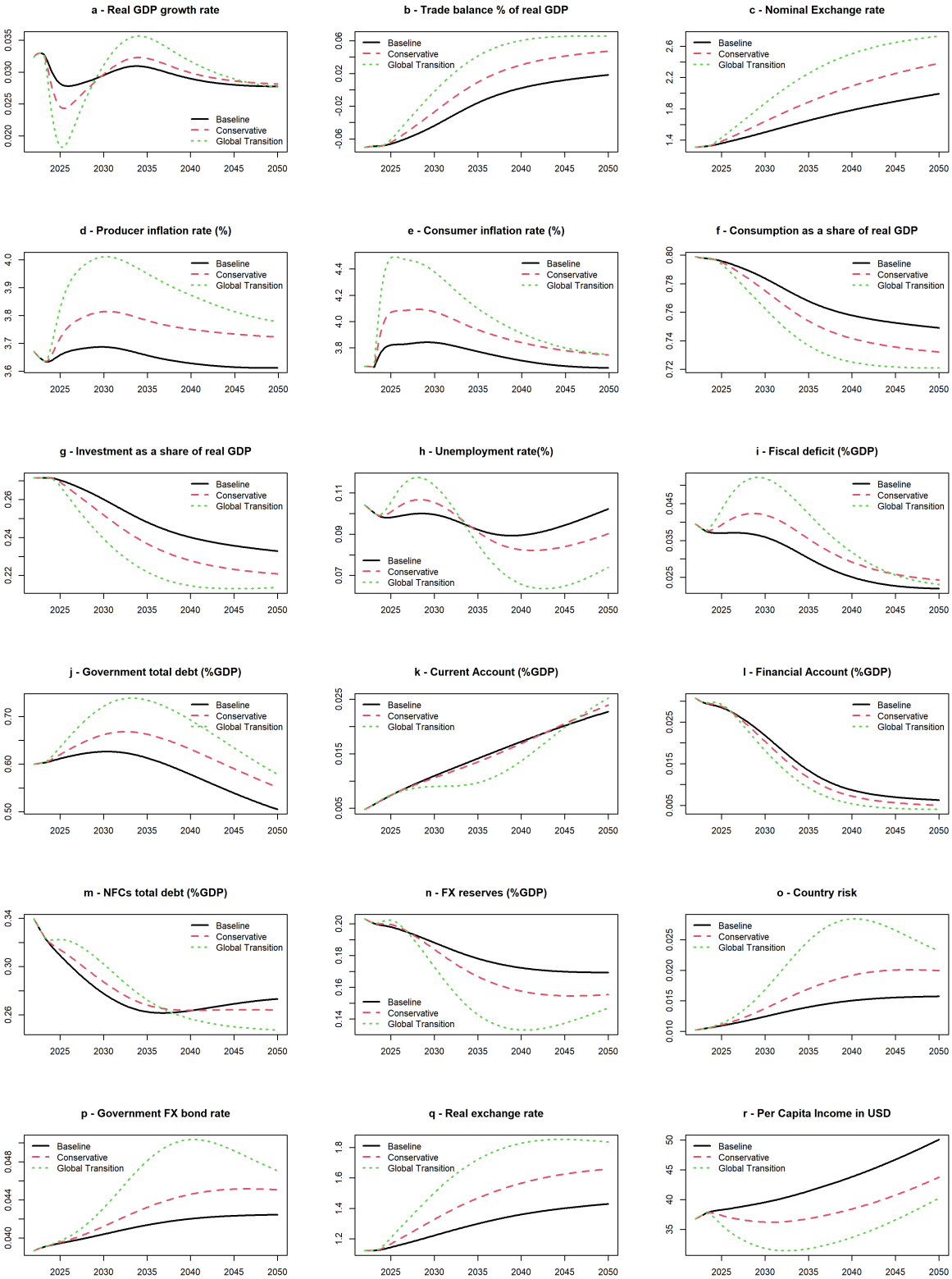

Figure 4: Baseline (black solid line), Conservative (red dashed) and Global Transition (green dotted) scenarios for selected variables. Source: authors' computations.

flows.

The reversal of dynamics is due to the income effect of remittance leading to increase in consumption on the one hand and to investment picking up due to public and households' investment. Once both consumption and investment recover, unemployment start decreasing further fueling the recovery.

As observed in the graph, there are long-term differences for each scenario. Stronger real depreciation (panel q) leads to more structural change via import reduction and export reduction.[12] Furthermore, prolonged and more acute deficits lead to more debt accumulation. All in all, it is easy to see that the GT leads to a more severe recession and to a more fragile economy either from a public finance or from an international finance perspective. An interesting indicator to look at is the per capita income in USD[13] (panel r). It reflects the fact that even if the economy is growing in real terms it does not compensate with real depreciation indicating that all international consumption goods start becoming very expensive, hence leading to lower standards of living. In the GT scenario, it takes more than 20 years to recover the living standard of 2023.

5.2. Currency crisis

It is worth noting that the GT scenario can lead to a currency crisis by the end of 2039 if the assumption, made in section 4.3, that export propensity reverts to its last decade average is not taken, see section 4.3. Figure 5 shows these simulations. In this scenario, the trade balance deterioration is so strong that it leads to an accelerating depreciation (panel b). This currency crisis leads to strong inflationary pressure (panel c), and to country risk (panel d), foreign interest rates (panel e), and public debt (panel f) exploding.

5.3. Exports diversification

In order to respond to the dramatic impacts of a global transition and avoid a potential currency crisis, we consider a policy response in the form of an increase of the propensity to export via the integration of the Colombian economy in Global Value Chains (GVCs), see Del Carpio et al. (2022). This is simulated via a gradual increase in the linear term of the propensity to export non fossil fuels, starting from 2024. We assume that this outcome is achieved via public or private investments.[14] We thus build two new scenarios from the GT one : *G.T. private investment* and *G.T. public investment* representing each investment possibility.

Figure 6 shows the results of these two scenarios along with the Baseline and the GT. Both policies lead to a reduction of the pressure exerted on the Colombian peso (panel c) via an

[12] This result should be mitigated by questions regarding whether only price effect lead to structural change. It would be interesting to connect the actual increase in export and reduction in import to capital accumulation in related sectors. This is outside the scope of this paper as it would require a multisectorial model.

[13] Per capita income was calculated in the model with respect to the labour force rather than the total population.

[14] We do not have any estimation what would cost such investment so we just assumed an arbitrary 0.5% increase in the growth rate of private or public capital accumulation, via an increase in the parameter value, see table 6 in appendix.

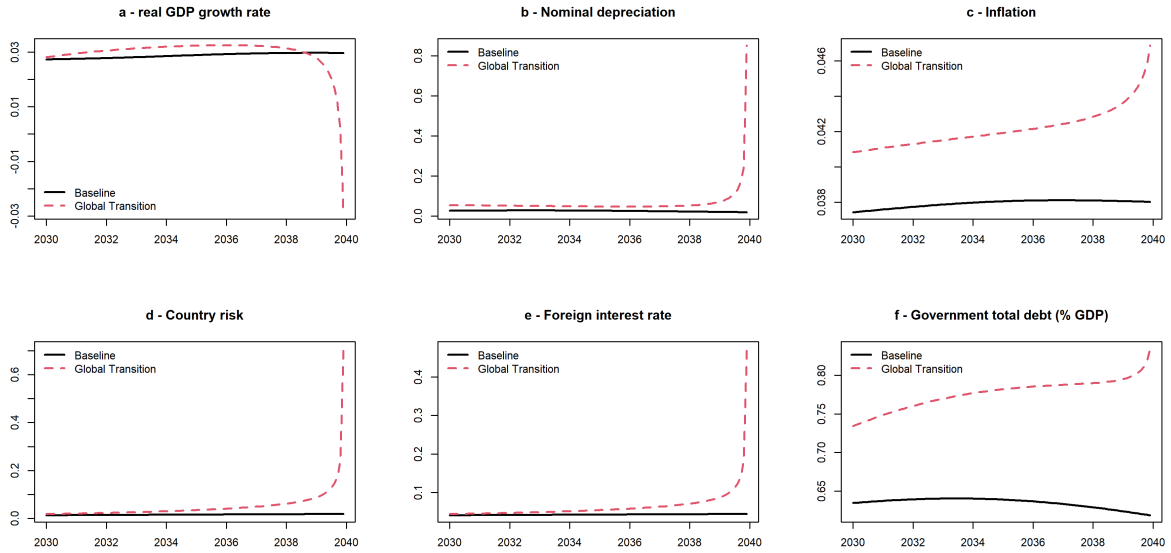

Figure 5: Currency Crisis for selected variables. Source: authors' computations.

increase in exports. The overall effect in the trade balance (panel b) is however negligible, compared to the GT scenario because the gain in export propensity is compensated by a lower real depreciation (panel q). It is interesting to note that the increase in private investment has a stronger multiplier effect at first (panel a). The immediate increase in demand due to extra exports and extra investment leads to higher inflation but this is quickly compensated by the reduction in import-driven inflation (panel d and e). Both scenarios leads to a restructuring of aggregate demand towards exports and investment, leading to a lower consumption share in GDP (panel f and g). The extra demand leads to a significant reduction in unemployment.

This fall in unemployment leads to lower social transfers and the higher growth rates of the economy increases tax revenues, hence reducing the fiscal deficit (panel i). Note that in the *G.T. public investment* scenario, the fiscal deficit barely changes from the GT scenario due to the increase in public investment compensating for lower social transfers and higher tax revenues. This is however temporary and quickly the decrease in social transfers and increase in tax revenues more than compensate the extra investment. Lower fiscal deficits mechanically amounts to lower public debt (panel j). In the case of the *G.T. private investment* scenario, the extra investment by NFC leads to higher NFC debt (panel m). The extra debt coming from firms leads to higher international financial flows (panel l) in the form of FDI and cross-border lending, helping to reduce further the pressure on the Colombian peso. Note that the current account (panel k) starts recovering faster in both scenarios, notwithstanding the extra debt incurred by firms and the lower value of remittances in peso.

The extra financial inflows along with lower trade deficit leads to more foreign reserves (panel n) to be accumulated at first and then decreasing at a slower pace, particularly for the *G.T. private investment* scenario. As a consequence of these improved macroeconomic condition, the country risk (pnael o) does not rise as much as in the GT scenario. The

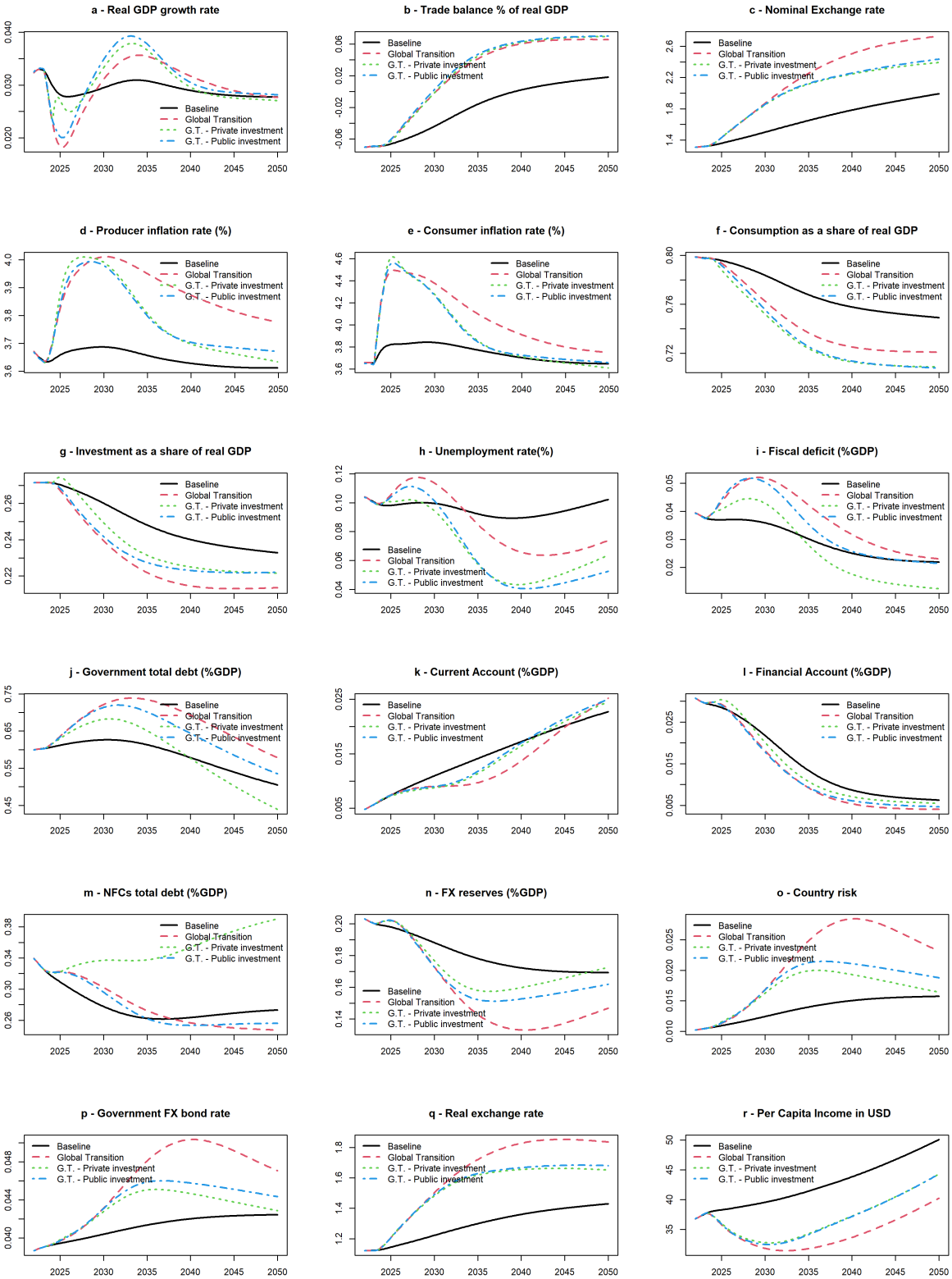

Figure 6: Baseline (black solid line), GT (red dashed), GT private (green dotted) and GT public (blue dash-dotted) scenarios for selected variables. Source: authors' computations.

premium paid on foreign interests (panel p) is hence lower and almost converging to the Baseline values. While the economy performs better under both publicly or privately-financed export diversification, Colombia still goes through a general impoverishment of its population in USD terms (panel r). The scenarios allow to gain 6 years in recovering GDP per capita in USD, but the crisis still lasts more than 15 years.

6. Discussion and conclusion

We developed an empirical SFC model for the Colombian economy to analyse the medium to long-term consequences of different scenarios of fossil fuel exports over the period 2023-2050. On the basis of three scenarios (Baseline, Conservative and Global Transition), we envisage that the decline in oil and coal exports will have deep impacts on the real and external sectors of the Colombian economy and will deteriorate its fiscal and financial conditions. Precisely, the feedback between these dimensions that is fully captured in the model does not rule out the possibility of a crisis whenever the productive system and policy responses do not adequately respond to the challenges and constraints imposed by a global low-carbon transition.

Important results to highlight in the Conservative and Global Transition scenarios include a slowdown in economic growth and a consequent increase in unemployment in the medium term, a rise in the inflation rate, the fiscal deficit, public debt levels and risk premiums over the long term, and a permanent currency depreciation leading to a fall in international reserves. It is worth noting that the peso depreciation is coming from two connected but distinct dynamics: a worsening of the trade balance (given by the scenarios) and a worsening of the financial account surplus (given by the reduction in FDI, which is likely to be worse in the case of a reduction in fossil fuel exports).

Colombia hence needs to respond to both dynamics by diversifying its exports and reducing its import dependency (not simulated) but also ensure a constant stream of international inflows. This can be done by means of industrialisation strategies and attracting FDI, with Colombia having a good record in the latter respect.

Our results thus highlight that while finance helps in mitigating the negative impacts of the Global Transition in the long term, the main driver of a recovery lie in the industrial policies aiming to reduce import dependencies and increase the export base with more sophisticated and higher value-added goods and services. However, insertion in Global Value Chains is not an easy task, as highlighted i, Del Carpio et al. (2022), and will require coordinated actions between industry, finance and the government, while the current lack of some productive and technological capabilities may hinder the competitiveness in green or sunrise industries (see Mealy and Teytelboym, 2022).

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A. Data challenges of building an empirical SFC model

Representing a theoretical TFM with actual data is not a straightforward procedure. Given the interest of the SFC approach in simultaneously modelling the real and financial spheres of the economy, the TFM behind these models tends to be quite data-intensive. While data requirements may vary from one exercise to another depending on the assumptions and simplifications made and the scope of the model in terms of the number of real and financial flows to be analysed (i.e., TFM entries), developing an empirical TFM depends substantially on the data availability.

Apart from the above, even when information is available, the way in which some macroeconomic variables are published and measured generates other challenges when constructing the empirical TFM. These difficulties result mainly from discrepancies between data sources and between current and financial accounts, from the insufficient level of disaggregation and detail with which some real and financial transactions between institutional sectors are presented, from the existence of accounting imputations in the data, and from conceptual differences between the theoretical model and the methodological procedures followed by official statistical sources

One of the most challenging issues is the harmonization of the real and financial sides of the TFM. Unlike the theoretical model, the lending/borrowing position of each institutional sector calculated by the IEA using real flows has discrepancies with the net lending/borrowing position calculated by the FoF using financial flows. This is because the sources and coverage of information, the treatment of the data and the methodological procedures are not the same between the IEA and the FoF.

Similarly, the SNA has conceptual differences with the BoP and the IIP in terms of how some real transactions and financial flows and stocks with the rest of the world are grouped and classified. Thus, although the BoP and the IIP may provide more detailed and accurate information on the dynamics of the external sector of the economy, this does not always have an exact counterpart in the SNA, which makes it difficult to compare and integrate both methodologies in the TFM.

Difficulties also arise from the raw data published by the SNA, which do not always allow for the identification of some real and financial transactions that take place between sectors. Firstly, the IEA do not provide disaggregated data on some income and expenditure flows between sectors, so in certain cases, it is not possible to identify who pays whom. For instance, although the IEA shows the interest received by FCs, it does not detail who pays it, nor does it breakdown this income by type of asset. Secondly, the FA and FoF do not always allow identifying who owes whom, which is due to the lack of disaggregated data on debt and financing relationships between sectors by type of asset. Thus, for example, while the FA account shows the value of debt instruments held by FCs, it does not detail what percentage was issued by NFCs, the government or the rest of the world.

As a result of the above, and despite the important emphasis of SFC models on the financial sphere of the economy, the raw SNA data do not show interest payments across sectors and by asset type. While some of these interest payments can be found in complementary data sources, it is important to consider how the SNA calculates interest payments in order

to avoid double counting. Unlike the model, the SNA calculates interest payments on loans and deposits based on a reference interest rate instead of market interest rates. Thus, a significant part of the interest flow actually paid is considered as value-added of the FCs and is grouped under the name of Financial Services Indirectly Measured (FISIM).

Other gaps between theory and practice emerge from the different roles played by the institutional sectors in the SNA. First, the SNA includes non-profit organisations as a sector despite being analytically irrelevant in the model. Second, the SNA includes the central bank as part of the FCs despite the importance of explicitly considering it as a sector in the model. Third, despite the fact that households play only a consumer role in the model, in the SNA they also play a producer role by engaging in market, non-market and self-consumption production. Fourth, as in the previous case, the government also performs a producer role in the SNA by carrying out market and non-market production.

B. Baseline Scenario for Fossil Fuels

One of the key issue when designing a baseline scenario for Colombia relates to the evolution of exports in general and so-called traditional exports (oil and coal mainly) in particular. This section will present the different scenarios found in the literature, concentrating first in fossil fuel exports and then addressing total exports in particular.

B.1. Oil Exports

We present here four different exercises regarding projections of oil exports:

1. the one presented in the latest (2022) medium-term fiscal framework (Marco Fiscal de Mediano Plazo) produced by the finance ministry (Ministerio de Hacienda y Crédito Público (2022)), consisting in one scenario labeled "MFMP";
2. the one presented in a report written by the Autonomous Committee on the Tax Rule (Comité Autónomo de la Regla Fiscal) on the Macroeconomic and Fiscal Effects of an Exploration Policy and the 2022 Tax Reform in the Hydrocarbon Sector (Comité Autónomo de la Regla Fiscal (2023)), consisting in four scenarios assuming no reduction in petrol production investment, labeled "CARF-BAU", and three scenario assuming linear reduction in oil extraction investment of 5% (CARF-5), 15% (CARF-15) and 30% (CARF-30);
3. the one presented in a report written by Fedesarollo, the largest Colombian economic think tank, on the Economic effects of the impact of the tax reform on the mining and energy sector (Fedesarrollo (2022)), consisting in three scenarios: one potential oil production (Fed-Pot), one with little exploration (Fed-Low) and one with little exploration and a tax reform (Fed-Tax); and
4. the one presented in a report written by Willis Towers Watson and Los Andes University on Understanding the impact of a low carbon transition on Colombia (Willis Towers Watson (2022)), consisting in one scenario labelled "WTW".

Figure 7 panel a shows the different oil exports projections in millions of barrel per year (mbpy) as presented in the different scenarios . One can see three different types of outcomes:

1. An increase in exports (CARF-BAU, CARF-5 and Fed-Pot) with average annual growth rates ranging between 3% (CARF-5) and 5% (CARF-BAU);
2. A stable export level (CARF-15); and
3. A decrease in export (CARF-30, MFMP, Fed-Low, Fed-Tax and WTW) with average annual reduction rate ranging between 3% (MFMP) and 11% (Fed-Tax).

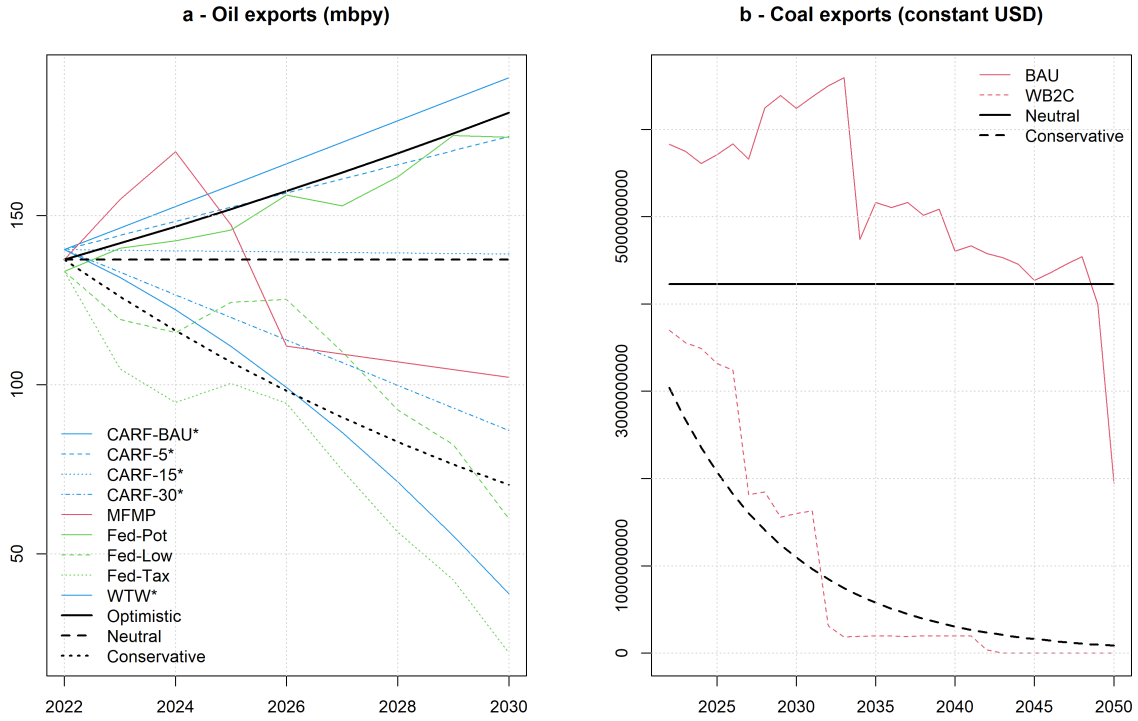

Figure 7: Oil and Coal exports projections. Source: Ministerio de Hacienda y Crédito Público (2022); Comité Autónomo de la Regla Fiscal (2023); Fedesarrollo (2022); Willis Towers Watson (2022), and authors' elaboration.

The goal of our scenario building is not to project exact values but rather to design representative scenarios, we thus propose to use three scenarios: an optimistic scenario with an increase of 4% of oil exports in value, a neutral scenario with no growth in oil exports and a Conservative scenario with a reduction of 6% of oil exports in value, also shown in panel a.

The value of these exports scenarios will of course depend on future oil prices, which is relatively complex to project. We will thus assume a constant price, for the sake of simplicity, knowing that there is a strong interaction between the demand for oil, production of oil and price of oil.

B.2. Coal Exports

There are fewer scenarios analysis future exports of Coal in the long-term. We thus rely only on the Willis Towers Watson (2022) study proposing two scenario for the exports of coal in Colombia (in millions of USD): a Business as Usual (BAU) scenario and a World Below 2 Degree Celsius (WB2C) scenario, see the figure 7 panel b. The BAU scenario sees first an increase in exports until 2034 and then a decrease in exports leading to value of exports in 2048 similar to 2021 values with then a rapid decrease. We approximate this scenario by a neutral scenario seeing no growth in coal exports. The WB2C scenario sees a rapid decrease of coal exports until 2032 followed by a plateau for the next decade and then no exports afterwards. We approximate that scenario by a conservative scenario characterized by a constant decline of coal exports of 12% year on year.

B.3. Fossil Fuel exports

We thus have three scenarios for oil exports (optimistic, neutral and conservative) and two coal scenarios (neutral and Conservative). Combining all of these would lead to six scenarios for the export of fossil fuels in Colombia, in million USD. We however discard two improbable combinations (the conservative coal scenario with either the optimistic or neutral oil scenarios), leading to four scenarios for the exports of fossil fuels in Colombia. The optimistic scenario sees an increase in oil exports and constant coal exports, leading to a constant 2.5% annual increase in fossil fuel sectors. The neutral scenario sees no increase in either fossil fuels. The Conservative scenario sees no increase in coal and reduction in oil exports, leading to a constant 3% annual reduction in fossil fuel exports. Finally, the Global Transition scenario sees decrease in oil and coal exports, leading to a constant 8.5% decrease in fossil fuel exports.

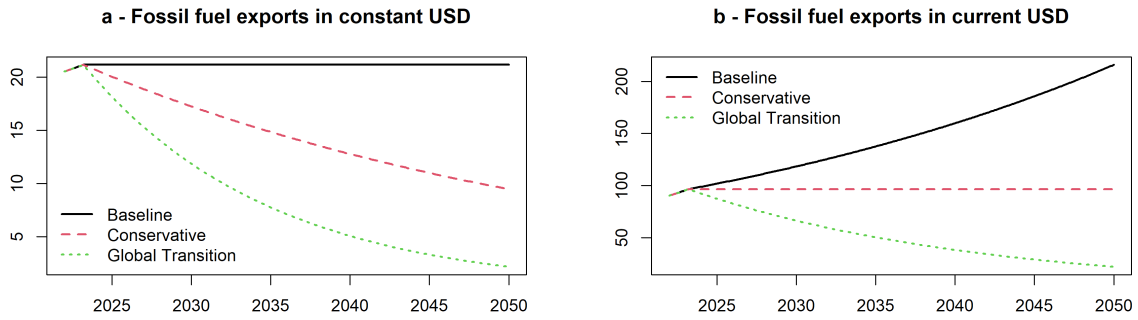

Figure 8: Oil and Coal exports projections. Source: authors' elaboration.

In this paper, we will consider only the last three scenarios (Neutral, Conservative and Global Transition scenario, see panel a of figure 8) because the optimistic scenario would entail further investments to open new oil fields f with the likely outcome of generating stranded assets. Using a constant inflation of fossil fuels of 3%, we obtain three scenarios of fossil fuel

exports in nominal terms, see panel b.

C. Nomenclature

Table 4: Variable name and description

Variable	Description	Type	Currency
Y^e	Expected sales	Real	
g_k	NFCs' capital stock growth rate	Real	
Y^P	Production of NFCs	Real	
$I^{V,d}$	Desired investment in inventories	Real	
V^d	Desired inventories	Real	
V	Inventories	Real	
I^V	Actual investment in inventories	Real	
$Y^{P,D}$	Domestic production of NFCs	Real	
Y^D	Nominal aggregate demand	Nominal	Domestic
$Y^{D,r}$	Real aggregate demand	Real	
C	Final consumption of goods	Nominal	Domestic
IC	Intermediate consumption	Nominal	Domestic
I^K	Total Investment	Nominal	Domestic
X	Total exports	Nominal	Domestic
X_C	Nominal oil and coal exports	Nominal	Domestic
x_C	Real oil and coal exports	Real	
X_{NC}	Non-oil and coal exports	Nominal	Domestic
$\sigma^T_{X_N}$	Target propensity to export non-commodity exports		
σ_{X_N}	Propensity to export non-commodity exports		
GDP_W	Foreign Gross Domestic Product	Real	
IM	Nominal imports	Real	
M	Real imports	Real	
$\sigma^T_{M,C}$	Target propensity to import consumption goods		
$\sigma_{M,C}$	Propensity to import consumption goods		
$\sigma^T_{M,IC}$	Target propensity to import int. consumption goods		
$\sigma_{M,IC}$	Propensity to import consumption goods		
$\sigma^T_{M,I}$	Target propensity to import investment goods		
$\sigma_{M,I}$	Propensity to import investment goods		
a_D	Domestic productivity	Real	
a_W	Foreign productivity	Real	
Y^B	Production of FCs	Nominal	Domestic
Y^G	Non-market production of the Government	Nominal	Domestic
G_C	Non-market consumption of the Government	Nominal	Domestic
GDP	Gross Domestic Product	Nominal	Domestic
UC	Unit cost of production	Nominal	Domestic
HUC	Historical unit cost of production	Nominal	Domestic

p^d	Desired production price level	Nominal	Domestic
μ	Mark-up on historical unit cost		
p	Production price level	Nominal	Domestic
p^C	Price of consumption goods	Nominal	Domestic
p^{IC}	Price of intermediate consumption goods	Nominal	Domestic
p^K	Price of investment goods	Nominal	Domestic
p^X	Price of export goods	Nominal	Domestic
p^W	Foreign price level	Nominal	Foreign
IC_F	Intermediate consumption of NFCs	Real	
INS_F	Insurance services paid by NFCs	Nominal	Domestic
COM_F	Financial commissions paid by NFCs	Nominal	Domestic
I_F^T	Target investment of NFCs	Real	
I_F	Investment of NFCs	Real	
K_F	Capital stock of NFCs	Real	
r_F	Profit rate	Nominal	
u	Utilisation rate of capital		
u^e	Expected utilisation rate of capital		
L_F	Employment in NFCs		
w_F	Wage paid by NFCs	Nominal	Domestic
GOS_F	Gross operating surplus of NFCs	Nominal	Domestic
MI_H	Mixed income	Nominal	Domestic
$GOS_{F,H}$	Gross operating surplus redistributed to Households	Nominal	Domestic
$GOS_{F,G}$	Gross operating surplus redistributed to the Government	Nominal	Domestic
GF_F	Gross profits of NFCs	Nominal	Domestic
F_F	Net profits of NFCs	Nominal	Domestic
F_F^{ND}	Net profits of NFCs net of deposits accumulation	Nominal	Domestic
D_F^{FX}	FX deposits of NFCs	Nominal	Foreign
D_F	Domestic deposits of NFCs	Nominal	Domestic
Div_F	Dividends paid by NFCs	Nominal	Domestic
$Div_{F,G}$	Dividends paid by NFCs to the Government	Nominal	Domestic
$Div_{F,W}$	Dividends paid by NFCs to the RoW	Nominal	Domestic
$Div_{F,H}$	Dividends paid by NFCs to Households	Nominal	Domestic
RE_F	Retained earnings of NFCs	Nominal	Domestic
TFN_F	Total financing needs of NFCs	Nominal	Domestic
$L_F^{FX,B,d}$	Desired FX loans of NFCs with FCs	Nominal	Foreign
$L_F^{FX,B}$	FX loans of NFCs with FCs	Nominal	Foreign
$L_F^{FX,W,d}$	Desired FX loans of NFCs with the RoW	Nominal	Foreign
$L_F^{FX,W}$	FX loans of NFCs with the RoW	Nominal	Foreign
L_F^d	Domestic currency loans of NFCs	Nominal	Domestic
$rat_F^{FX.B}$	Rationing of FCs to NFCs' FX loans demand		
$rat_F^{FX.W}$	Rationing of the RoW to NFCs' FX loans demand		
GOS_B	Gross operating surplus of FCs		
L_B	Employment in FCs		
IC_B	Intermediate consumption of FCs	Real	
w_B	Wage paid by FCs	Nominal	Domestic

ST_B	Social transfers paid by FCs	Nominal	Domestic
I_B	Investment of FCs	Real	
K_B	Capital stock of FCs	Real	
GF_B	Gross profits of FCs	Nominal	Domestic
F_B	Net profits of FCs	Nominal	Domestic
OF_B^{CAR}	Capital required to comply with leverage regulations	Nominal	Domestic
RE_B	Retained earnings of FCs	Nominal	Domestic
OF_B	Own funds of FCs	Nominal	Domestic
Div_B	Dividends paid by FCs	Nominal	Domestic
$Div_{B,H}$	Dividends paid by FCs to Households	Nominal	Domestic
$Div_{B,W}$	Dividends paid by FCs to the RoW	Nominal	Domestic
L^d	Domestic currency loans	Nominal	Domestic
D^d	Domestic currency deposits	Nominal	Domestic
Rd	Domestic currency reserves	Nominal	Domestic
Bg_B	Government bonds held by FCs	Nominal	Domestic
$L_B^{FX,W,d}$	Desired FX loans of FCs with the RoW	Nominal	Foreign
$L_B^{FX,W}$	FX loans of FCs with the RoW	Nominal	Foreign
$rat_B^{FX.W}$	Rationing of the RoW to FCs' FX loans demand		
D_B^{FX}	FX deposits of FCs	Nominal	Foreign
$R_B^{FX,d}$	Desired FX reserves of FCs	Nominal	Foreign
R_B^{FX}	FX reserves held by FCs	Nominal	Foreign
TFN_B	Total financing needs of FCs	Nominal	Domestic
A	Liquidity Advances	Nominal	Domestic
i^D	Interest rate on domestic deposits	Nominal	Domestic
md	Mark-down on monetary policy rate	Nominal	Domestic
i_F^L	Interest rate on loans to NFCs	Nominal	Domestic
AFC	Average funding cost of FCs	Nominal	Domestic
$prem_F^T$	Target interest rate premium on loans to NFCs	Nominal	Domestic
$prem_F$	Interest rate premium on loans to NFCs	Nominal	Domestic
i_H^L	Interest rate on loans to Households	Nominal	Domestic
$prem_H^T$	Target interest rate premium on loans to Households	Nominal	Domestic
$prem_H$	Interest rate premium on loans to Households	Nominal	Domestic
$i_B^{FX,W}$	Interest rate on FX loans of FCs with the RoW	Nominal	Foreign
$prem_{FX}$	Premium on FX loans	Nominal	Foreign
$i_F^{FX,B}$	Interest rate on FX loans of NFCs with FCs	Nominal	Foreign
$i_F^{FX,W}$	Interest rate on FX loans of NFCs with the RoW	Nominal	Foreign
$i_B^{FX,R}$	Interest rate on FX reserves of FCs	Nominal	Foreign
$i^{P,T}$	Target monetary policy rate	Nominal	Domestic
i^P	Monetary policy rate	Nominal	Domestic
F_{CB}	Central Bank Profits	Nominal	Domestic
R_{CB}^{FX}	FX reserves held by the Central Bank	Nominal	Foreign
$i_{CB}^{FX,R}$	Interest rate on FX reserves of the Central Bank	Nominal	Foreign
YD_H	Disposable income of Households	Nominal	Domestic
L	Total employment		
$unem$	Unemployment rate		

pop	Labour force		
wL	Wage income	Nominal	Domestic
ESC	Employers' social contributions	Nominal	Domestic
WSC	Workers' social contributions	Nominal	Domestic
INS_H	Insurance services paid by Households	Nominal	Domestic
COM_H	Financial commissions paid by Households	Nominal	Domestic
C_H^T	Target final consumption of Households	Nominal	Domestic
C_H	Final consumption of Households	Nominal	Domestic
m_1	Propensity to consume out disposable income		
m_2	Propensity to consume out wealth		
I_H^T	Target investment of Households	Nominal	Domestic
I_H	Investment of Households	Nominal	Domestic
γ_{IH}	Households' investment to disposable income ratio		
K_H	Capital stock of Households	Real	
S_H	Households' savings	Nominal	Domestic
TFN_H	Total financing needs of Households	Nominal	Domestic
L_H^d	Domestic currency loans of Households	Nominal	Domestic
$L_H^{d,C}$	Consumption loans of Households	Nominal	Domestic
v_{LC}^T	Target consumption credit to disposable income ratio		
v_{LC}	Consumption credit to disposable income ratio		
$L_H^{d,I}$	Mortgage loans of Households	Nominal	Domestic
TIR_H	Technical insurance reserves	Nominal	Domestic
D_H	Domestic currency deposits of Households	Nominal	Domestic
FR	Fiscal revenue	Nominal	Domestic
T_T	Tax revenue	Nominal	Domestic
T^I	Taxes on income	Nominal	Domestic
T^M	Taxes on imports	Nominal	Domestic
T^V	Value-added taxes	Nominal	Domestic
T^P	Other net taxes on products	Nominal	Domestic
T^Y	Taxes on production	Nominal	Domestic
Roy	Royalties	Nominal	Domestic
G_T	Total expenditures of the Government	Nominal	Domestic
G_P	Primary expenditures of the Government	Nominal	Domestic
C_G	Final consumption of the Government	Nominal	Domestic
w_G	Wage paid by the Government	Nominal	Domestic
L_G	Employment in the Government		
IC_G	Intermediate consumption of the Government	Real	
I_G^T	Target investment of the Government	Real	
I_G	Investment of the Government	Real	
K_G	Capital stock of the Government	Real	
ST	Social transfers received by Households	Nominal	Domestic
ST_G	Social transfers paid by the Government	Nominal	Domestic
G_{IP}	Interest payments on public debt	Nominal	Domestic
FD	Fiscal deficit	Nominal	Domestic
D_G^T	Target domestic currency deposits of the Government	Nominal	Domestic

D_G	Domestic currency deposits of the Government	Nominal	Domestic
$D_G^{CB,T}$	Target deposits of the Government at the Central Bank	Nominal	Domestic
D_G^{CB}	Deposits of the Government at the Central Bank	Nominal	Domestic
D_G^{FX}	FX deposits of the Government	Nominal	Foreign
TFN_G	Total Financing Needs of the Government	Nominal	Domestic
Bg^{FX}	FX bonds issued by the Government	Nominal	Foreign
Lg^{FX}	FX loans of the Government	Nominal	Foreign
$\Omega_G^{FX,T}$	Target share of FX debt in new public debt issued		
Ω_G^{FX}	Share of FX debt in new public debt issued		
Bg	Domestic currency bonds issued by the Government	Nominal	Domestic
i_G^B	Interest rate on domestic Government bonds	Nominal	Domestic
$prem_G^T$	Target Int. rate premium on domestic Government bonds	Nominal	Domestic
$prem_G$	Interest rate premium on domestic Government bonds	Nominal	Domestic
$i_G^{B,FX}$	Interest rate on FX Government bonds	Nominal	Foreign
$i_G^{L,FX}$	Interest rate on FX Government loans	Nominal	Foreign
CAD	Current account deficit	Nominal	Domestic
TB	Trade balance	Nominal	Domestic
IA	Income account of the balance of payments	Nominal	Domestic
Rem	Remittances	Nominal	Foreign
FDI	Foreign direct investment	Nominal	Domestic
FDI_F	Foreign direct investment in NFCs	Nominal	Domestic
FDI_B	Foreign direct investment in FCs	Nominal	Domestic
FDI_F^G	Greenfield foreign direct investment in NFCs	Nominal	Domestic
FDI_F^{NG}	Non-Greenfield foreign direct investment in NFCs	Nominal	Domestic
Bg_W	Domestic Government bonds held by the RoW	Nominal	Domestic
$L^{FX,W}$	FX loans with the RoW	Nominal	Foreign
D^{FX}	FX deposits	Nominal	Foreign
R^{FX}	FX reserves	Nominal	Foreign
S^{FX}	Foreign exchange supply	Nominal	Foreign
D^{FX}	Foreign exchange demand	Nominal	Foreign
e^N	Nominal exchange rate	Nominal	Domestic
$e^{N,e}$	Expected nominal exchange rate	Nominal	Domestic
e^R	Real exchange rate		
rsk	Country risk	Nominal	Foreign
i_W	International reference interest rate	Nominal	Foreign

D. Model Equations

D.1. Production, Aggregate Demand and GDP

$$\dot{Y}^e = \beta_y \cdot \left(Y^{D,r} - Y^e\right) + g_k \cdot Y^e \tag{1}$$

$$g_K = \frac{I_F^K - \frac{FDI_F^G}{p^K}}{K_F} - \delta_F \tag{2}$$

$$Y^P = Y^e + I^{V,d} \tag{3}$$

$$I^{V,d} = \beta_{IV} \cdot \left(V^d - V\right) \tag{4}$$

$$V^d = \alpha_v \cdot Y^e \tag{5}$$

$$\dot{V} = Y^P - Y^{D,r} \tag{6}$$

$$I^V = \dot{V} \tag{7}$$

$$Y^{P,D} = Y^P - M \tag{8}$$

$$Y^D = C + IC + I^K + X \tag{9}$$

$$Y^{D,r} = \frac{C}{p^C} + \frac{IC}{p^{IC}} + \frac{I^K}{p^K} + \frac{X}{p^X} \tag{10}$$

$$C = C_H + C_G \tag{11}$$

$$IC = p^{IC} \cdot (IC_F + IC_B + IC_G) \tag{12}$$

$$I^K = p^K \cdot I_F^K + I_G^K + I_H^K + I_B^K + FDI_F^G \tag{13}$$

$$X = X_C + X_{NC} \tag{14}$$

$$X_C = x_C \cdot p_C^W \cdot \ e^N \tag{15}$$

$$\dot{x_C} = \alpha_x \cdot x_C \tag{16}$$

$$X_{NC} = \sigma_{X_N} \ \cdot GDP_W \cdot p_X^W \cdot e^N \tag{17}$$

$$\sigma_{X_N}^T = \sigma_p^X \cdot \left(\frac{e_X^R}{1+\tau_W}\right)^{\epsilon_p^X} + \sigma_a^X \cdot \left(\frac{a_D}{a_W}\right)^{\epsilon_a^X} \tag{18}$$

$$\dot{\sigma}_{X_N} = \beta_{X_N} \cdot \left(\sigma_{X_N}^T - \sigma_{X_N}\right) \tag{19}$$

$$IM = M \cdot p^W \cdot e^N \tag{20}$$

$$M = \sigma_{M,C} \cdot \left(\frac{C}{p^C}\right) + \sigma_{M,IC} \cdot \left(\frac{IC}{p^{IC}}\right) + \sigma_{M,I} \cdot \left(\frac{I^K}{p^K}\right) \tag{21}$$

$$\sigma_{M,C}^T = \sigma_{p,C}^M \cdot \left[e^R \cdot \left(1+\tau^M\right)\right]^{-\epsilon_{p,C}^M} + \sigma_{a,C}^M \cdot \left(\frac{a_W}{a_D}\right)^{\epsilon_{a,C}^M} \tag{22}$$

$$\sigma_{M,IC}^T = \sigma_{p,IC}^M \cdot \left[e^R \cdot \left(1+\tau^M\right)\right]^{-\epsilon_{p,IC}^M} \ + \sigma_{a,IC}^M \cdot \left(\frac{a_W}{a_D}\right)^{\epsilon_{a,IC}^M} \tag{23}$$

$$\sigma_{M,I}^T = \sigma_{p,I}^M \cdot \left[e^R \cdot \left(1+\tau^M\right)\right]^{-\epsilon_{p,I}^M} \ + \sigma_{a,I}^M \cdot \left(\frac{a_W}{a_D}\right)^{\epsilon_{a,I}^M} \tag{24}$$

$$\dot{\sigma}_{M,C} = \beta_{M,C} \cdot \left(\sigma_{M,C}^T - \sigma_{M,C}\right) \tag{25}$$

$$\dot{\sigma}_{M,IC} = \beta_{M,IC} \cdot \left(\sigma_{M,IC}^T - \sigma_{M,IC}\right) \tag{26}$$

$$\dot{\sigma}_{M,I} = \beta_{M,I} \cdot \left(\sigma_{M,I}^T - \sigma_{M,I}\right) \tag{27}$$

$$\dot{a_D} = \alpha_D \cdot a_D \tag{28}$$

$$Y^B = INS_H + INS_F + Com_H + Com_F \tag{29}$$

$$Y^G = (1+\tau_{W,G}) \cdot w_G \cdot L_G + p^{IC} \cdot IC_G + \delta_G \cdot p^K \cdot K_G \tag{30}$$

$$G_C = Y^G \tag{31}$$

$$GDP = C + I^K + G_C + X - IM \tag{32}$$

D.2. Pricing

$$UC = \frac{(1+\tau_{W,F}) \cdot w_F \cdot L_F + p^{IC} \cdot IC_F + \tau_F^Y \cdot Y^{P,D}}{Y^{P,D}} \tag{33}$$

$$\dot{HUC} = \beta_{HUC} \cdot (UC - HUC) \tag{34}$$

$$p^d = (1+\mu) \cdot HUC \tag{35}$$

$$\mu = \mu_0 - \mu_1 \cdot \left(\frac{V}{Y^e} - \alpha_v\right) \tag{36}$$

$$\dot{p} = \beta_p \cdot \left(p^d - p\right) \tag{37}$$

$$p^C = \left(1+\tau^V\right) \cdot \left[(1-\sigma_{M,C}) \cdot p \; + \left(1+\tau^M\right) \cdot \sigma_{M,C} \cdot p^W \cdot e^N\right] \tag{38}$$

$$p^{IC} = \left(1+\tau^P\right) \cdot \left[(1-\sigma_{M,IC}) \cdot p \; + \left(1+\tau^M\right) \cdot \sigma_{M,IC} \cdot p^W \cdot e^N\right] \tag{39}$$

$$p^K = \left(1+\tau^P\right) \cdot \left[(1-\sigma_{M,I}) \cdot p \; + \left(1+\tau^M\right) \cdot \sigma_{M,I} \cdot p^W \cdot e^N\right] \tag{40}$$

$$p^X = \frac{X}{x_C + \sigma_{X_N} \cdot GDP_W} \tag{41}$$

D.3. Non-Financial Corporations

$$IC_F = \theta_{IC,F} \cdot Y^P \tag{42}$$

$$INS_F = \theta_{Ins,F} \cdot p^K \cdot K_H \tag{43}$$

$$Com_F = \theta_{Com,F} \cdot L_F^d \tag{44}$$

$$I_F^{K,T} = \left[\kappa_0 + \kappa_1 \cdot \left(r_F - \frac{\dot{p}}{p}\right)\right] \cdot K_F \tag{45}$$

$$\dot{I_F^K} = \beta_{\mathsf{IF}} \cdot \left(I_F^{K,T} - I_F^K\right) \tag{46}$$

$$\dot{K_F} = I_F^K - \delta_F \cdot K_F \tag{47}$$

$$r_F = \frac{F_F}{p^K \cdot K_F} \tag{48}$$

$$L_F = \frac{Y^{P,D}}{a_D} \tag{49}$$

$$\dot{w_F} = \left(\omega_{F,0} \cdot \frac{\dot{a_D}}{a_D} + \omega_{F,1} \cdot \left(\frac{L}{\mathsf{pop}} - \omega_{F,2}\right) + \omega_{F,3} \cdot \frac{\dot{p}}{p}\right) \cdot w_F \tag{50}$$

$$GOS_F = Y^D - IM - T^P - T^M - T^V - \tau^{Y,F} \cdot Y^{P,D} - p^{IC} \cdot IC_F - INS_F \ldots$$
$$\ldots - Com_F - (1+\tau_{W,F}) \cdot w_F \cdot L_F \tag{51}$$

$$MI_H = \theta_{MI} \cdot GOS_F \tag{52}$$

$$GOS_{F,H} = \theta_{GH} \cdot GOS_F \tag{53}$$

$$GOS_{F,G} = \theta_{GG} \cdot GOS_F \tag{54}$$

$$GF_F = GOS_F + i_F^D \cdot D_F - i_F^L \cdot L_F^d - i_F^{FX,B} \cdot L_F^{FX,B} \cdot e^N \ldots$$
$$\ldots - i_F^{FX,W} \cdot L_F^{FX,W} \cdot e^N - Roy - MI_H - GOS_{F,H} - GOS_{F,G} \tag{55}$$

$$F_F = \left(1 - \tau_F^I\right) \cdot GF_F \tag{56}$$

$$F_F^{ND} = F_F - D_F^{\dot{F}X} \cdot e^N - \dot{D_F} \tag{57}$$

$$\dot{D_F} = \beta_{DF} \cdot (\eta_{D,F} \cdot (1 + \tau_{W,F}) \cdot w_F \cdot L_F - D_F) \tag{58}$$

$$\dot{D_F^{FX}} = \beta_{DF}^{FX} \cdot \left(\eta_{D,F}^{FX} \cdot \left(L_F^{FX,B} + L_F^{FX,W}\right) - D_F^{FX}\right) \tag{59}$$

$$Div_F = (1 - s_F) \cdot F_F^{ND} \tag{60}$$

$$Div_{F,G} = \left[\zeta_{0G} + \zeta_{1G} \cdot \left(\frac{X_C}{GDP}\right)\right] \cdot Div_F \tag{61}$$

$$Div_{F,W} = \left[\zeta_{0W} + \zeta_{1W} \cdot \left(\frac{X_C}{GDP}\right)\right] \cdot Div_F \tag{62}$$

$$Div_{F,H} = Div_F - Div_{F,G} - Div_{F,W} \tag{63}$$

$$RE_F = s_F \cdot F_F^{ND} - O_F \tag{64}$$

$$O_F = \nu_F * Y^{P,D} \tag{65}$$

$$TFN_F = p^K \cdot I_F^K - RE_F \tag{66}$$

$$L_F^{F\dot{X},B,d} = \eta_F^{FX,B} \cdot \frac{TFN_F}{en} \tag{67}$$

$$L_F^{F\dot{X},B} = \left(1 - rat_B^{FX}\right) \cdot L_F^{F\dot{X},B,d} \tag{68}$$

$$L_F^{F\dot{X},W,d} = \eta_F^{FX,W} \cdot \frac{TFN_F}{e^N} \tag{69}$$

$$rat_F^{FX} = LB_F^{FX} + \frac{1}{1 + exp\left(-\epsilon_F^{FX} \cdot \left(rsk - \chi_F^{FX}\right)\right)} \cdot \left(UB_F^{FX} - LB_F^{FX}\right) \tag{70}$$

$$L_F^{F\dot{X},W} = \left(1 - rat_F^{FX}\right) \cdot L_F^{F\dot{X},W,d} \tag{71}$$

$$\dot{L_F^d} = TFN_F - L_F^{F\dot{X},B} \cdot e^N - L_F^{F\dot{X},W} \cdot e^N \tag{72}$$

D.4. Financial Corporations

$$GOS_B = Y^B - p^{IC} \cdot IC_B - \tau_B^Y \cdot Y^B - (1 + \tau_{W,B}) \cdot w_B \cdot L_B \tag{73}$$

$$\dot{L_B} = \lambda_B \cdot L_B \tag{74}$$

$$IC_B = \theta_{IC,B} \cdot L_B \tag{75}$$

$$\dot{w_B} = \left(\omega_{B,0} \cdot \frac{\dot{a_D}}{a_D} + \omega_{B,1} \cdot \frac{\dot{p}}{p}\right) \cdot w_B \tag{76}$$

$$ST_B = (1 - \varsigma_{ST,G}) \cdot ST \tag{77}$$

$$I_B = \kappa_B \cdot Y^B \tag{78}$$

$$\dot{K_B} = \frac{I_B}{p^K} - \delta_B \cdot K_B \tag{79}$$

$$\begin{aligned} GF_B = {} & GOS_B + i_H^L \cdot L_H^d + i_F^L \cdot L_F^d + i_F^{FX,B} \cdot L_F^{FX,B} \cdot e^N + i_G^B \cdot Bg_B \ldots \\ & \ldots + i_B^{FX,R} \cdot R_B^{FX} \cdot e^N - i^D \cdot D_G - i_H^D \cdot D_H - i_F^D \cdot D_F \ldots \\ & \ldots - i_B^{FX,W} \cdot L_B^{FX,W} \cdot e^N - i^P \cdot A - ST_B \end{aligned} \tag{80}$$

$$F_B = \left(1 - \tau_B^I\right) \cdot GF_B \tag{81}$$

$$OF_B^{car} = car \cdot \left(L_F^d + L_H^d + L_F^{FX,B} \cdot e^N\right) \tag{82}$$

$$RE_B = \beta_{OF} \cdot \left(OF_B^{car} - OF_B\right) \tag{83}$$

$$\dot{OF}_B = RE_B \tag{84}$$

$$Div_{B,H} = F_B - RE_B - O_B \tag{85}$$

$$O_B = \nu_B * Y^{P,D} \tag{86}$$

$$\dot{L^d} = \dot{L_F^d} + \dot{L_H^d} \tag{87}$$

$$\dot{D^d} = \dot{D_F} + \dot{D_H} + \dot{D_G} \tag{88}$$

$$\dot{Rd} = lr \cdot \dot{D^d} \tag{89}$$

$$\dot{Bg_B} = \dot{Bg} - \dot{Bg_W} \tag{90}$$

$$L_B^{F\dot{X},W,d} = \eta_B^{FX,L} \cdot \frac{OF_B}{e^N} + L_F^{F\dot{X},B} \tag{91}$$

$$L_B^{F\dot{X},W} = \left(1 - rat_B^{FX}\right) \cdot L_B^{F\dot{X},W,d} \tag{92}$$

$$rat_B^{FX} = LB_B^{FX} + \frac{1}{1 + exp\left(-\epsilon_B^{FX} \cdot \left(rsk - \chi_B^{FX}\right)\right)} \cdot \left(UB_B^{FX} - LB_B^{FX}\right) \tag{93}$$

$$\dot{D_B^{FX}} = \beta_{DB}^{FX} \cdot \left[\eta_B^{FX} \cdot \left(L_F^{FX,B} + L_F^{FX,W}\right) - D_B^{FX}\right] \tag{94}$$

$$\dot{R_B^{FX,d}} = L_B^{F\dot{X},W,d} - \dot{D_B^{FX}} - L_F^{F\dot{X},B} \tag{95}$$

$$\dot{R_B^{FX}} = \dot{R}^{FX} - \dot{R}_{CB}^{FX} \tag{96}$$

$$\begin{aligned} TFN_B = &\left[\dot{L^d} + \dot{Bg_B} + \dot{Rd} + I_B\right] - \left[(1 + lr) \cdot \dot{D^d} + \dot{OF_B} + FDI_B + \dot{TIR_H}\right] \dots \\ &\dots + \left[\dot{D_B^{FX}} \cdot e^N + L_F^{F\dot{X},B} \cdot e^N + \dot{R_B^{FX}} \cdot e^N - L_B^{F\dot{X},W} \cdot e^N\right] \end{aligned} \tag{97}$$

$$\dot{A} = TFN_B \tag{98}$$

$$i^D = (1 - md) \cdot i^P \tag{99}$$

$$i_H^D = (1 - md_H) \cdot i^D \tag{100}$$

$$i_F^D = (1 - md_F) \cdot i^D \tag{101}$$

$$md = \rho_0 - \frac{\rho_1}{1 + e^{-\rho_2\left(\frac{A}{D^D} - \rho_3\right)}} \tag{102}$$

$$i_F^L = AFC \cdot (1 + prem_F) \tag{103}$$

$$AFC = \frac{i^D \cdot D_G + i_H^D \cdot D_H + i_F^D \cdot D_F + i^P \cdot A}{D^d + A} \tag{104}$$

$$prem_F^T = \phi_{F0}^{\mathsf{Pr}} + \frac{\phi_{F1}^{\mathsf{Pr}}}{1 + exp\left(-\phi_{F2}^{\mathsf{Pr}} \cdot \left(\frac{L_F^d + L_F^{FX,B} \cdot e^N + L_F^{FX,W} \cdot e^N}{p \cdot Y^{P,D}}\right)\right)} \tag{105}$$

$$\dot{prem}_F = \beta_{Pr}^F \cdot \left(prem_F^T - prem_F\right) \tag{106}$$

$$i_F^{FX,B} = i_B^{FX,W} \cdot \left(1 + + \varrho_F^{FX,B} \cdot prem_F\right) \tag{107}$$

$$i_H^L = i_F^L \cdot (1 + prem_H) \tag{108}$$

$$prem_H^T = \phi_{H0}^{\mathsf{Pr}} + \frac{\phi_{H1}^{\mathsf{Pr}}}{1 + exp\left(-\phi_{H2}^{\mathsf{Pr}} \cdot \left(\frac{L_H^d}{YD_H}\right)\right)} \tag{109}$$

$$\dot{prem}_H = \beta^H_{\mathsf{Pr}} \cdot \left(prem^T_H - prem_H\right) \tag{110}$$

D.5. Central Bank

$$i^{P,T} = \iota_0 + \iota_1 \cdot \left(\frac{\dot{p}}{p} - \iota_2\right) \tag{111}$$

$$\dot{i^p} = \beta_{ip} \cdot \left(i^{P,T} - i^P\right) \tag{112}$$

$$F_{CB} = i^P \cdot A + i^{FX,R}_{CB} \cdot R^{FX}_{CB} - i^D_{CB} \cdot D^{CB}_G \tag{113}$$

$$\dot{R^{FX}_{CB}} = max\left[\theta_{FX,M} \cdot M \cdot p^W - R^{FX}_{CB}, 0\right] \tag{114}$$

D.6. Households

$$YD_H = \left(1 - \tau^I_W\right) \cdot wL + MI_H + GOS_H + ESC + ST + i^D_H \cdot D_H + Div_{F,H} \ldots$$
$$\ldots + Div_{B,H} + Rem \cdot e^N \cdot -WSC - i^L_H \cdot L^d_H - INS_H - Com_H + O_H \tag{115}$$

$$L = L_F + L_B + L_G \tag{116}$$

$$unem = 1 - \frac{L}{\mathsf{pop}} \tag{117}$$

$$\dot{pop} = \alpha_P \cdot pop \tag{118}$$

$$wL = w_F \cdot L_F + w_B \cdot L_B + w_G \cdot L_G \tag{119}$$

$$ESC = \tau_{W,F} \cdot w_F \cdot L_F + \tau_{W,B} \cdot w_B \cdot L_B + \tau_{W,G} \cdot w_G \cdot L_G \tag{120}$$

$$WSC = ESC + \tau_{SC} \cdot wL \tag{121}$$

$$O_H = \nu_H * Y^{P,D} \tag{122}$$

$$INS_H = \theta_{Ins,H} \cdot p^K \cdot K_H \tag{123}$$

$$Com_H = \theta_{Com,H} \cdot L^d_H \tag{124}$$

$$C = C_H INS_H + Com_H \tag{125}$$

$$C^T_H = m_1 \cdot YD_H + m_2 \cdot \left(D_H + TIR_H + p^K \cdot K_H\right) + \dot{L^d_H} \tag{126}$$

$$\dot{C_H} = \beta_C \cdot \left(C^T_H - C_H\right) \tag{127}$$

$$m_1 = LB^{YD}_H + \frac{1}{1 + exp\left(-\epsilon^{YD}_H \cdot \left(\left(i^D_H - \frac{\dot{p}}{p}\right) - \chi^{YD}_H\right)\right)} \cdot \left(UB^{YD}_H - LB^{YD}_H\right) \tag{128}$$

$$I^T_H = \left(\kappa_{H,0} - \kappa_{H,1} \cdot i^L_H - \kappa_{H,2} \cdot unem\right) \cdot YD_H \tag{129}$$

$$\dot{I_H} = \beta_{IH} \cdot \left(I^T_H - I_H\right) \tag{130}$$

$$\dot{K_H} = \frac{I_H}{p^K} - \delta_H \cdot K_H \tag{131}$$

$$S_H = YD_H - C_H \tag{132}$$

$$TFN_H = I_H - S_H \tag{133}$$

$$\dot{L_H^d} = \dot{L_H^{d,C}} + \dot{L_H^{d,I}} \tag{134}$$

$$\dot{L_H^{d,C}} = \beta_{LDCH} \cdot \left(\eta_{LC} \cdot YD_H - L_H^{d,C}\right) \tag{135}$$

$$\dot{L_H^{d,I}} = \eta_{LI} \cdot I_H \tag{136}$$

$$\dot{TIR_H} = \eta_{TIR} \cdot wL \tag{137}$$

$$\dot{D_H} = S_H - I_H + \dot{L_H^d} - \dot{TIR_H} \tag{138}$$

D.7. Government

$$FR = T_T + Roy + GOS_G + WSC + i^D \cdot D_G + i_{CB}^D \cdot D_G^{CB} + Div_{F,G} \tag{139}$$

$$T_T = T^I + T^M + T^V + T^P + T^Y \tag{140}$$

$$T^I = \tau_W^I \cdot wL + \tau_F^I \cdot GF_F + \tau_B^I \cdot GF_B \tag{141}$$

$$T^M = \tau^M \cdot IM \tag{142}$$

$$T^V = \tau^V \cdot \frac{C \cdot \left[(1-\sigma_{M,C}) \cdot p \; + \left(1+\tau^M\right) \cdot \sigma_{M,C} \cdot p^W \cdot e^N\right]}{p^C} \tag{143}$$

$$\begin{aligned} T^P = {} & \tau^P \cdot \frac{C \cdot \left[(1-\sigma_{M,C}) \cdot p \; + \; \left(1+\tau^M\right) \cdot \sigma_{M,C} \cdot p^W \cdot e^N\right]}{p^C} \ldots \\ & \ldots + \tau^P \cdot \frac{IC \cdot \left[(1-\sigma_{M,IC}) \cdot p \; + \; \left(1+\tau^M\right) \cdot \sigma_{M,IC} \cdot p^W \cdot e^N\right]}{p^{IC}} \ldots \\ & \ldots + \tau^P \cdot \frac{I^K \cdot \left[(1-\sigma_{M,I}) \cdot p \; + \; \left(1+\tau^M\right) \cdot \sigma_{M,I} \cdot p^W \cdot e^N\right]}{p^K} \end{aligned} \tag{144}$$

$$T^Y = \tau_F^Y \cdot p \cdot Y^{P,D} \; + \tau_B^Y \cdot Y^B \tag{145}$$

$$Roy = \theta^R \cdot X_C \tag{146}$$

$$G_T = G_P + G_{\mathsf{IP}} + O_G \tag{147}$$

$$G_P = C_G + (1+\tau_{W,G}) \cdot w_G \cdot L_G \; + p^{IC} \cdot IC_G + p^K \cdot I_G + ST_G \tag{148}$$

$$O_G = \nu_G * Y^{P,D} \tag{149}$$

$$C_G^T = \theta_{G,C} \cdot GDP \tag{150}$$

$$\dot{C_G} = \; \beta_{CG} \cdot \left(C_G^T - C_G\right) \tag{151}$$

$$\dot{w_G} = \left(\omega_{G,0} \cdot \frac{\dot{a_D}}{a_D} + \; \omega_{G,1} \cdot \frac{\dot{p}}{p}\right) \cdot w_G \tag{152}$$

$$L_G = \theta_{G,L} \cdot pop \tag{153}$$

$$IC_G = \theta_{IC,G} \cdot L_G \tag{154}$$

$$I_G^T = \kappa_G \cdot K_G \tag{155}$$

$$\dot{I_G} = \; \beta_{IG} \cdot \left(I_G^T - I_G\right) \tag{156}$$

$$\dot{K_G} \; = I_G - \delta_G \cdot K_G \tag{157}$$

$$ST = \theta_{G0,ST} \cdot w_F \cdot (pop - L) + \theta_{G1,ST} \cdot w_F \cdot pop \tag{158}$$

$$ST_G = \varsigma_{ST,G} \cdot ST \tag{159}$$

$$G_{IP} = i_G^B \cdot Bg + i_G^{B,\,FX} \cdot Bg^{FX} \cdot e^N + i_G^{L,FX} \cdot Lg^{FX} \cdot e^N \tag{160}$$

$$FD = G_T - FR - F_{CB} \tag{161}$$

$$\dot{D_G} = \beta_{DG} \cdot (\eta_{DG} \cdot G_T - D_G) \tag{162}$$

$$\dot{D_G^{CB}} = \beta_{DG}^{CB} \cdot (\eta_{DG}^{CB} \cdot G_T - D_G^{CB}) \tag{163}$$

$$\dot{D_G^{FX}} = \beta_{DG}^{FX} \cdot (\eta_{DG}^{FX} \cdot (Bg^{FX} + Lg^{FX}) - D_G^{FX}) \tag{164}$$

$$TFN_G = FD + \dot{D_G} + \dot{D_G^{CB}} + \dot{D_G^{FX}} \cdot e^N \tag{165}$$

$$\dot{Bg} = TFN_G - \dot{Bg^{FX}} \cdot e^N - \dot{Lg^{FX}} \cdot e^N \tag{166}$$

$$i_G^B = i^P + prem_G \tag{167}$$

$$prem_G^T = \phi_{G0}^{\mathsf{Pr}} + \frac{\phi_{G1}^{\mathsf{Pr}}}{1 + exp\left(-\phi_{G2}^{\mathsf{Pr}} \cdot \left(\frac{Bg + Bg^{FX} + Lg^{FX}}{GDP}\right)\right)} \tag{168}$$

$$\dot{prem_G} = \beta_{Pr}^G \cdot (prem_G^T - prem_G) \tag{169}$$

D.8. Rest of the World

$$\dot{GDP_W} = \alpha_{GW} \cdot GDP_W \tag{170}$$

$$\dot{a_W} = \alpha_W \cdot a_W \tag{171}$$

$$\dot{p^W} = \alpha_{pW} \cdot p^W \tag{172}$$

$$\dot{p_X^W} = \alpha_{pW} \cdot p_X^W \tag{173}$$

$$\dot{p_C^W} = \alpha_{pW} \cdot p_C^W \tag{174}$$

$$CAD = -(TB + IA) \tag{175}$$

$$TB = X - IM \tag{176}$$

$$\begin{aligned} IA = {} & Rem \cdot e^N + i_{CB}^{FX,R} \cdot R_{CB}^{FX} \cdot e^N + i_B^{FX,R} \cdot R_B^{FX} \cdot e^N - i_G^{B,\,FX} \cdot Bg^{FX} \cdot e^N \ldots \\ & \ldots - i_G^{L,FX} \cdot Lg^{FX} \cdot e^N - i_G^B \cdot Bg_W - i_F^{FX,W} \cdot L_F^{FX,W} \cdot e^N \ldots \\ & \ldots - i_B^{FX,W} \cdot L_B^{FX,W} \cdot e^N - Div_{F,W} - Div_{B,W} + O_W \end{aligned} \tag{177}$$

$$Rem = \theta_{REM} \cdot GDP_W \cdot p^W \tag{178}$$

$$O_W = \nu_W * Y^{P,D} \tag{179}$$

$$FDI = \psi^{FDI} \cdot p^K \cdot I_F \tag{180}$$

$$FDI_F = \psi_F^{FDI} \cdot FDI \tag{181}$$

$$\dot{EQ_F^W} = FDI_F \tag{182}$$

$$FDI_B = (1 - \psi_F^{FDI}) \cdot FDI \tag{183}$$

$$\dot{EQ_B^W} = FDI_B \tag{184}$$

$$FDI_F^G = \psi_G^{FDI} \cdot FDI_F \tag{185}$$

$$FDI_F^{NG} = (1 - \psi_G^{FDI}) \cdot FDI_F \tag{186}$$

$$\dot{Bg_W} = -\eta_{GW}^D \cdot TB \tag{187}$$

$$\dot{B_G^{FX}} = \phi_{BG}^{FX} \cdot \left(\Omega_G^{FX} \cdot \frac{-TB}{e^N} \right) \tag{188}$$

$$\dot{L_G^{FX}} = \left(1 - \phi_{BG}^{FX}\right) \cdot \left(\Omega_G^{FX} \cdot \frac{-TB}{e^N} \right) \tag{189}$$

$$\Omega_G^{FX,T} = \Omega_{G0} + \Omega_{G1} \cdot \frac{CAD}{GDP} \tag{190}$$

$$\dot{\Omega_G^{FX}} = \beta_{FX,G} \cdot \left(\Omega_G^{FX,T} - \Omega_G^{\mathsf{FX}} \right) \tag{191}$$

$$L^{F\dot{X},W} = L_F^{F\dot{X},W} + L_B^{F\dot{X},W} + L_G^{F\dot{X},W} \tag{192}$$

$$D^{\dot{F}X} = D_F^{\dot{F}X} + D_B^{\dot{F}X} + D_G^{\dot{F}X} \tag{193}$$

$$\dot{R}^{FX} = \frac{TB}{e^N} + \frac{IA}{e^N} + \frac{FDI}{e^N} + \dot{Bg^{FX}} + \dot{Lg^{FX}} + L^{F\dot{X},W} + \frac{\dot{Bg_W}}{e^N} - D^{\dot{F}X} \tag{194}$$

$$\begin{aligned} S^{FX} = {} & \frac{X}{e^N} + Rem + O_W + i_{CB}^{FX,R} \cdot R_{CB}^{FX} + i_B^{FX,R} \cdot R_B^{FX} \dots \\ & \dots + \frac{FDI}{e^N} + \dot{Bg^{FX}} + \dot{Lg^{FX}} + L^{F\dot{X},W} + \frac{\dot{Bg_W}}{e^N} - \dot{R}_{CB}^{FX} \end{aligned} \tag{195}$$

$$\begin{aligned} D^{FX} = {} & \frac{IM}{e^N} + i_G^{B,\,FX} \cdot Bg^{FX} + i_G^{L,FX} \cdot Lg^{FX} + \frac{i_G^B \cdot Bg_W}{e^N} \dots \\ & \dots + i_F^{FX,W} \cdot L_F^{FX,W} + i_B^{FX,W} \cdot L_B^{FX,W} + \frac{Div_{F,W}}{e^N} + \frac{Div_{B,W}}{e^N} + \dot{R}_{CB}^{FX,d} \end{aligned} \tag{196}$$

$$\dot{e^N} = \beta_{eN} \cdot \left(\frac{D^{FX} - S^{FX}}{S^{FX}} \right) \tag{197}$$

$$e^R = \frac{p^W \cdot e^N}{p} \tag{198}$$

$$rsk = \xi_0 \cdot \left(\frac{M \cdot p^W}{R^{FX}} \right)^{\xi_1} \tag{199}$$

$$i_B^{FX,W} = i_W + prem_{FX} \tag{200}$$

$$prem_{FX} = \phi_0^{FX} + \phi_1^{FX} \cdot (rsk)^{\phi_2^{FX}} \tag{201}$$

$$i_F^{FX,W} = i_W + \varrho_F^{FX,W} \cdot prem_{FX} \tag{202}$$

$$i_B^{FX,R} = i_W + \varrho_B^{FX,R} \tag{203}$$

$$i_{CB}^{FX,R} = i_W + \varrho_{CB}^{FX,R} \tag{204}$$

$$i_G^{B,FX} = i_W + \zeta_G^{B,FX} \cdot prem_{FX} \tag{205}$$

$$i_G^{L,FX} = \left(1 - \zeta_G^{L,FX}\right) \cdot i_G^{B,FX} \tag{206}$$

D.9. Scenario

$$\sigma_p^X(t) = \frac{1}{1 + exp\left(\sigma_{Speed}^{Xp} \cdot t - \sigma_{Init}^{Xp}\right)} \cdot \left(\sigma_0^{Xp} - \sigma_0^{Xp} \cdot \sigma_{New}^{Xp}\right) + \sigma_0^{Xp} \cdot \sigma_{New}^{Xp} \tag{207}$$

$$\psi^{FDI}(t) = \frac{1}{1 + exp\left(\psi_{Speed}^{FDI} \cdot t - \psi_{Init}^{FDI}\right)} \cdot \left(\psi_0^{FDI} - \psi_0^{FDI} \cdot \psi_{New}^{FDI}\right) + \psi_0^{FDI} \cdot \psi_{New}^{FDI} \tag{208}$$

E. Parameters and initial values

Table 5: Parameters value and description.

Name	Value	Description
β_y	3.00e+00	Speed of convergence of expected demand, equation 1
δ_F	4.00e-02	Depreciation rate, equation 2
β_{IV}	1.63e-01	Speed of convergence for desired inventory accumulation, equation 4
α_v	7.83e-02	Ratio of desired inventories to expected sales, equation 5
α_x	3.00e-02	Growth rate of fossil fuel exports, equation 16
ϵ_p^X	6.00e-01	Price elasticity for propensity to export, equation 18
σ_a^X	2.50e-04	Linear term in productivity effect on propensity to export, equation 18
ϵ_a^X	1.37e+00	Productivity elasticity for propensity to export, equation 18
β_X	1.00e+00	Speed of convergence of non fossil fuel exports, equation 19
$\sigma_{p,C}^M$	1.30e-01	Linear term in price effect on propensity to import consumption goods, equation 22
$\epsilon_{p,C}^M$	7.54e-01	Price elasticity for propensity to import consumption goods, equation 22
$\sigma_{a,C}^M$	2.50e-04	Linear term in productivity effect on propensity to import consumption goods, equation 22
$\epsilon_{a,C}^M$	1.58e+00	Productivity elasticity for propensity to import consumption goods, equation 22
$\sigma_{p,IC}^M$	1.01e-01	Linear term in price effect on propensity to import intermediate consumption goods, equation 23
$\epsilon_{p,IC}^M$	6.91e-01	Price elasticity for propensity to import intermediate consumption goods, equation 23
$\sigma_{a,IC}^M$	8.50e-04	Linear term in productivity effect on propensity to import intermediate consumption goods, equation 23
$\epsilon_{a,IC}^M$	2.06e+00	Productivity elasticity for propensity to import intermediate consumption goods, equation 23
$\sigma_{p,I}^M$	3.05e-01	Linear term in price effect on propensity to import investment goods, equation 24
$\epsilon_{p,I}^M$	4.45e-01	Price elasticity for propensity to import investment goods, equation 24
$\sigma_{a,I}^M$	2.20e-04	Linear term in productivity effect on propensity to import investment goods, equation 24
$\epsilon_{a,I}^M$	2.41e-01	Productivity elasticity for propensity to import investment goods, equation 24
$\beta_{M,C}$	5.86e-01	Speed of convergence of consumption import, equation 25
$\beta_{M,IC}$	6.41e-01	Speed of convergence of intermediate consumption import, equation 26

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Table 5 – continued from previous page

Name	Value	Description
$\beta_{M,I}$	1.78e+00	Speed of convergence of investment import, equation 27
α_a	2.00e-02	domestic productivity growth rate, equation 28
β_{HUC}	1.50e+01	speed of convergence of historical unit costs, equation 34
μ_0	5.91e-01	Autonomous parameter in markup, equation 36
μ_1	1.32e-02	Sensitivity of markup to inventory accumulation, equation 36
β_p	7.50e-01	Speed of convergence of prices, equation 37
$\theta_{IC,F}$	4.06e-01	Intermediate consumption technical coefficient from firms, equation 42
$\theta_{Ins,F}$	0.00e+00	Insurance generation from firms' debt, equation 43
$\theta_{Com,F}$	1.37e-01	Commission generation from firms' debt, equation 44
κ_0	2.70e-02	Autonomous parameter investment function, equation 45
κ_1	5.00e-01	Sensitivity of investment to real profit rate, equation 45
β_{IF}	1.00e+00	speed of convergence for investment, equation 46
$\omega_{F,0}$	1.00e+00	Sensitivity of firms' wage curve to productivity, equation 50
$\omega_{F,2}$	8.80e-01	Unemployment rate as reference for wage curve, equation 50
$\omega_{F,3}$	1.00e+00	Sensitivity of firms' wage curve to prices, equation 50
θ_{MI}	3.80e-01	Share of GOS' firms distributed as mixed income, equation 52
$\theta_{G,H}$	9.72e-02	Share of firms' GOS distributed to Households, equation 53
$\theta_{G,G}$	5.75e-03	Share of firms' GOS distributed to Government, equation 54
β_{DF}	1.00e+00	Speed of convergence of firms' deposits, equation 58
$\eta_{D,F}$	3.50e-01	Share of wage bill used for firms' deposits targets, equation 58
β_{DF}^{FX}	1.00e+00	Speed of convergence of firms' FX deposits, equation 59
$\eta_{D,F}^{FX}$	1.40e-01	Share of FX loans used for firms' FX deposits targets, equation 59
s_F	4.61e-01	Saving rate of firms, equation 60
ζ_{0G}	-1.76e-01	Autonomous term on dividend distribution towards government, equation 61
ζ_{1G}	2.75e+00	Sensitivity of dividends distribution to Fossil fuel exports towards government, equation 61
ζ_{0W}	-5.16e-02	Autonomous term on dividend distribution towards rest of world, equation 62
ζ_{1W}	6.37e+00	Sensitivity of dividends distribution to Fossil fuel exports towards rest of the world, equation 62
ν_F	-3.90e-04	Share of nominal production distributed as Other flows to firms (negative flows), equation 65
$\eta_F^{FX,B}$	4.00e-02	Share of firms' financing needs asked in the form of FX loans from banks, equation 67
$\eta_F^{FX,W}$	1.30e-01	Share of firms' financing needs asked in the form of direct FX loans, equation 69
UB_F^{FX}	1.12e+00	Upper bound for rationing of firms in FX, equation 70
LB_F^{FX}	2.99e-02	Lower bound for rationing of firms in FX, equation 70
ϵ_F^{FX}	3.00e+01	Elasticity of firms' rationing to country risk, equation 70
χ_B^{FX}	8.00e-02	Country risk reference for firms' rationing, equation 70

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Table 5 – continued from previous page

Name	Value	Description
λ_B	1.00e-02	Growth rate of banks' employees, equation 74
$\theta_{IC,B}$	7.52e+01	Intermediate consumption technical coefficient from banks, equation 75
$\omega_{B,0}$	1.00e+00	Sensitivity of banks wage curve to productivity, equation 76
$\omega_{B,0}$	1.00e+00	Sensitivity of banks wage curve to prices, equation 76
κ_B	6.86e-02	Propensity for banks to invest out of banking production, equation 78
δ_B	4.48e-02	Depreciation rate of banks' capital, equation 79
car	2.74e-01	Capital Adequacy Ratio, equation 82
β_{OF}	1.00e+00	Speed of convergence for capital adequacy ratio, equation 84
ν_B	7.27e-03	Share of nominal production distributed as Other flows to banks (negative flows), equation 86
lr	1.59e-01	liquidity ratio, equation 89
$\eta_B^{FX,L}$	2.00e-01	Share of banks' own funds used for FX loans determination, equation 91
UB_B^{FX}	1.08e+00	Upper bound for rationing of banks in FX, equation 93
LB_B^{FX}	3.72e-01	Lower bound for rationing of banks in FX, equation 93
ϵ_B^{FX}	3.00e+01	Elasticity of banks' rationing to country risk, equation 93
χ_B^{FX}	8.00e-02	Country risk reference for banks' rationing, equation 93
η_B^{FX}	5.35e-02	Share of banks' FX loans used for banks' FX deposits target, equation 94
β_{DB}^{FX}	8.00e-01	Speed of convergence for Banks' FX deposits, equation 94
md_H	3.14e-01	Mark-down on deposits interests for households, equation 100
md_F	2.82e-01	Mark-down on deposits interests for firms, equation 101
ρ_0	5.30e-01	Autonomous term for mark-down on policy rate for deposit rate, equation 102
ρ_1	1.00e+00	Linear term for mark-down on policy rate for deposit rate, equation 102
ρ_2	1.00e+00	Elasticity of mark-down on policy rate for deposit rate on Advances over Deposits, equation 102
ρ_3	1.00e-02	Target for Advances over Deposits for mark-down on policy rate for deposit rate, equation 102
ϕ_{F0}^{Pr}	9.15e-01	Autonomous term for Risk premium of firms, equation 105
ϕ_{F1}^{Pr}	1.00e+00	Linear term for Risk premium of firms, equation 105
ϕ_{F2}^{Pr}	4.00e+00	Elasticity of Risk premium of firms on Advances over Deposits, equation 105
β_{Pr}^{F}	8.51e-01	Speed of convergence of firms' premium, equation 106
$\varrho_F^{FX,B}$	1.85e-01	Multiplier of firms FX direct lending rate based on their domestic premium, equation 107
ϕ_{H0}^{Pr}	1.55e-01	Autonomous term for Risk premium of households, equation 109
ϕ_{H1}^{Pr}	5.00e-01	Linear term for Risk premium of households, equation 109

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Table 5 – continued from previous page

Name	Value	Description
ϕ_{H2}^{Pr}	1.00e+00	Elasticity of Risk premium of households on Debt to income ratio, equation 109
β_{Pr}^{H}	1.23e+00	Speed of convergence of households' premium, equation 110
ι_0	4.85e-02	autonomous term for policy rate, equation 111
ι_1	2.00e+00	linear term for policy rate on inflation, equation 111
ι_2	3.00e-02	target inflation for policy rate, equation 111
β_{ip}	5.00e-01	Speed of convergence for policy rate, equation 112
$\theta_{FX,M}$	7.40e-01	Share of imports to determine FX reserves target of central bank, equation 114
α_p	1.00e-02	population growth rate, equation 118
$\tau_{W,B}$	1.88e-01	Employer contribution on banks' wages, equation 120
$\tau_{W,F}$	1.64e-01	Employer contribution on firms' wages, equation 120
$\tau_{W,G}$	2.72e-01	Employers' social contribution rate of public employment, equation 120
τ_{SC}	1.59e-02	Social contribution rate on wages, equation 121
ν_H	1.51e-02	Share of nominal production distributed as Other flows to households (positive flows), equation 122
$\theta_{Ins,H}$	0.00e+00	Insurance generation from household debt, equation 123
$\theta_{com,H}$	9.07e-02	Commission generation from household debt, equation 124
β_C	1.00e+00	Speed of convergence for consumption, equation 127
UB_H^{YD}	9.88e-01	Upper bound of sigmoidal of marginal propensity to consume, equation 128
LB_H^{YD}	8.70e-01	Lower bound of sigmoidal of marginal propensity to consume, equation 128
ϵ_H^{YD}	-6.00e+00	Elasticity on marginal propensity to consume, equation 128
χ_H^{YD}	1.30e-02	target real deposit rate in propensity to consume, equation 128
$\kappa_{H,0}$	7.27e-02	autonomous term in investment propensity of households, equation 129
$\kappa_{H,1}$	0.00e+00	Sensitivity to interest rate of investment propensity of households, equation 129
$\kappa_{H,2}$	0.00e+00	Sensitivity to unemployment rate of investment propensity of households, equation 129
β_{IH}	1.00e+00	Speed of convergence for households' investment, equation 130
δ_H	3.20e-06	Depreciation rate of households' capital, equation 131
β_{Ldch}	1.20e+01	Speed of convergence for households consumption credit, equation 135
η_{LC}	0.32e+00	Share of disposable income targeted for consumption loans, equation 135
η_{LI}	1.27e-01	Share of households' investment borrowed, equation 136
η_{TIR}	3.47e-02	Share of wage bill saved as Insurance Technical Reserves, equation 137
τ_W^I	8.40e-02	Income tax on wages , equation 141

Continued on next page

Table 5 – continued from previous page

Name	Value	Description
τ_F^I	1.74e-01	Tax rate on firms' profits, equation 141
τ_B^I	1.14e-01	Tax rate on banks' profits, equation 141
τ^M	6.41e-02	Import duties, equation 142
τ^V	9.27e-02	VAT rate, equation 143
τ^P	2.44e-02	Other tax on intermediate consumption rate, equation 144
τ_F^Y	1.73e-02	Tax rate on firms' production, equation 145
τ_B^Y	3.00e-02	Tax rate on banks' production, equation 145
θ^R	1.02e-01	Propensity of fossil fuel export to generate royalties, equation 146
ν_G	3.30e-03	Share of nominal production distributed as Other flows to government (negative flows), equation 149
$\theta_{G,C}$	2.25e-02	Share of GDP for government final consumption, equation 150
β_{Cg}	1.00e+00	Speed of convergence for public investment, equation 151
$\omega_{G,0}$	1.00e+00	Sensitivity of public wage curve to productivity, equation 152
$\omega_{G,1}$	1.00e+00	Sensitivity of public wage curve to prices, equation 152
$\theta_{G,L}$	8.70e-02	Share of population employed as public employees, equation 153
$\theta_{IC,G}$	2.32e+01	Intermediate consumption technical coefficient from firms, equation 154
κ_G	7.00e-02	Public capital investment rate, equation 155
β_{IG}	1.00e+00	Speed of convergence for government' investment, equation 156
δ_G	3.50e-02	Depreciation rate of public capital, equation 157
$\theta_{G0,ST}$	5.05e-01	Share of wages paid as unemployment benefit, equation 158
$\theta_{G1,ST}$	3.43e-01	Share of wages paid as social transfer, equation 158
$\varsigma_{ST,G}$	9.29e-01	Share of social transfer paid to the government, equation 159
β_{DG}	9.65e-01	Speed of convergence of government deposits, equation 162
η_{DG}	0.11e+00	Share of government expenditure to determine government domestic deposits target, equation 162
β_{DG}^{CB}	1.00e+00	Speed of convergence of government deposits at central bank, equation 163
$\eta_{DG}^{C}B$	2.47e-02	Share of government expenditure to determine government central bank deposits target, equation 163
β_{DG}^{FX}	1.00e+00	Speed of convergence for public FX deposits, equation 164
η_{DG}^{FX}	2.65e-02	Share of FX public debt to determine government FX deposits target, equation 164
ϕ_{G0}^{Pr}	1.20e-02	Autonomous term of premium of public bond rate over policy rate, equation 168
ϕ_{G1}^{Pr}	0.00e+00	Linear term of premium of public bond rate over policy rate, equation 168
ϕ_{G2}^{Pr}	0.00e+00	Elasticity of premium of public bond rate from Public debt to GDP ratio, equation 168
β_{Pr}^{G}	1.00e+00	Speed of convergence for public premium, equation 169
α_{GW}	3.00e-02	world gdp growth rate, equation 170

Continued on next page

Table 5 – continued from previous page

Name	Value	Description
α_W	2.00e-02	world productivity growth rate, equation 171
α_{pW}	3.00e-02	world inflation rate, equation 172
θ_{REM}	2.36e-04	Share of World GDP distributed as remittances, equation 178
ν_W	4.92e-03	Share of nominal production distributed as Other flows to rest of world (negative flows), equation 179
ψ_F^{FDI}	7.76e-01	Share of FDI towards firms, equation 181
ψ_G^{FDI}	4.84e-01	Share of firms' FDI that are greenfield, equation 185
η_{GW}^{D}	1.60e-02	Share of trade balance to determine international investment in public bonds, equation 187
η_{GW}^{FX}	6.00e-01	Share of trade balance to determine public borrowing in FX (bonds and loans), equation 188
Ω_{G0}	2.00e-02	Autonomous term of share of trade balance to determine FX public debt, equation 190
Ω_{G1}	5.00e-01	Sensitivity of share of trade balance to determine FX public from Current Account deficit as a share of GDP, equation 190
$\beta_{FX,G}$	3.00e+00	Speed of convergence for public debt issuance in FX, equation 191
β_{en}	2.50e+00	Speed of convergence of nominal exchange rate, equation 197
ξ_0	8.54e-03	Linear term in country risk, equation 199
ξ_1	2.00e+00	Elasticity of country risk to Import to Official reserve ratio, equation 199
ϕ_0^{FX}	3.00e-03	Autonomous term for foreign risk premium of banks, equation 201
ϕ_1^{FX}	7.01e-01	Linear term for foreign risk premium of banks, equation 201
ϕ_2^{FX}	1.00e+00	Elasticity of foreign risk premium of banks on foreign debt to total debt ratio, equation 201
$\varrho_F^{FX,W}$	6.40e+00	mark-up on firms' direct FX rate, equation 202
$\varrho_B^{FX,R}$	1.94e-02	mark-up on banks' reserve return rate, equation 203
$\varrho_{CB}^{FX,R}$	-3.15e-03	mark-up on official reserve return rate, equation 204
$\varrho_G^{B,FX}$	8.87e-01	multiplier of risk on public bonds in FX, equation 205
$\varrho_G^{L,FX}$	7.78e-02	mark-down for public borrowing rate in FX, equation 206
σ_0^{Xp}	1.43e-03	Linear term in price effect on propensity to export, equation 207
σ_{New}^{Xp}	1.00e+00	Linear term in price effect on propensity to export (for scenario purposes), equation 207
σ_{Speed}^{Xp}	4.00e-01	Speed of variation for export scenarios, equation 207
σ_{Init}^{Xp}	5.00e+00	Init of variation for export scenarios, equation 207
ψ_O^{FDI}	3.86e-01	Parameter determining the evolution of FDI entering the economy (as a share of firms' investment), equation 208
ψ_{Speed}^{FDI}	3.00e-01	Parameter determining the evolution of FDI entering the economy (as a share of firms' investment), equation 208
ψ_{Init}^{FDI}	4.00e+00	Parameter determining the evolution of FDI entering the economy (as a share of firms' investment), equation 208
ψ_{New}^{FDI}	6.80e-01	Parameter determining the evolution of FDI entering the economy (as a share of firms' investment), equation 208

Table 6: Scenario parameters value and description.

Name	Baseline	Conservative	Global Transition	G.T - public	G.T - private
α_x	0.00e+00	-3.00e-02	-8.50e-02	-8.50e-02	-8.50e-02
κ_0	2.70e-02	2.70e-02	2.70e-02	2.70e-02	3.20e-02
κ_G	7.00e-02	7.00e-02	7.00e-02	7.50e-02	7.00e-02
σ_{New}^{Xp}	1.20e+00	1.20e+00	1.20e+00	1.40e+00	1.40e+00

Table 7: Initial values

Name	**Value**	**Name**	**Value**	**Name**	**Value**
Y^e	1674.564	$L_B^{FX,W}$	69.91541	D_G^{FX}	8.599901
V	127.1373	A	8.55	B_G	338.851
K_F	2213.6793921781	B_G^B	254.865	B_G^{FX}	147.8425
I_F^K	104.167738781951	Rd	102.482	B_G^W	83.986
$\sigma_{M,C}$	0.11989	OF_B	105.95	L_g^{FX}	59.73074
$\sigma_{M,IC}$	0.09466	$prem_F$	1.65962	$prem_G$	0.012
$\sigma_{M,I}$	0.29089	$prem_H$	0.44049	R^{FX}	171.8851
σ_{X_N}	0.001288757	i_p	0.058	D_W^{FX}	32.20152
HUC	0.714649985328843	C_H	686.6039807	R_{CB}^{FX}	131.6116
p	1.087	K_H	368.88722	e^N	1.19513
w_F	11.443	I_H^K	49.722	a	74.45
D_F	82.931	D_H	173.869	a_W	80
D_F^{FX}	16.73778	L_H^d	198.497	p^W	0.9513
$L_F^{FX,B}$	21.5441	TIR_H	506.068	p_X^W	0.555204468
$L_F^{FX,W}$	97.22792	$L_H^{d,I}$	62.111	p_C^W	4.038202828
L_F^d	234.187	w_G	29.596	GDP_W	88952.63574
L_B	0.348	I_G^K	36.683	pop	24.404942
K_B	9.917121116	C_G	21.601	$L_H^{d,C}$	236.386
w_B	47.09	K_G	498.486630008789	Ω_G^{FX}	0.04
R_B^{FX}	40.27344	D_G	50.705	x_C	19.09267727
D_B^{FX}	11.71839	D_G^{CB}	7.943		

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