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A baseline stock-flow model for the analysis of macroprudential regulation for Latin America and the Caribbean

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Abstract

This paper provides a critical view of macroprudential regulation/policies found in mainstream and post-Keynesian economics. The paper provides a macroeconomic framework that can be used as a basis for the analysis of macroprudential guidelines and policies. It is based on on five main principles/guidelines: (i) financial fragility is endogenous and results from the normal functioning of market based economies driven by the profit motive; (ii) financial fragility can originate in the financial and real sectors of an economy; (iii) financial cycles are not necessarily driven by boom and busts and financial fragility need not originate in an economic boom; (iv) macroprudential policies should be viewed from a dynamic perspective, that is they must take into account the changes in the international financial architecture/structure and be region/country specific; and (v) macroprudential regulation/guidelines requires a truly macroeconomic framework. These principles are captured in the specification of a baseline stock-flow model for Latin America and the Caribbean with five sectors (government, central bank, financial sector, private sector, and external sector). The model is a tool that can be used for evaluating other macroprudential policies.

Key words: Debt, external constraint, external financial cycle, financial flows, Latin America and the Caribbean, microprudential and macroprudential regulation, stock-flow.

JEL Codes: B59, E32, E52, F21, F41, G15

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Introduction

Macroprudential policy/regulation focusses on maintaining the stability of the financial system through the minimization of systemic risk. Within mainstream economics systemic risk originates in the existence of externalities affecting the financial sector. The literature on the subject identifies four different types of systemic externalities. These are informational contagion; loss of informational links between a failed financial institution and its customers; the existence of interconnectivity; and upward/downward liquidity spirals. These externalities give rise to financial cycles characterized by episodes of booms leading to busts.

In practice, macroprudential regulation consists of an array of instruments to avoid the excessive expansion and contraction of balance sheets and liquidity. They are aimed at mitigating the risks that arise from: (i) excessive credit growth and leverage; (ii) excessive maturity mismatch and market liquidity; (iii) direct and indirect exposure concentrations; (iv) misaligned incentives with a view to reducing moral hazard; and (v) strengthening the resilience of financial infrastructures.

In post-Keynesian economics the main reference for financial and macroprudential regulation is the work of Hyman Minsky (1919-1996) and derives directly from his main contribution to economics: the financial instability hypothesis (FIH). The FIH argues that financial fragility is endogenous to the normal workings of a free market economy. Contrary to the financially centered mainstream regulatory approach, systemic financial fragility can originate not only in the financial sector but also in the real sector (the non-financial corporate sector and household (residential housing) to a lesser extent).

According to the post-Keynesian view, capital requirements should be used, but high capital requirements should be avoided as these can be a source of financial instability. Leverage and interconnectedness are also sources of financial fragility. Macroprudential regulation should be dynamic in nature. It should reflect not only current and expected economic conditions and be institution specific but also take into account changes in the financial and real sectors, and be reassessed in line with the changes in financial institutions and in the structure of financial institutions and of the non-financial corporate sector.

This Minskyan approach suffers from two shortcomings. First as in the case of mainstream economies, it views the financial cycle as a boom-and-bust cycle. Second, the economic model that explains how financial fragility is generated is, in essence, microeconomic and cannot be expanded to the macroeconomic level.

This paper provides a critical view of macroprudential regulation/policies found in mainstream and post-Keynesian economics. Building on both approaches, and especially on post-Keynesian economics, while at the same time trying to avoid their weaknesses, the paper provides a macroeconomic framework that can be used as a basis for the analysis of macroprudential guidelines and policies.

The framework is based on the following on five main principles/guidelines: (i) financial fragility is endogenous and results from the normal functioning of market based economies driven by the profit motive; (ii) financial fragility can originate in the financial and real sectors of an economy; (iii) financial cycles are not necessarily driven by boom and busts and financial fragility need not originate in an economic boom; (iv) macroprudential policies should be viewed from a dynamic perspective, that is they must take into account the changes in the international financial architecture/structure and be region/country specific; and (v) macroprudential regulation/guidelines requires a truly macroeconomic framework.

These principles are captured in the specification of a stock-flow model for Latin America and the Caribbean with five sectors (government, central bank, financial sector, private sector, and external sector). The model assumes that, as in the case of other developing economies, Latin American countries are balance-of-payments constrained but that the external constraint is mainly financial. Financial cycles are driven by external impulses and the transmission mechanisms identified are specific to the Latin American context.

On the basis, of the discussion in this paper and the analysis of macroprudential regulation at the conceptual level and practical levels in Africa Asia and Latin America found in Pérez Caldentey, Nalin and Rojas (DA COVID-19 Project Paper 18.21) the paper applies selected macroprudential measures to the financial cycle derived from the workings of the stock-flow model. These measures include limiting leverage through increase retained earnings and a cap on foreign currency borrower, and, also, include limiting speculation. The simulations are carried out assuming a sustainability rule for the government sector developed by UNCTAD.[2]

[2] See De Freitas (2021) & Schonerwald (2021). This paper is a companion paper to Nalín, Rojas and Pérez Caldentey (2021) and to Pérez Caldentey Nalín and Rojas (2021).

I. Macroprudential policies/regulation in mainstream economics

Macroprudential policy/regulation focusses on maintaining the stability of the financial system as a whole, through the minimization of systemic risk. Systemic risk is defined as "the risk of disruption of financial services caused by a disruption of all or part of the financial system that may have a significant negative impact on the real economy."[3] This includes limiting the formation of booms/busts of asset and credit bubbles and minimizing the economic and social costs associated with a credit crunch resulting from an excessive contraction of the balance sheets of financial institutions facing a common shock (Hanson, Kashyap, and Stein, 2010).

A. Microprudential and macropudential regulation

Macroprudential regulation was conceived to overcome the limits of micro prudential policy/regulation in addressing financial stability, systemic risk and the procyclicality of the financial sector (Ebrahimi & Lehar, 2017; Galati & Moessner, 2013; Tang et al. 2021). Micro prudential regulation, which is concerned with the factors that affect the stability of individual financial institutions, entails several fallacies of composition including the belief that the adequate regulation of an individual financial institutional is equivalent to the adequate regulation of the system as a whole, that "actions and decisions that make sense for individual institutions in isolation, always yield desirable aggregate outcomes", and that the same regulation (for example capital requirements) applies equally to all institutions. (Ebrahimi & Lehar, 2017; Brunnermeier et al. 2009) (See, table 1 below).

In fact, the different degrees in size, leverage, the interconnectedness at the individual institutional level as well as the heterogeneity of financial institutions generates negative systemic externalities which give rise to financial cycles characterized by episodes of booms leading to busts. As explained by Brunnermeier et al. 2009, p.4: "Financial crashes do not occur randomly, but generally follow booms."

[3]The origin of the term macro prudential dates back to the seventies (see Clement, 2010). Public references date back to the mid-80s receiving new impetus from the early 2000s (Galati and Moessner, 2011). According to part of the literature on macro-prudential regulation, systemic risk has two relevant dimensions, a temporary one – which is about how the risk of the financial system evolves over time, how it accumulates and how it is linked to the real economic cycle – and another intersectoral – which is about how risk is distributed throughout the financial system and what interconnections and common exposures can exist among its agents (IMF, 2010). See also Kaufman & Scott (2003).

Table 1

Micro and macroprudential regulation and their differences

	Macroprudential	Microprudential
Proximate objective	Limit financial system wide distress	Limit distress of individual institutions
Ultimate objective	Avoid output (GDP) costs	Consumer (investor /depositor) protection
Characterization of risk	Seen as dependent on collective behavior ("endogenous")	Seen as independent of individual agent's behavior ("exogenous)
Correlations and common exposures across institutions	Important	Irrelevant
Calibration of prudential controls	In terms of system-wide risk: top-down	In terms of risk of individual institutions: bottom-up

Fuente: Borio (2003) cited in Ebrahimi & Lehar (2017) p. 94.

B. The rationale for macroprudential regulation

The literature on the subject identifies four different types of systemic externalities. These are informational contagion; loss of informational links between a failed financial institution and its customers; existence of interconnectivity; and upward/downward liquidity spirals (See, table 2). Using some of these externalities a financial cycle can be described as follows (ibid. p. 5):

> "…a decline in the value of the assets held by a bank…Liquidity problems usually generate underlying solvency worries. In order to deal with such liquidity problems prior to failure, and in the course of liquidation after failure, the bank in difficulties will often be forced to sell assets (fire sales).[4] But such sales will drive down the current market price of the same assets held on other banks' books, when these are valued on a mark-to-market basis. And, of course, the same is true the other way around; solvency is not exogenous to liquidity. When there is a generalised liquidity problem attempts to deal with it will lead to declines in asset values, creating a solvency problem, even where none existed before. In short, there is an internal amplifying process (liquidity spirals) whereby a falling asset market leads banks, investment houses, etc., to make more sales (deleveraging), which further drives down asset prices and financial intermediaries' assessed profit and loss and balance sheet net worth."

This scenario describes the "…internal, self-amplifying dynamic that has lain at the root of both the recent (Global Financial Crisis, 2008-2009), and virtually all prior, financial crises."[5] Since, booms precede busts, the same logic underlying the bust scenario presented above applied to the upward phase of the cycle.

In the description provided above the behavior of individual financial institutions is rational. It makes sense for individual financial institutions to sell assets (or acquire assets and expand credit) when faced with a liquidity constraint (with increased liquidity) and avoid insolvency. However, this falls prey to the fallacy of composition when considering all financial institutions. Hence, risk at the aggregate level is systemic and endogenous. It depends on the collective behavior of the different financial institutions.

[4] See al Schleiffer and Vishny (2010) on fire sales.
[5] Ibid. The parenthesis were added by the authors of this paper.

Table 2
Systemic externalities and their effects

Externality	Description and impact
Informational contagion (context of intermediaries with a maturity mismatch between assets and liabilities)	The failure of one bank increases the doubt of the solvency of another bank which is in the same category. Depositors and lenders of the latter bank lose confidence and can cause a liquidity problem for this bank.
Loss of access to future funding (for failed banks customers)	Client of one failed bank can try to transfer funds to another bank but this bank will have less information on the client and is likely, within a context of failing banks, to provide replacement credit facilities on more strict terms.
Interconnectedness	Banks and financial intermediaries tend to trade much more among themselves than do corporates. This interaction between banks and other financial intermediaries relate to forward interbank market and derivative markets and involves guarantees, credit default swaps and prime brokerage services.
Liquidity spirals (expansion)	Selling financial assets to regain liquidity and improve capital ratios.
Liquidity spirals (contraction)	Restrict new credit expansion through by rationing through higher margins/haircuts or raising interest rates or other costs to borrowers.

Source: Brunnermeier et al. 2009

The logic of behavior of the financial sector and its consequences at the aggregate level is not applicable to the non-financial corporate sector. As explained by Brunnermeier et al. 2009, p. 3:

> "…the existence of sufficient externalities that the social, and overall, costs of market failure exceed both the private costs of failure and the extra costs of regulation is by far the most important reason why banks, and certain other key financial intermediaries and markets, need regulation. But why does the failure of banks, and of some other financial institutions, involve systemic externalities that are not present when an ordinary manufacturing or service-sector firm goes bust. The basic answer comes from the fact that the failure of a banking-type institution, say Lehman Bros, Northern Rock or Glitnir, weakens the other banks and financial markets with which they were involved, whereas the failure of, say, a car company or a laundry tends to strengthen the remaining companies in the same sector, by removing a competitor. And lying behind this is the even more important consideration that the continued health of the financial system, and even more so of the banking sector within it, is key to the satisfactory functioning of the wider economy, to a qualitatively different extent from most other sectors."

C. The failure to understand the nature of systemic risk

The failure to understand the systemic nature of risk can lead to amplify the mechanism and dynamics described above. This is exemplified by micro prudential regulation and can be illustrated, by the establishment of capital requirements on individual financial institutions and its consequences during the upward phase of the economic cycle.

A boom phase characterized by high profitability and low risk tends to increase capital ratios and thus generate the impression of greater solvency and better financial conditions. In turn, this encourages the financial system to build up its asset positions and, more specifically, the increase in loans based on the current economic conditions. However, this often occurs to the detriment of credit standards. Empirical evidence for some developed countries reflects this stylized fact by showing that provisions tend to decrease in boom periods (Cavallo and Majnoni, 2001; Hahm et al., 2012).

On the liability side, financial institutions become more dependent on liquidity provided by other financial institutions. In this situation, the financial system tends to skew the composition and structure of liabilities towards a higher level of indebtedness, that is, towards higher leverage ratios,[6] so that the relationship between the growth rate of assets and that of leverage is positive. The correlation coefficient between the two variables for a sample of 21 U.S. banks for the period December 2003 to September 2010 equaled to 0.70 for the entire sample and 0.89 for investment banks.[7]

High leverage levels create considerable opportunities for profitability because the higher is the leverage level, the higher is the return on capital. In this regard, the expectation of higher returns provides an incentive for excessive leverage. The rate of return of equity (ROE) (a measure of profitability) equals the rate of return on assets (ROA) time leverage (L) so that $ROE = ROA * L \Longrightarrow \Delta L \Longrightarrow \Delta ROE \; for \; \overline{ROA}$. But at the same time, however, a greater dependence on debt generates greater fragility since bigger risks are assumed due to the higher exposure and vulnerability to illiquidity and, even more important, to insolvency.[8]

As stated above the objective of macroprudential regulation is to correct for the externalities created by financial intermediaries that are at the root of financial cycles characterized by booms and busts. The more developed and sophisticated financial intermediaries and their instruments are, the greater will be the possibility for the existence and increased importance of the externalities described above and the more likely will be the occurrence of financial booms and busts.

[6] Leverage (debt to equity ratio) reflects the extent to which financial intermediaries use borrowing to finance the acquisition of their assets.
[7] Pérez Caldentey and Cruz (2012).
[8] See Barajas et al. (2007).

In this sense, the development of the financial system is prone to distorting the function of financial intermediaries which in the mainstream view is to allocate (voluntary) savings towards investment (Shin, 2009). More precisely, the sophistication of financial system goes hand in hand with longer and indirect intermediation chains between savings and investment. Thus, macroprudential policies/regulation should amount to shortening intermediation chains and ensure that the credit granted by the financial system is determined by the savings decisions of economic agents. As explained by Shin (2009, p. 22):"The idea is to restrain the lengthening of intermediation chains, and encourage the formation of shorter intermediation chains."[9]

In practice, macroprudential regulation consists of an array of instruments to avoid the excessive expansion and contraction of balance sheets. These instruments are described in table 3 (Araujo et al. 2020). They are aimed to mitigate the risks that arise from: (i) excessive credit growth and leverage; (ii) excessive maturity mismatch and market liquidity; (iii) direct and indirect exposure concentrations; (iv) misaligned incentives with a view to reducing moral hazard; and (v) strengthening the resilience of financial infrastructures (European Parliament, 2020).

[9] This has a marked Hayekian flavor. Hayek (1931) argued that distorting the relation between voluntary savings and investment by the banking system was the root of financial crises.

Table 3
List of macroprudential tools

Groups	Tools	Definition
Broad based	Counter cyclical buffers	Requirement for banks to maintain a countercyclical capital buffer.
	Conservation buffers	Requirement for banks to maintain a capital buffer (includes de buffer established under Basel III).
	Capital requirements	Capital requirements for banks (risk weights, systemic risk buffers, capital conservation buffers).
	Leverage limits	Limit on leverage for banks (measure for capital divided by non-risk weighted exposures).
	Loan loss provisions	Includes dynamic provision and sectoral provisions (e.g. housing loans).
	Limits on credit growth	Limits on growth, or volume of aggregate credit, household sector credit, corporate sector credit by banks.
	Loan restrictions	Loan limits and prohibitions conditioned by loans characteristics (maturity, size, LTV ratio, interest rate) and bank characteristics.
	Limits on foreign currency loans	Limits on foreign currency lending and rules/recommendations on foreign currency loans.
Liquidity	Liquidity	Measures to mitigate systemic liquidity and funding risks. Includes minimum requirements for liquidity coverage ratios, liquid asset ratios, net stable funding ratios, core funding ratios, external debt restrictions.
	Limits on loan-to-deposit ratio	Limits to the loan-to-deposit ratios and penalties for high loan-to-deposit ratios.
	Limits on foreign exchange positions	Limits on net or gross foreign exchange positions, limits on foreign exchange exposures, foreign exchange funding and foreign mismatch regulations.
	Reserve requirements	Reserve requirements (domestic or foreign currency) for macroprudential purposes.
Housing	Limits on loan-to-value ratio	Limits to the loan-to-value ratios for housing, car and commercial real estate loans.
	Limits on the debt-service-to-income ratio	Limits to the size of debt services or debt relative to income (housing loans, consumer loans, commercial real estate loans).
Other	Systemically important financial institutions	Measures to mitigate risks from global and domestically systemically important financial institutions (includes capital and liquidity surcharges)
	Tax measures	Taxes and levies applied to specific transactions, assets and liabilities, including stamp duties and capital gain taxes.
	Other	Measure other than those in the above categories (i.e. stress testing, measures on interconnectedness, restrictions on profit distribution.

Source: Araujo et.al. (2020)

II. Macroprudential policies/regulation in post-Keynesian economics

The term macroprudential is seldom used in post-Keynesian economics[10] which may reflect the fact post-Keynesians have paid little attention to the prudential regulation of banks and of the financial systems (Docherty, 2020), even though, paradoxically, these are central a monetary/financial theory of production.[11] The main reference for financial regulation in post-Keynesian economics is the work of Hyman Minsky (1919-1996) and derives directly from his main contribution to economics: the financial instability hypothesis (FIH).

A. The Financial Instability Hypothesis (FIH)

The FIH is meant to explain instability as "an internally generated result of the normal functioning of capitalist economies" (Minsky, 1972, pp. 144-145; 1978, p.92, p.111). It is based on two theorems (Minsky, 1992, 1986).

The first states that a capitalist economy has financing regimes (characterized by relations between cash payment commitments on debts and expected cash receipts) under which it is stable and financing regimes under which it is unstable. Minsky identifies three financing regimes: hedge, speculative and Ponzi. Their importance and weight in economic unit's portfolios determine to a large extent the stability or instability of an economy.

Hedge finance refers to a situation where the gross capital income of an economic unit (defined as gross profits before taxes minus interest paid on business

[10] The term macroprudential does not appear in the most comprehensive post-Keynesian textbook and it has only one reference to prudential regulation (Lavoie, 2014).

[11] This paradox is not easy to explain. The banking and the financial system played a central role in Keynes's thought as exemplified by the role played by the banking system in the Treatise on Money (1930) and in other lesser known early works such as for example War and the Financial System (Keynes, 1983 (1914) pp. 269-271 and the review of Fisher's Purchasing Power of Money (ibid. pp. 375-381) focusing on the transition periods between an increase in the money supply and the proportional increase in prices. Although in the General Theory of Employment, Interest and Money (1936), Keynes downplays the role of banks, financial markets and in particular the stock market are important components of his overall arguments. Keynes's disciples including Robinson (1951) and Kahn (1954 (1972)) did not further than Keynes' view of financial markets. As explained by Ingrao and Sardoni (2019, p. 127) both retained a two-asset analytical framework. Minsky (1975, p. 69) argues that Keynes did not provide a satisfactory discussion of finance, portfolios and how these relate to the pricing of capital assets and the pace of investment. Keynes focused on interest rate instead of on the price of capital assets and the terms of money loans, Also, when discussing the determination of the price of capital assets and financial assets he reverted to an equilibrium growth perspective rather than to a financial cycle. For his part Kalecki also emphasized the importance of financial markets and their potential for instability. He highlighted the importance of internal profits to reduce the financial risk of capital subscribers (Kalecki, 1969 (1954), pp. 91-95) and, also the role of private sector debt in leading to corporate collapse and a crisis of confidence (Kalecki, 1990 (1944)). It is worth mentioning that Sraffa (1922, p. 196) went beyond the figure of the Keynesian speculator and the Kaleckian rentier as he saw financiers and financial markets as an organized industry.

debts) " exceeds by some margin the payment commitments due to debts in every relevant period over the horizon given by the debts now on the books and the borrowings that must be made if expected gross capital income is to be earned" (Minsky, 1980a, p. 25). Speculative finance refers to a situation where cash payment commitments on debts are greater or some periods than the expected gross capital income. Ponzi finance refers to "speculative units with the special characteristics that for some if not for all near term periods cash payment commitments to pay interest are not covered by the income portion of the expected excess of receipts over current labor and material costs." Ponzi units must borrow to pay interest on their obligations so that the outstanding debt grows over time.

The FIH second theorem holds that prosperity is conducive to financial instability, i.e, "stability is destabilizing". As Minsky put it: ". . . over periods of prolonged prosperity, the economy transits from financial relations that make for a stable system to financial relations that make for an unstable system" (Minsky, 1992, p.8).

B. The financial instability hypothesis (FIH) and its implications for financial regulation

Minsky's proposals for financial regulation derive directly from the FIH and its priors 'that reflect views about the fundamental characterization of capitalist economies with sophisticated and ever-evolving financial structures" (Minsky and Campbell, 1988, p. 3). The main prior is that 'the endogenously-determined processes of capitalist economies become incoherent, as a result, of their own dynamics' Ibid. The FIH provides a theory that jointly with empirical facts explains why the functioning of capitalist economies becomes susceptible to episodes of incoherence (ibid, p. 6.).

Although Minsky did not use the terms micro or macroprudential, his analysis addresses the limitations of microprudential regulation and his proposals can be easily viewed as macroprudential regulation *avant la lettre* (Kregel, 2012, 2014).

Minsky recognized that capital requirements must be part of bank regulation and supervision ("In order to contain the destabilizing effect of banking, it is necessary to regulate the amount and the rate of increase of bank assets. The major control device is the permitted capital-asset ratio and the rate of growth of bank capital." Minsky, 1986, p. 356). However, he warned against the use of capital requirements as a straight-jacket and in fact the use of higher capital requirements was not conducive to financial stability as these could constrain profits and encourage banks to adopt riskier commercial practices.[12] Higher capital ratios

[12] Wray (2016, p. 184), Minsky (1986)

implies a higher risk-return portfolio of assets to compensate for the negative effect on profitability.[13]

Minsky also focused his proposals on addressing leverage and interconnectedness as sources of instability very much in line with the consensus in macroprudential regulation. Debt and leverage and their perceptions (as captured in the borrower's and lender's risk) are of the essence to Minsky's depiction of the financial cycle.

Minsky's exposition of the FIH is framed in terms of the interplay between the supply price for investment and the demand price for capital goods adjusted for the borrower's and lender's risks. During the upward (downward) phase of the cycle the lender and borrower's risks decrease (increase) and as a result, firms are willing to increase (decrease) their leverage to finance a greater (lower) volume of investment.

Assume as Minsky does (1980a; 1980b; 1986, pp.193-194; 1975, p. 114) that during an upward phase of the cycle aggregate achieved investment is above its expected level and that as a result realized profits exceed the expected level of profits. A higher level of expected profits will translate into higher than expected internal funds, an increase in the willingness of borrowers to debt finance (reduction of lender's risk) and an increase in the demand price of capital assets due both to the expectations of higher quasi-rents and a decline in the borrowers' risk. The decline in the borrower's risk is due to an increasing confidence that future profits will exceed debt commitments (De Antoni, 2006). Also, the borrower's risk declines due to a rise in the capitalization rate provoked by the increase in liquidity that is characteristic of the upward phase of the cycle and which reduces the value placed upon liquidity and increases the value placed upon non-monetary assets including capital goods (Minsky, 1975, p.102-105).[14]

For the upward phase of the cycle to lead to financial fragility and instability two conditions must be met. First, debt commitments have to increase at a faster pace than the underlying income supporting those levels of debt. Second the composition of debt has to shift towards the short-term (Minsky (1995, p.201).

Also, in Minsky's view financial fragility depends on the degree of interconnectedness of the financial system. As Minsky and Campbell (1988, p. 255) explain: "…bank failures…occur mainly because of the interdependence of payment commitments and position making transactions across institutions and units." Also, according to Minsky, the financial position of an individual institution depended on the behavior of the economy and financial markets (Minsky, 1967).

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[13] See Pérez Caldentey, Nalin & Rojas (2021) DA COVID-19 Project Paper 18.21 for an analysis of the limitations of capital requirements recommended in Basel I, II and III.

[14] Minsky's story of the upward phase of the cycle and the transition from robust to fragile financial structures also assumes a given structure of the rates of interest. For example, in the case where hedge finance dominates Minsky identifies an interest rate structure favorable to profit opportunities that induces financing of investment through short-term liquid liabilities. See González and Pérez Caldentey (2012).

The normal functioning of financial markets implies the realization of optimistic expectations regarding profit flows (i.e., quasi-rents). Within this context the possibility of crisis can arise from factors that can disappoint these expectations. According to Minsky (1975, p. 115) these include "rising wages or production costs, feedbacks from rising interest rates to the value of older long-term debt, the high cost of refunding previous debt." We can add to this list, more stringent lending restrictions, default on payments commitments by an important institution from the financial or non-financial corporate sector, and interest rates increases (Wray, 2015, p.33). The generalized sale of assets (which have increased their degree of illiquidity following a boom) to raise cash to face debt commitments leads to declines in their price of capital assets, and in the demand prices of capital goods and in general in asset values.

The above process can also include a key role of the short-term rate of interest which Minsky saw as the result of the combination of a rising inelastic demand for finance combined with an inelastic (or even less than infinitely elastic) supply of finance in leading to a downturn and the bust (Minsky, 1978 p.107).[15]

In perfect analogy with the description of the upward phase of the cycle, where the expansion of investment brings about an increase in leverage, the contraction of investment brings about a process of deleveraging.

A common thread running through Minsky's works is the idea that the evolution of economies is a historically and institutionally contingent process.[16] In line with this approach, financial regulation 'must not only reflect current and expected economic conditions but also be institution and theory specific and to remain effective must be reassessed frequently and made consistent with evolving market and financial structures.' Changes in the institutional structure of the financial system must be accompanied with changes in the regulatory and supervisory structure.[17] That is, financial regulation and macroprudential regulation cannot remain fixed and static over time must be thought of in dynamic terms (dynamic macroprudential regulation).

[15] The increase in the short-term rate of interest translates into a rise in the long-term rate of interest. Both have opposite effects on the demand price for capital assets and the supply price of investment goods. The rise in the short-term interest rate will increase the supply price of capital goods while the rise in the long-term interest rate will lower the present value of quasi-rents and thus the demand price for investment goods. This will lead to a fall in investment which lowers expected profits. This in turn deteriorates firm's confidence to fulfill their financial commitments which increases both borrower's and lenders' risks reinforcing the contraction in investment

[16] This expression is based Godley and Cripps (1983), p. 44.

[17] Kregel (2014), pp.7-8; Minsky and Campbell (1988).

C. The limitations of Minsky's analysis

With all its merits the approach to financial regulation found in Minsky suffers from two important limitations.

First, the type of financial cycle envisaged by Minsky corresponds to a boom-and-bust cycle. Busts are necessarily preceded by booms and the degree of the bust keeps correspondence with the size of the boom. In Minsky, financial fragility is always upwards. The transition from stability to instability occurs during the upward phase of the cycle ("the path of this basic instability is upwards" (Minsky, 1980b, p.517; 1980a p.83).[18]

From the point of view of this paper cycles can differ over time. They can be characterized by booms and busts episodes. But they also follow patterns that do not conform to booms and busts. In, the particular case, of Latin America and the Caribbean, the available evidence since the early 1980's shows a persistent decline in the trend rate of growth of GDP for Latin America and the Caribbean. The available evidence for the period ranging from 1950 to 2019 shows that the growth rate of regional GDP fell from an average of 5.6% for the period 1951-1980, to 2.5% for the period 1981-2009, to 1.9% for the period 2010-2019 (See Nalín, Rojas and Pérez Caldentey, 2021).

During the 1980's and 1990s Latin American and the Caribbean was affected by a series of recurrent financial crises which had a dampening effect on the region's growth trajectory. These crises include the 1980s debt crisis, the Tequila Crisis (1994-1995), the East Asian Crisis (1997-1998), the Brazilian-Russian Crisis (1999), the Argentine Crisis (2001-2002), and the Global Financial Crisis (2008-2009).

However, the same argument cannot explain the decline in the economic growth rate between 2010 and 2019 (6.2% and 0.1% respectively), which, in fact, is one of the sharpest on record, since there were no economic shocks or crises of the magnitude registered during 1981-2009. In this sense, an adequate exposition of the causes of growth and, also business fluctuations, must supersede that based on booms and busts which characterizes a great deal of the literature on this topic.

The second limitation is the microeconomic nature of Minsky's analysis which leads to so-called "Paradox of debt." Minsky's explanation of booms and busts financial cycles builds from generalizing his representative firm analysis to the macroeconomic level (1975, 1982 and 1996). His analysis assumes an unchanging financial constraint (a given curve of retained profits) that ultimately leads to characterize business cycles as leverage-

[18] Minsky thought that fragile financing patterns take time to emerge due to four factors: (i) the limits placed by borrower's and lenders' risk; (ii) conservatism and orthodoxy as a barrier to the assimilation of financial innovation; (iii) the "assured refinancing by organizations engaging in speculative finance." and (iv) the rise in profits and in internal funds (Minsky, 1986, pp. 211-213).

deleveraging cycles. However, at the same time, on the basis of Kalecki (1969 (1954)) Minsky argued that the financial constraint depends on the phases of business cycle.

As a result, when the level of investment changes the level of aggregate profits must also change. This has to induce a change in the profits of the representative firm and in its capacity to finance investment with retained earnings. Thus, when the risk perceptions of the borrower and lender change the level of investment, the internal financing constraint of the representative firm has to change. This means that the basic condition to generate leverage and deleveraging cycles which are at the core of the FIH may not be present.

Hence upward phases of the cycle may coexist with deleveraging while downward phases can coexist with leveraging. This means that debt and financial fragility are inversely correlated. and that debt and investment move countercyclically. Thus business cycles can exhibit the opposite leveraging patterns than those described by Minsky.[19]

III. Macroprudential regulation: an alternative approach

The following sections present an alternative macroprudential framework building on both mainstream and post-Keynesian approaches, but especially on the latter, while at the same time trying to avoid their weaknesses described above. The framework proceeds from the ideas developed in the companion papers (Pérez Caldentey, Nalin & Rojas (2021) DA COVID-19 Project Paper 18.21 and Nalín, Rojas and Pérez Caldentey (2021) DA COVID-19 Project Paper 17.21).

The framework is based on the following on five main principles/guidelines: (i) financial fragility is endogenous and results from the normal functioning of market based economies driven by the profit motive; (ii) financial fragility can originate in the financial and real sectors of an economy; (iii) financial cycles are not necessarily driven by boom and busts and financial fragility need not originate in an economic boom; (iv) macroprudential policies should be viewed from a dynamic perspective, that is they must take into account the changes in the international financial architecture/structure and be region/country specific; and (v) macroprudential regulation/guidelines requires a truly macroeconomic framework.

These principles are captured in the specification of a stock-flow model for Latin America and the Caribbean with five sectors (government, central bank, financial sector, private sector, and external sector). The model assumes that, as other developing economies, Latin American countries are balance-of-payments constrained but that the external constraint is mainly financial. Financial cycles are driven by external impulses and the transmission mechanisms are specific to the Latin American context.

[19] The possibility of the paradox of debt has been underscored by several post Keynesian authors which have contested Minsky's assertion that during expansions, debt grows at a higher rate than the underlying income to support it (Lavoie and Seccareccia, 2001; Bellofiore and Halevi, 2009; Passarella, 2012). See González and Pérez Caldentey (2012) for an econometric analysis of the paradox of debt in the case of Latin America.

The specification of the equations of the model are based on prior empirical work (descriptive statistics and econometrics) that exemplify the main transmission mechanisms that give life to a financial cycle narrative, linking external, domestic, financial and real factors in a consistent manner and that simulates satisfactorily the economic performance of Latin America during the period 2000-2020 (see Nalin, Rojas and Pérez Caldentey. 2021 DA COVID-19 Project Paper 17/21). These transmission mechanisms include:

(i) The high sensitivity of bond prices to international interest rates which has increased since the Global Financial Crisis (2008-2009);

(ii) The high correlation between nominal exchange rate variations and the EMBI inverse correlation between the trend of sovereign risk as measured by the Emerging Markets Bond Index (EMBI)[20] and nominal currency depreciation or appreciation. A depreciation (expected or effective) of the local currency is associated with a higher risk perception and can easily cause capital flight (BIS, 2019). Empirical data collected for Latin America display positive and statistically significant correlations between the rates of variation of the EMBI and those of the nominal exchange rate —for example, Argentina 0.21, Brazil 0.71, Chile 0.46, Colombia 0.64, Mexico 0.63 and Peru 0.39 (see Abeles, Pérez Caldentey and Porcile, 2020);

(iii) The high association between sovereign and non-financial corporate sector risk, captured by the positive and statistically significant correlation between EMBI and CEMBI;

(iv) The positive correlation between EMBI, CEMBI and external debt service;

(v) The non-linear relationship between cash flow and investment below a certain leverage (debt) threshold, cash flow (derived from the issuance of bonds in the international capital markets) and investment (and obviously debt) have a positive One hypothesis focuses on the dynamics between firm cash flow and investment. It argues that both variables have a non-linear relationship. Beyond that threshold the relationship turns negative as firms may feel more financially constrained, leading them to increase their retained earnings and cash holdings to protect themselves against illiquidity and ultimately insolvency.[21] Another hypothesis maintains that nonfinancial corporations

[20] The emerging market bond index is the key emerging economy risk indicator. It is calculated as the spread between the interest rate that countries pay on dollar-denominated bonds issued by those economies and United States Treasury bonds, which are considered risk-free. The index is based on the behaviour of external debt issued by each country. The less certainty there is that a country will meet its obligations, the higher its EMBI, and vice versa. The minimum rate that an investor would require to invest in a certain country would be equal to the rate on United States Treasury bonds (risk-free) plus the EMBI. The reasoning here assumes that changes in EMBI are endogenous to changes in the nominal exchange rate. See Borio (2019).

[21] An econometric estimation that relates investment in tangible assets to cash flow by degree of leverage for 270 firms in six Latin American countries (Argentina, Brazil, Chile, Colombia, Mexico and Peru) for the 2010–2016 period, shows that when leverage exceeds a 0.77 threshold, a 1% increase in cash flow-to-assets is associated with a reduction in investment of 0.25%–0.24%. In terms of the growth of tangible assets, the estimated equation shows that when leverage exceeds the 0.77 threshold a 1% increase in cash flow-to-assets

become financial intermediaries by capturing international liquidity through bond issues and investing a growing amount in financial assets (Advjiev 2014; De Camino, Vera and Pérez Caldentey, 2022). The available evidence shows the region has been receiving increasing flows into financial assets from corporations outside the region. Those flows have been channeled through trade credit and cross-border loans and deposits and, especially, intercompany loans.[22] This hypothesis implies the extensive use of the international bond market by the nonfinancial corporate sector has not been accompanied by an increase in investment and is associated with a strategy of financial accumulation.[23]

The workings of the financial cycle, its origins and transmission and propagating mechanisms can be exemplified with the case of an expansionary monetary policy such as that currently followed by the United States Federal Reserve Board and other major central banks. The expansionary monetary policy consists in the lowering the short-term policy rate to levels close or at zero (in nominal terms) and the increase in central bank's balance sheets, as a result, of the purchase of government securities.

In turn, the expansion of central banks' balance sheets results in a decline in the yield to maturity of government securities. The decline in the yield to maturity pushes investors to search for higher profitability (higher yields) and demand and invest in developing country sovereign and corporate bonds. On the supply side, governments and non-financial corporations are willing to take advantage of the favourable external financial conditions to issue debt. As a result, short-term financial gross inflows increase while at the same time the government and non-financial corporations witness an increase in their debt levels.

Also, the increase in gross short-term financial inflows can lead to an appreciation of the nominal exchange, which in turn leads to a decline in the risk of sovereign (EMBI) and non-financial corporates (CEMBI) pushing down future borrowing costs. In addition, the appreciation of the exchange rate improves balance sheet conditions by reducing government and firms' liabilities external debt servicing costs (for those firms that work with domestic currencies) and, also the debt stock)). In the case of firms, currency mismatches are narrowed which means that the net-worth increases. Finally, the appreciation of the nominal exchange creates windfall profit opportunities for foreign investors that hold domestic bonds issued in local currency.

This set of factors can set the stage for an upward movement consisting of increasing short-term gross inflows, appreciating nominal exchange rates and higher debt levels. These are three stylized facts observed in the period 2010-2019.

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is associated with a 0.75% reduction in the rate of growth of tangible assets. See Pérez Caldentey, Favreau-Negront and Méndez (2019).

[22] This explanation contrasts with the view that attributes to decline in investment to real factors, such as for example a lack of competitiveness due to an appreciated real exchange rate.

[23] See Advjiev (2014), Rodrigues-Bastos et al. (2016), and Pérez Caldentey and Vernengo (2021).

The impact of these financial factors on the performance of the real sector will depend on profitability, actual relative to normal capacity utilization, and, also on leverage. As explained above, up to a given leverage threshold, increases in debt can increase investment. Beyond this threshold increases in debt do not translate in an increase in investment. Thus, increasing financial flows, exchange rate appreciation and rising debt coexist with declines in investment.

The following section presents a consistent stock-flow model that incorporates these transmission mechanisms, which have come to characterize the functioning of Latin American and Caribbean economies in the 2000s decade and especially since the Global Financial Crisis (2008-2009). This is also applicable to other developing economies.

On the basis, of the discussion in this paper and the analysis of macroprudential regulation at the conceptual level and in its implementation in Africa Asia and Latin America found in Pérez Caldentey, Nalin and Rojas (DA COVID-19 Project Paper 18.21) the paper applies selected macroprudential measures to the financial cycle derived from the workings of the stock-flow model. These measures include limiting leverage through increase retained earnings and a cap on foreign currency borrower, and, also, include limiting speculation. The model also incorporates the debt sustainability rule proposed by UNCTAD for the government. [24]

IV. A brief description of the stock-flow model

The stock-flow model presented in its transaction-flows matrix (TFM) form, reported below, incorporates five institutional sectors: i) the private sector, which includes households, non-financial corporations; ii) the financial sector; ii) the public sector, which includes central national government, non-financial public enterprises, and financial public enterprises; iii) the central bank; iv) and the Rest of the World (ROW), which, following Valdecantos (2016), represents foreign partners linked to the domestic economy through trade and international capital markets.

The model includes five financial assets: i) public debt issued in domestic and foreign currency, both purchased by the private and financial sector, as well as ROW; ii) private debt issued in domestic and foreign currency purchased by the financial sector and the ROW; iii) debt issued by the ROW and purchased by both the public sector and the private sector as form of investment or reserve accumulation. We also consider two type of direct bank lending, that is, loans and consumer credit to the private sector.

The variables EMBI and the CEMBI risk premiums are among the main novelties of the model. They affect several real and financial variables, such as private investment, exchange rate expectations, interest rate premiums, and ROW demand for local assets. The model also considers explicitly the role of debt - and in particular mismatches – in

[24] See De Freitas (2021) & Schonerwald (2021).

determining the path of financial variables. The model a debt sustainability rule for the government to capture the relationship between financial dynamics and fiscal policy.

Table 4
Transactions flow matrix

		Production	Private Sector		Financial Sector		Government Sector		Central bank		ROW	Σ
			Current	Capital	Current	Capital	Current	Capital	Current	Capital		
Consumption		$+C_d$	$-C_d$									0
Investment		$+I^k$		$-I^k$								0
Government Spending		$+G_d$					$-G_d$					0
Imports		$-IM$									$+IM$	0
Exports		$+X$									$-X$	0
[GDP]		$[-Y]$	$[+Y]$									$[Y]$
Interest on	Govt Bonds (domestic currency)		$+int_p^g$		$+int_{fs}^g$		$-int^g$		$+int_{bc}^g$		$+int_{row}^g$	0
	Govt Bonds (FX currency)		$+int_p^{\$g}$		$+int_{fs}^{\$g}$		$-int^{\$g}$				$+int_{row}^{\$g}$	0
	Private Debt		$-int^p$		$+int_{fs}^p$		$+int_g^p$				$+int_{row}^p$	0
	Private Debt FX		$-int^{\$p}$								$+int_{row}^{\$p}$	0
	Bonds ROW		$+int_p^{row}$		$+int_{fs}^{row}$				$+int_{bc}^{row}$		$-int^{row}$	0
	Public Deposits						$+int_{mm_g}^{cb}$		$-int_{mm_g}^{cb}$			0
	Private deposits		$+int_{mm_p}^{fs}$		$-int_{mm_p}^{fs}$							0
	Consumption Credit		$-intc^p$		$+intc_{fs}^p$							0
	Advances				$-int^{afs}$				$+int_{cb}^{afs}$			0
	Loans		$-int^{lp}$		$+int^{lp}$							0
	Loans (FX)				$-int^{\$lfs}$						$+int^{\$lfs}$	0
Financial gains(dividends)							$+FB_g^{bc}$		$-FB^{bc}$			0
[Gross National Income]			$[GNI_{PS}]$		$[GNI_{FS}]$		$[GNI_{GS}]$					$[GNI]$
Taxes			$-T$		$-T$		$+T$					0
Savings			$[S_{PS}]$		$[S_{FS}]$		$[S_{GS}]$				$[S_{RoWS}]$	0
Capital			$+K$									$-K$
Inventories			$+IN$									$-IN$
Govt Bonds (domestic currency)				$-B_p^g$		$-B_{fs}^g$		$+B^g$		$-B_{bc}^g$	$-B_{row}^g$	0
Govt Bonds (FX currency)				$-B_p^{\$g}$		$-B_{fs}^{\$g}$		$+B^{\$g}$			$-B_{row}^{\$g}$	0
Priv Debt				$+D^p$		$-D_{fs}^p$		$-D_g^p$			$-D_{row}^p$	0
Priv Debt FX				$+D^{\$}$							$-D_{row}^{\$}$	0
Bonds ROW				$-B_p^{row}$		$-B_{fs}^{row}$				$-B_{bc}^{row}$	B^{row}	0
High power money				$+H^{bc}$						$-H^{bc}$		

Public Deposits							$-M^g$		$+M^g$		0
Private Deposits			$-M^p$		$+M^p$						0
Consumption Credit			$+\mathrm{Cc}$		$-\mathrm{Cc}$						
Advances					$+A^{fs}$				$-A^{fs}$		0
Loans			$+L_p^{fs}$		$-L_p^{fs}$						0
Loans (FX)					$+L_{fs}^{\$row}$					$-L_{fs}{}^{\$row}$	
Σ	0	0	0	0	0	0	0	0	0	0	0

Source: Authors' own elaboration

The sections below present and explain the rationale underlying the specification of the model for each of the sectors considered. The specification of the real sector is for the most part standard and follows (Godley and Lavoie, 2007; Lavoie and Zezza, 2012). The most innovative features of the model relate to the specification of the financial sector and its interaction with the real sector.

A. Production, Income, and Wealth

Consumption, together with private investment, public spending and ROW trade determines the level of sales. Expected sales depend on the previous level of sales adjusted for world GDP growth. There is no assumption of full employment, and thus in each period there is a target level of inventories by the production sector. Expected sales and the deviation of the level of inventories from their target determine the level of production. Finally, nominal GDP is obtained by multiplying the level of sales by a domestic price index.

(1) $c = \alpha_1 yd^e + \alpha_2 v_{-1}$

Sales

(2) $s = c + i + g + (x - m)$

Total Production

(3) $y = s^e + (in^T - in_{-1})$

Expected sales

(4) $s^e = ß \,.\, s_{-1} + (1 - ß) \,.\, \Delta Y_{row}$

Target inventories

(5) $in^T = \gamma . s^e$

Real inventories

(6) $in = y - s$

Nominal GDP

(7) $Y = s.p$

Private sector consumption is specified as a function of real expected disposable income and wealth. The specification of income follows the High-Simmons' tradition that

defines it as the sum of real (wages earned) and financial (interest on assets held) flows, adjusted for the tax rate, θ. The proportion of income that is not consumed increases wealth.

Disposable Income

(8) $$YD = \left(Y + int_p^g + int_p^{\$g} - int_g^p - int_{row}^{\$p} + int_p^{row} + CG_{-1} \right). (1 - \theta)$$

(9)

Consumption

(10) $$c = \alpha_1 yd^e + \alpha_2 v_{-1}$$

Expected disposable income

(11) $$yd^e = \beta_1 . yd_{-1}$$

Wealth

(12) $$\Delta V = YD - C$$

Sales prices are obtained applying a profit margin over the historical unit cost, where the latter is a function of its lagged value and the nominal unitary cost (the ratio of the wage bill over physical output). The level of employment depends on the deviation of the current level of employment from its target level. The latter is a function of production and productivity. Wages and productivity grow according to ***gr,*** an exogenous parameter.

Sales Price

(13) $$p_s = (1 + \pi) * UC$$

Unitary Cost

(14) $$UC = \frac{\left((WB) + M + int^p + int_{row}^{\$p} \right)}{y}$$

Wage Bill

(15) $$WB = W . N$$

Employment Level

(16) $$N = N_{-1} + \Omega_n . (N_{-1} - N^T)$$

Employment Target

(17) $$N^T = N_{-1}^T + \Omega_{n_1} \left(\frac{y_{-1}}{pr_{-1}} \right)$$

Productivity

(18) $$pr = pr_{-1} . (1 + gr)$$

Wages

(19) $$W = w_{-1} . (1 + gr)$$

Capital Gains

(20) $CG = (B^{\$}_{p_{-1}} + B^{row}_{p_{-1}}).\Delta E$

B. Capital accumulation and Private Debt

The level of investment is determined within the private sector. In each period, investment flows vary according to the evolution of capital depreciation (a fixed proportion of the stock of capital) and that of an investment confidence index, Δi_{ic}. Expectations are crucial for investment. Prospects on future returns, π^e, are a function of two elements: the return on investment, ROI, and a corporate risk premium, CEMBI (defined below). In turn, expectations, jointly with the rate of growth of the ROW, ΔY_{RoW}, determine the investment confidence index, i_{ic}. The parameter δ governs the impact of π^e on i_{ic}. Its value depends on firms leverage, that is on debt to capital ratio (D / K). The parameter δ is not fixed. It declines when firms leverage expands beyond a given threshold. (Perez Caldentey et al, 2019).

Additionally, the model includes the parameter, δ_1, which captures the effect of world growth on expectations. This parameter also exhibits a nonlinear relationship with i_{ic} which is meant to reflect the impact of a world contraction on the performance of the domestic economy. When world GDP growth turns negative, the parameter increases in order to take into account the effect of this negative external real shock. The specification here adopted permit investment flows to be closely related to the development of the domestic, external, and financial sectors.

Capital Accumulation

(21) $\Delta k = i - d.k_{-1}$

Private Investment

(22) $i = (dp.k_{-1}).p_d + i_{-1}.(\frac{\Delta i_{ic}}{i_{ic_{-1}}})$

Confidence Index

(23) $i_c = \delta.\pi^e + \delta_1 \Delta Y_{RoW}$

Expected Profits

(24) $\pi^e = \varsigma_1.\frac{F_{-1}}{I_{-1}} + (1 - \varsigma_1).\Delta cembi_{-1}$

Total Profits

(25) $F = YD - UC.y - int^p - int^{pfx}_{RoW} + int^g_p + int^g_{Pfx} - cons + WB + depreciation_p$

Private profits, F, are computed as the difference between real and financial revenues and costs. When F is positive, a proportion of profits is retained within the private sector to finance investment. Profits that are not retained are used in two ways: a fraction is allocated to the repayment of previously accumulated debt, while the remaining is distributed to the

private sector that uses it to buy financial assets. If investment requirements are lower than the retained profits allocated to finance it, then the excess of profits will be used to accumulate more financial assets.

(26) $Fr = \theta_f . F$

Distributed Profits

(27) $Fd = FdT - Fdc$

Profits not retained

(28) $FdT = (1 - \theta_f) . F$

Profits not retained used to repay debt

(29) $Fdc = \theta_{fdT} * FdT$

Excess profits

(30) $Frn = Fr - i \quad if\ Fr > i$

Private Budget Constraint

When investment is higher than retained profits, the private sector issues debt (ΔD^t), a fraction of which (δ_{cd}) is in foreign currency. According to the available empirical evidence in Latin America, 25% of total debt is issued in foreign currency. As a result, δ is set at 0.75.

In the domestic market, there are two types of fixed-income instruments available in local currency for financing investment, bonds and loans. The proportion of bonds to loans in local currency is given by ΔL_p^d.

Retained Profits

(31) $\Delta D^t = I - Fr$

Total Private debt (local currency)

(32) $\Delta D^{tlc} = \delta_{cd} . \Delta D^t$

Proportion of Private debt issued as Bonds (local currency)

(33) $\Delta D^p = \delta_d . \Delta D^{tlc}$

(34) $\delta_d = \delta_{d_0} + \delta_{d_1} \left(\frac{(1+i^{lp})}{(1+i^p)} \right)$

Loans demanded by private sector in local currency

(35) $\Delta L_p^d = (1 - \delta_d) . D^{tlc}$

Total Private debt (foreign currency)

(36) $\Delta D^{\$p} = (1 - \delta_{cd}) . \Delta D^t$

(37) ***Allocations***

Private debt supply to Financial Sector (local currency)

(38) $\Delta D_{fs}^p = min\ [\Delta D_{fsd}^p, \Delta D^p]$

Private debt supply to RoW (local currency)

(39) $\Delta D^p_{row} = min\,[\Delta D^p - \Delta D^p_{fs}, \Delta D^p_{row}]$

Private debt supply to Govt (local currency)

(40) $\Delta D^p_g = [\Delta D^p - \Delta D^p_{fs} - \Delta D^p_{row}, \Delta D^p_{row}]$

The private sector accumulates wealth through three financial assets, domestic and foreign currency bonds issued by the domestic government, and ROW bonds (issued in foreign currency). The demand for each asset depends on two components. This first is an exogenous parameter that implies that, despite market conditions, the private sector always demand a proportion of those assets. The second component is endogenous and relies on 'arbitrage' conditions among yields (Godin and Yilmaz, 2020).

Private sector demand for domestic currency government bonds depends on the differential between the domestic interest rate and the expected rate of profits on physical capital. The government's demand for foreign currency bonds depends on arbitrage between the domestic and ROW interest rates. Finally, for the case of ROW securities, the private sector behavior is explained on the basis of the differential between the domestic interest rate on foreign currency liabilities and the ROW interest rate.

Private Demand for Govt bonds

(41) $\Delta B^g_{p\_d} = \epsilon_1 . F_d$

Private Demand Sensitivity for government bonds

(42) $\epsilon_1 = \epsilon_{1_0} + \epsilon_{1_1}\left(\frac{1+i^g}{1+\pi^e}\right)^{\sigma_b}$

Private Demand for domestic bonds in USD

(43) $\Delta B^{\$g}_{p\_d} = \epsilon_2 . F_d$

Private Demand sensitivity for domestic bonds in USD

(44) $\epsilon_2 = \epsilon_{2_0} + \epsilon_{2_1}\left(\frac{1+i^{g\$}}{1+i^{row}}\right)^{\sigma_{b\$}}$

Private demand for ROW bonds

(45) $\Delta B^{row}_{pd} = \epsilon_3 . F_d$

Private Demand sensitivity for ROW bonds

(46) $\epsilon_3 = \epsilon_{3_0} + \epsilon_{3_1}\left(\frac{1+i^{row}}{1+i^{g\$}}\right)^{\sigma_{row}}$

C. Risk premiums and their relationship with investment

The modelling of perceived country risk ($EMBI$) and corporate risk ($CEMBI$) is one of the novelties of the model. The determinants of $EMBI$ include the debt-to-GDP ratio, foreign-debt-to-reserve-ratio, and exchange rate variations (IMF, 2010). For its part, corporate risk ($CEMBI$) is a function of country risk ($EMBI$), a premium, ϕ_0, the currency mismatch, $\frac{D^{\$p}}{B_p^{row}}$ that is, the ratios of foreign liabilities to foreign assets, and the loan-to-GDP ratio.

(47) $embi = \varepsilon_0 + \varepsilon_1.\left(\frac{B^g}{Y}\right) + \varepsilon_2.\left(\frac{B^{\$g}}{B_g^{row}}\right) + \varepsilon_3.\Delta E$

(48) $cembi = \phi_0 + \phi_1\left(\frac{D^{\$p}}{B_p^{row}+B_p^{\$g}}\right) + \phi_2.embi + \phi_3.\left(\frac{D^{\$p}+D^{p}}{Y}\right) + \phi_3.\left(\frac{L_{fs}^{\$row}}{Y}\right)$

Substitution of (71) and (72) into (22) and (23), and then plugging the result into (21), investment flows are expressed as a function of real and financial variables, that is:

(49) $i = (dp.k_{-1}).p_d + i_{-1}.\{[\varsigma_1.\frac{F_{-1}}{I_{-1}} + (1-\varsigma_1).\Delta[\phi_0 + \phi_1\left(\frac{D^{\$p}}{B_p^{row}}\right) + \phi_2.[(\varepsilon_0 + \varepsilon_1.\left(\frac{B^g}{Y}\right) + \varepsilon_2.\left(\frac{B^{\$g}}{B_g^{row}}\right) + \varepsilon_3.\Delta E)] + \delta_1\Delta Y_{RoW}$

In summary investment flows are determined by:

- Real Capital depreciation, $(dp.k_{-1}).p_d$.
- Return on investment (ROI), $\frac{F_{-1}}{I_{-1}}$.
- Private currency mismatch $\left(\frac{D^{\$p}}{B_p^{row}}\right)$.
- The government overall level of public debt sustainability $\left(\frac{B^{\$g}}{B_g^{row}}, \frac{B^g}{Y}\right)$ due to its effect on risk premiums.
- Currency fluctuations, $.\Delta E$.
- ROW growth rate, ΔY_{RoW}.

D. The external sector

The specification of the external sector equations follows a standard approach. The quantity demanded of exports and imports (in terms of rates of growth) depend on foreign and domestic GDP growth, as well as the performance of the nominal exchange rate adjusted by the ratio of external to internal prices. As usual, the current and financial accounts track the movement of financial and real flows among ROW and the domestic economy.

Exports growth

E. $\Delta x = \eta_0 . Y_{row}^{\eta_1} . \left(E \frac{p^*}{p}\right)^{\eta_2}$

Real Exports

F. $X = x.p$

Imports growth

G. $\Delta m = \eta_3 . \frac{Y^{\eta_4}}{\left(E\frac{p^*}{p}\right)^{\eta_5}}$

Real Imports

H. $M = m.p$

Current Account

I. $CAB = X - M - int_{B_{row}}^{g} - int_{BFX_{row}}^{g} - int_{d_{row}}^{p} - int_{dFX_{row}}^{p} + int_{B}^{row}$

Capital Account

J. $KAB = \Delta B_{row} + \Delta B_{row}^{\$} + \Delta D_{row} + \Delta D_{row}^{\$} - \Delta B^{row}$

On the one hand, the ROW demand for domestic government bonds depends on world GDP growth adjusted by the parameter ξ_1 which varies according to interest differentials and currency expectations. On the other hand, the ROW demand for government bonds issued in foreign currency is determined by interest rate differentials. The sum of public ($\Delta B_{row}^{g\$} + \Delta B_{row}^{g}$) and private bonds ($\Delta D_{row}^{\$p} + \Delta D_{row}^{p}$) bought by the ROW are equal to the world financial flows (WFF).

The ROW total supply of securities to the domestic economy is the sum of ROW bonds demanded by the private and public sector. In this case, the model assumes that supply always matches demand, and that the international interest rate is exogenous. Also, as expected, the world GDP growth is exogenous.

ROW Demand for Private Debt (local currency)

K. $\Delta D_{row}^{p} = (1 - \lambda).D^{p}$

ROW demand for Private Debt (foreign currency)

L. $\Delta D_{row}^{\$p} = \Delta D^{\$p}$

ROW demand for Govt Debt (local currency)

M. $\Delta B_{row\_d}^{g} = \xi_1.(Y^{row})$

$\xi_1 = \xi_{1_0} + \xi_{1_1.}(i^{\$g} - i^{\$}) + \xi_{1_2.}\Delta E^{e})$

ROW demand for Govt Debt (foreign currency)

N. $\Delta B_{row\_d}^{g\$} = \xi_2.Y^{row}$

O. $\xi_2 = \xi_{2_0} + \xi_{2_1}.(i^{\$g} - i^{\$})$

ROW supply of debt

P. $\Delta B^{row} = \Delta B_p^{row} + \Delta B_g^{row} + \Delta B_{fs}^{row}$

World Financial Flows (WFF)

Q. $WFF = \Delta B_{row}^{g\$} + \Delta B_{row}^{g} + \Delta D_{row}^{\$p} + \Delta D_{row}^{p}$

ROW GDP

R. $Y^{row} = exogenous$

International interest rate

S. $i^{row} = exogenous$

Note that for consistency purposes, it is important to consider that in each period the holding of foreign assets may generate capital gains or losses according to variations in the exchange rate:

T. $Capital\ loss = \Delta E.B_p^{RoW}{}_{-1} + \Delta E.B_p^{\$g}{}_{-1} - \Delta E.D_{row-1}^{\$p}$

U. $Capital\ loss_g = -\Delta E.B_{-1}^{\$g}$

V. $Capital\ loss_{ROW} = -\Delta E.B_{-1}^{RoW} + \Delta E.B_{row-1}^{\$g} + \Delta E.D_{row-1}^{\$p} + \Delta E.L_{fs}^{\$row}$

W. $Capital\ loss_{CB} = \Delta E.B_{cb}^{RoW}{}_{-1}$

X. $Capital\ loss_p = \Delta E.B_{fs}^{RoW}{}_{-1} + \Delta E.B_{fs}^{\$g}{}_{-1} - \Delta E.L_{fs}^{\$row}$

E. The public Sector

The public sector collects taxes on income and a proportion of it (T_d) is used for the repayment of public debt. Real spending fluctuates each year according to the rate of growth of government spending, gr^g. The rate of growth of government spending follows a standard debt sustainability rule that adjust according to the deviation between actual debt and its target level (B_t^*) – i.e., there is space to increase public spending, as long, as debt remains below the target. The target depends on two components. The first is the differential between the real target interest rate and output growth rate ($r - \Delta Y$). The real target interest rate, r, is a function of the nominal interest rate adjusted by the growth rate of domestic (∂_d) and foreign debt (∂_f) and a risk premium (φ^g, formalized in the following section). The second component is the fiscal deficit as a proportion of GDP. This sustainability rule will be replaced later on by a sustainability rule developed by UNCTAD that captures the specificities of developing countries.

Taxes

D. $T = \theta . Y$

E. $T_d = \theta_{T_d} . T$

Government spending

F. $G = G_{-1} + gr^g$

Debt sustainability rule

G. $gr_g = \varphi_0 + \varphi_1 (B_t^* - B_t)$

Debt Target

H. $B_t^* = (r - \Delta Y)\, d + \frac{(G-T)}{Y}$

Real interest target rate

I. $r = (i_g . (\partial_d + (1 + \varphi^g\ ) . \partial_f))$

The total amount of debt issued depends on the public sector budget restriction ($PSBR$)), that is on the difference between inflows and outflows in the public balance alleviated by the central bank's profits obtained from holding reserves, FB^{bc}. A fraction, ζ, of debt is issued in foreign currency. The supply of debt equals to the minimum among sectorial demands ($-\Delta B^g_{p\_d}$, $\Delta B^g_{row\_d}$ for domestic bonds and $\Delta B^{g\$}_{p\_d}$, $\Delta B^{g\$}_{row\_d}$ for foreign debt) and total public financial needs, ΔB.

Public sector budget restriction

J. $PSBR = G - T - int^g_B - int^g_{Bfx} + int^p_{d_g} + int^{row}_{Bg} + -FB^{bc}$

Government Debt Supply (local currency)

K. $\Delta B = \zeta . PSBR$

Government Debt Supply (foreign currency currency)

L. $\Delta B^{\$} = (1 - \zeta) . PSBR$

Government Debt Supply to Financial Sector (Local Currency)

M. $\Delta B^g_{fs} = min\,[\Delta B^g_{fsd}, \Delta B]$

Government Debt Supply to Private Sector (Local Currency)

N. $\Delta B^g_p = min\,[(\Delta B - \Delta B^g_{fs}), \Delta B^g_{pd}]$

Government Debt Supply to ROW (Local Currency)

O. $\Delta B^g_{row} = \min\,[\varsigma_{row} . (\Delta B - \Delta B^g_{fs} - \Delta B^g_p), \Delta B^g_{rowd}]$

Government Debt Supply to ROW (foreign currency)

P. $\Delta B^{g\$}_{row} = \min\,[\Delta B^{\$}, \Delta B^{g\$}_{rowd}]$

Government Debt Supply to Financial sector (foreign currency)

Q. $\Delta B_{fs}^{g\$} = min\left[\varsigma_{fs}.\left(\Delta B^{\$} - \Delta B_{row}^{g\$}\right), \Delta B_{fsd}^{g\$}\right]$

Government Debt Supply to Private Sector (Foreign Currency)

R. $\Delta B_{p}^{g\$} = min\left[(\Delta B^{\$} - \Delta B_{fs}^{g\$} - \Delta B_{row}^{g\$}), \Delta B_{pd}^{g\$}\right]$

Government deposits to financial sector

S. $M^{g} = superávit$

F. Interest Rates, and Exchange Rate

Following Godin and Yilmaz (2020) the demand and supply of bonds may differ, and both adjust via interest rates. The domestic interest rate, i^{g}, depends on the international rate of interest, i^{row}, a spread φ^{g}, and sovereign risk ($EMBI$). But it also varies according to the excess demand for debt – calculated as the sum of private, central bank, and ROW demand over the total issuance of debt. The nominal interest rate on foreign-denominated debt is obtained by adding to the international interest rate a risk premium, where the latter is a function of sovereign risk ($EMBI$). Private sector nominal rates on domestic and foreign debt are specified in a similar fashion.

Government Nominal Rate (domestic currency)

G. $i^{g} = i^{row} + \tau_1.\left(\frac{\Delta B - \Delta B_{p\_d}^{g} - \Delta B_{row\_d}^{g} - \Delta B_{cb\_d}^{g}}{\Delta B}\right) + (1 - \tau_1).\Delta embi + \varphi^{g}$

Government Nominal Rate (foreign currency)

H. $i^{\$g} = i^{row} + \varphi^{\$g}$, $where\ \ \varphi^{\$g} = \varphi_0^{\$g} + \varphi_1^{\$g}\Delta embi_g$

Private Nominal Rate (domestic currency)

I. $i^{p} = i^{g} + \varphi^{p},\ \ where\ \ \varphi^{p} = \varphi_0^{p} + \varphi_1^{p}.\Delta cembi_p$

Private Nominal Rate (foreign currency)

J. $i^{\$p} = i^{\$g} + \varphi^{\$p},\quad where\ \ \varphi^{\$p} = \varphi_0^{\$p} + \varphi_1^{\$p}.\Delta cembi_p$

` The specification of the nominal exchange rate is modelled on Lavoie and Daigle (2011). In addition it is assumed that the nominal exchange rate follows an autoregressive process of order 1 (AR(1)) and is affected by the degree of 'rationality embodied' in expectations and by the ROW financial flows to developing economies.

The parameter ψ (whose values range between 0 and 1) determine de degree of rationality in the formation of expectations. The closer is the value of this parameter to 1, the higher the degree of rationality. In turn, expectations depend on the composition of the foreign exchange market.

There are two types of agents: the fundamentalists and the chartists. Fundamentalists consider the existence of a fundamental E^T, influenced by traditional macroeconomic factors – we proxy E^T by the 3-years moving average of E, implicitly assuming that over a horizon of three years shocks in E are absorbed and that there is convergence to its long run trajectory.

Sovereign risk ($EMBI$) also influences fundamentalists' expectations, which represent an extension of Lavoie and Daigle (2011). Also given the specific conditions of Latin America and the Caribbean, it is important to include the terms-of-trade (TOT), as a relevant variable in both the fundamentalist and chartist specifications. Furthermore, the model assumes that fundamentalists have a higher elasticity than chartists, and that chartists are trend-followers that is, speculative agents that rely on technical analysis. They also follow $EMBI$ as it incorporates valuable information on public debt and include the behavior of TOT in the definition of their expectations. Expectations are given by the market structure: the higher the share of chartist traders, the more volatile are expectations and, in turn, the more volatile is the nominal exchange rate.

The inclusion of the terms-of-trade (TOT) not only expands the vector of explanatory variables but also makes explicit another channel that in practice reflects the financial nature of the external restriction. The evolution of the TOT is determined not only by real but also by financial factors.

Nominal Exchange Rate

K. $$E = E_{-1} + \psi.\Delta E^e + \psi_{wff}.\Delta WFF_{ec}$$

Nominal exchange rate expectations (fundamentalist)

L. $$\Delta E_f^e = \psi_{f1}(E_{-1} - E_{-1}^T) + \psi_{f_2}.\Delta EMBI_{-1} + \psi_{f_3}.\Delta TOT$$

Nominal exchange rate expectations(chartist)

M. $$\Delta E_c^e = \psi_{c1}\Delta E_{-1} + \psi_{c_2}.\Delta EMBI_{-1} + \psi_{c_3}.\Delta TOT$$

Total Expectations

N. $$\Delta E^e = \omega_f.\Delta E_f^e + \omega_c.\Delta E_c^e$$

Exchange Rate Target

O. $$E^T = 5\ year\ Moving\ Average$$

G. Central Bank

The central bank demands domestic bonds according to a target, which depends on the performance of the credit and exchange rate market. Indeed, the ideal quantity of bonds the central is willing to hold depends on the interest rate differential between the current rate,

$\boldsymbol{i_{-1}^{g}}$, and the central bank's target rate, $\boldsymbol{i_{-1}^{cb}}$, and the volatility observed in the exchange rate, $\boldsymbol{e^{risk}}$. The volatility observed in the exchange rate market is calculated as a rolling standard deviation. When it is above 3 standard deviations, the coefficient $\boldsymbol{\vartheta_{e^{risk}}}$ will take a value of 1 and the demand for bonds will adjust accordingly. This mechanism works equally, but with opposite sign, in case of both appreciations and depreciations in the nominal exchange rate. Additionally, the central bank follows a Taylor Rule reflecting the fact that deviations in inflation and output growth from their target level determine the desired monetary policy rate.

Central bank target of its demand for domestic government bonds

H. $B_{cb}^{g*} = B * (\vartheta_{bc}(i_{-1}^{g} - i_{-1}^{cb}) + \vartheta_{e^{risk}}.\ e^{risk})$

Taylor's Rule

I. $i^{cb} = \pi_t + i_t^{cb*} + \vartheta_1(\pi_t - \pi_t^*) + \vartheta_2\ (\Delta y_t - \Delta y_t^*),$

$$where\ \ \Delta y_t^* = 5yr\ MA, \qquad i_t^{cb*} = i^{row} + \varphi^{cb}$$

Central bank currency volatility indicator

J. $$e^{risk} = \begin{Bmatrix} if\ s.d.\ of\ E \geq 3, & 1 \\ if\ s.d.\ of\ E < 3, & 0 \\ if\ s.d.\ of\ E \geq -3, & -1 \end{Bmatrix}$$

The quantity of domestic government bonds assigned to the Central Bank (ΔB_{cb}^{g}) is the maximum, between its demand for bonds and the residual not allocated to financial, private, and external sector. The supply of international reserves to the central bank from the ROW is illimited and equals to the net financial flows between both the developing economy and the ROW.

Public sector supply of bond to the central bank

K. $\Delta B_{cb}^{g} = max[\Delta B - \Delta B_{fs}^{g} - \Delta B_{row}^{g} - \Delta B_{p}^{g},\ B_{cb}^{g*}]$

ROW supply of debt to the central bank

L. $\Delta B_{g}^{row} = -CAB + WFF + B_{P}^{row}.E - depreciation_{RoW}$

Finally, the central bank's demand for bonds is equal to the amount of deposits that the government is willing to supply (see equation 85).

1. Stock

The positive (negative) variation in flows of each period translate into an accumulation (deaccumulation) of stocks:

(50) $B = B_{fs}^{g} + B_{p}^{g} + B_{row}^{g} + B_{fs}^{\$g} + B_{p}^{\$g} + B_{row}^{\$g}$

(51) $B_{p}^{g} = B_{p\,-1}^{g} + \Delta B_{p}^{g} - T_{d_3}$

(52) $B_{row}^{g} = B_{row_{-1}}^{g} + \Delta B_{row}^{g} - T_{d_4}$

(53) $B_{fs}^{g} = B_{fs_{-1}}^{g} + \Delta B_{fs}^{g}$

(54) $B_{fs}^{\$g} = \left(B_{fs\,-1}^{\$g} + \Delta B_{fs}^{\$g}\right).E$

(55) $B_{p}^{\$g} = \left(B_{p\,-1}^{\$g} + \Delta B_{p}^{\$g} - \frac{T_{d_1}}{E}\right).E$

(56) $B_{row}^{\$g} = \left(B_{row_{-1}}^{\$g} + \Delta B_{row}^{\$g} + \frac{T_{d_2}}{E}\right).E$

(57) $D^{T} = D_{-1}^{T} + \Delta D^{T}$

(58) $D_{g}^{p} = D_{g\,-1}^{p} + \Delta D_{g}^{p}$

(59) $D_{fs}^{p} = D_{fs_{-1}}^{p} + \Delta D_{fs}^{p}$

(60) $D_{row}^{p} = D_{row_{-1}}^{p} + \Delta D_{row}^{p}$

(61) $D_{row}^{\$p} = (D_{row_{-1}}^{\$p} + \Delta D_{row}^{\$p}).E$

(62) $D_{fs}^{\$p} = (D_{fs\,-1}^{\$p} + \Delta D_{fs}^{\$p}).E$

(63) $V = V_{-1} + \Delta V$

(64) $k = k_{-1} - d + \Delta k$

(65) $M^{P} = M_{-1}^{p} + \Delta M^{P}$

(66) $M^{G} = M_{-1}^{G} + \Delta M^{G}$

(67) $A^{fs} = A_{-1}^{fs} + \Delta A^{fs}$

(68) $L_{p}^{fs} = L_{p_{-1}}^{fs} + \Delta L_{p}^{fs}$

(69) $L_{fs}^{\$row} = L_{fs_{-1}}^{\$row} + L_{fs}^{\$row}$

The identity between the capital and current account represents the closure of the model:

(70) $CAB \equiv KAB$

2. Interest payments

Interest paid by the government on bonds in domestic currency

(71) $int^g = i^g_{-1}.B^g_{-1}$

Interest paid by the government to the private sector

(72) $int^g_p = i^g_{-1}.B^g_{p_{-1}}$

Interest paid by the government to financial sector

(73) $int^g_{fs} = i^g_{-1}.B^g_{fs_{-1}}$

Interest paid by the government to rest of the world

(74) $int^g_{row} = i^g_{-1}.B^g_{row_{-1}}$

Interest paid by the government for the Bond in foreign currency

(75) $int^g_{FX} = (i^{\$g}_{-1}.B^{\$g}).E$

Interest paid by the government to private sector (foreign currency)

(76) $int^g_{pFX} = (i^{\$g}.B^{\$g}_p).E$

Interest paid by the government to ROW (foreign currency)

(77) $int^g_{rowFX} = \left(i^{\$g}.B^{\$g}_{row}\right).E$

Interest paid by the government for bondd in foreign currency to financial sector

(78) $int^g_{fsFX} = \left(i^{\$g}.B^{\$g}_{fs}\right).E$

Interest paid by the private sector on debt (domestic currency)

(79) $int^p = i^p.D^p$

Interest paid by the private sector to the government (domestic currency)

(80) $int^p_g = i^p.D^p_g$

Interest paid by the private sector to ROW (domestic currency)

(81) $int^p_{row} = i^p.D^p_{row}$

Interest paid by the private sector to the financial sector (domestic currency)

(82) $int_{fs}^{p} = i^{p}.D_{fs}^{p}$

Interest paid by the private sector on foreign currency

(83) $int_{FX}^{p} = i^{\$p}.D^{\$p}$

Interest paid by private sector for the debt in foreign currency to fs

(84) $int_{FX_{fs}}^{p} = (i^{\$p}.D_{fs}^{\$p}).E$

Interest paid by private sector for the Debt in foreign currency to the ROW

(85) $int_{FX_{row}}^{p} = (i^{\$p}.D_{row}^{\$p}).E$

Interest paid by ROW sector for the Foreign Bonds

(86) $int^{row} = (i^{row}.B^{row}).E$

Interest paid by ROW sector for the Foreign Bonds to the Government

(87) $int_{g}^{row} = \left(i^{row}.B_{g}^{row}\right).E$

Interest paid by the ROW sector for the holdings of foreign bonds to the private sector

(88) $int_{p}^{row} = (i^{row}.B_{p}^{row}).E$

Interest paid by the ROW sector for the Foreign Bonds to the financial sector.

(89) $int_{fs}^{row} = (i^{row}.B_{fs}^{row}).E$

Interests paid by the financial sector to the private sector

(90) $int_{mm_p}^{fs} = i_{-1}^{mm}.M_{-1}^{p}$

(91) $intc_{fs}^{p} = i_{-1}^{c}.Cc_{-1}^{p}$

(92) $int^{afs} = i_{-1}^{afs}.A^{fs}$

(93) $int^{lp} = i_{-1}^{lp}.L_{p}^{fs}$

(94) $int^{\$lp} = i_{-1}^{\$lp}.L_{fs}^{\$row}$

H. The financial sector

The financial sector covers its financial needs by issuing two types of liabilities. These are central Bank's advances, (A^{fs}), and foreign currency bonds issued to the ROW, ($L_{fs}^{\$row}$). Advances are calculated as a proportion (δ_{afs}) of the sector's financial needs, which

are given exogenously. The remaining financial needs are covered through bonds issued in foreign currency and sold to the ROW.

The financial sector's balance sheet comprises seven assets. Two of these assets, consumer credit (Cc_s^p) and loans for investment purposes (L_p^d) are acquired from the sector's lending activity to the private sector. The demand for consumer credit (Cc_s^p) depends on the difference between the private wage bill and private consumption. When the latter exceeds the former, the financial sector finances private consumption with consumer credit (Cc_d^p). It is assumed for simplicity, that the financial sector meets the total demand for consumer credit.

The financial sector also finances private sector investment with loans (L_p^d). In this case, the demand for loans depends on profits and capital expenditures. The supply of loans also meets the demand for loans. The sum of consumer credit and loans corresponds to the total volume of deposits (Mm) of the private sector in the financial sector.

The interest payments received for holding local bonds and foreign reserves constitute the financial sectors' inflows. Interests paid on foreign borrowing and for advances from the central bank correspond to outflows. The difference between inflows and outflows determines profits (f_{fs}).

A share of profits (fa_{fs}) is used to accumulate wealth through financial assets: government bonds (in local and foreign currency), private debt (only in domestic currency), and foreign debt used as reserves. The demand for each type of asset reflects arbitrage conditions as postulated by Godin and Yilmaz (2019).

Demand for consumer credit

(95) $$Cc_d^p = C - WB$$

Supply of consumer credit

(96) $$Cc_s^p = Cc_d^p$$

Loans supplied by financial sector to the private sector

(97) $$\Delta L_p^s = \Delta L_p^d$$

$Profit\ of\ the\ financial\ sector$

(98) $$f_{fs} = int_{fs}^{g} + int_{fs}^{\$g} + int_{fs}^{p} + int_{fs}^{row} - int_{mm_p}^{fs} + intc_{fs}^{p} - int^{afs} + int^{lp} - int^{\$lfs}$$

(99) $$\Delta FN_{fs}^{t} = T + \Delta B_{fs}^{g} + \Delta B_{fs}^{\$g} + \Delta D_{fs}^{p} + \Delta D_{fs}^{\$} + \Delta B_{fs}^{row} + \Delta L_{p}^{fs} + \Delta Cc_{fs}^{p} - (1 - \sigma_{Rb})M^{p} - f_{fs} + R_p$$

$Financial\ Proportion\ of assets\ bought\ by\ the\ financial\ sector$

(100) $fa_{fs} = (1 - \sigma_{Rb})M^p - f_{fs}$

Advances of the financial sector

(101) $\Delta A^{fs} = \delta_{afs}.\Delta FN_{fs}^t$

Loans demanded by the financial sector in foreign currency

(102) $\Delta L_{fs}^{\$row} = \frac{\left((1-\delta_{afs}).\Delta FN_{fs}^t\right)}{E}$ where δ_{afs} *is exogenous*

Financial Sector Demand for Government bonds

(103) $\Delta B_{fs\_d}^{g} = \epsilon_{f_1}.fa_{fs}$

Elasticity of the demand of the financial sector for government bonds

(104) $\epsilon_{f_1} = \epsilon_{f_{1_0}} + \epsilon_{f_{1_1}}\left(\frac{1+i^g}{1+i^{g\$}}\right)^{\sigma_{f_b}}$

Financial Sector Demand for domestic bonds in USD

(105) $\Delta B_{fs\_d}^{\$g} = \epsilon_{f_2}.fa_{fs}$

Elasticity of the demand of the financial sector for domestic bonds in USD

(106) $\epsilon_{f_2} = \epsilon_{f_{2_0}} + \epsilon_{f_{2_1}}\left(\frac{1+i^{g\$}}{1+i^{row}}\right)^{\sigma_{f_{b\$}}}$

Financial Sector demand for ROW bonds

(107) $\Delta B_{fsd}^{row} = \epsilon_{f_3}.fa_{fs}$

The demand for finance is the same as the supply for finance

Elasticity of the demand of the financial sector for ROW bonds

(108) $\epsilon_{f_3} = \epsilon_{f_{3_0}} + \epsilon_{f_{3_1}}\left(\frac{1+i^{row}}{1+i^{g\$}}\right)^{\sigma_{f_{row}}}$

(109) $\Delta D_{fs\_d}^{p} = \epsilon_{f_4}.fa_{fs}$

Elasticity of the demand of the financial sector for government bonds

$\epsilon_{f_4} = \epsilon_{f_{4_0}} + \epsilon_{f_{4_1}}\left(\frac{1+i^p}{1+i^g}\right)^{\sigma_{f_d}}$

V. Macroprudential measures and their results

The model above is specified to capture the business cycle of Latin America and the Caribbean which is shaped by the external financial restriction and by the transmission mechanisms described in section III.

Using the above model, this section shows the impact of selected macroprudential measures on the evolution of the business cycle. The choice of macroprudential measures is based on the conceptual discussion of macroprundential regulation in this paper and on the analysis of the companion paper *A critical assessment of macroprudential regulation and comparative regional experiences focusing on Latin America and the Caribbean* DA-COVID 19 Project paper 18.21 (Pérez Caldentey, Nalin & Rojas, 2021).

The measures include: (i) the increase in retained profits of the private sector; (ii) the reduction in the number of speculators (chartist traders) in the Forex market; and (iii) the decline in the foreign debt in the private sector. The model also shows that these measures are more effective when combined with a government sustainability rule that takes into accounts the specificities of developing countries.[25] The measures are simulated over the period 1995-2025 and the description of the results focus on the 2020 COVID-19 crisis. The scenarios assume that macroprudential policies are implemented starting in 2016. The result of adopting these measures is compared with a baseline scenario with no macroprudential policies in place.

The choice of these macroprudential measures is derived from both theoretical and empirical considerations.

The first macroprudential policy considered, retained earnings, has a direct relation to Minsky's model of financial fragility using the representative firm. According to Minsky's model, the greater are retained earnings to 'finance' investment, the less likely will be the need for firms to obtain finance via debt and thus the more robust will the margins of safety and the less likely with the weight of speculative and Ponzi finance in the financial structure. The theoretical argument is also based on Kalecki (1969 (1954)). At the empirical level, the evidence presented for macroprudential policies in the case of Asia analyzed in Pérez Caldentey, Nalin & Rojas (2021) indicates that 50% of banking supervisors have implemented temporary restrictions on dividends and bonuses as a tool for the management of the business cycle. The simulation proposed increases the parameter of equation 8 from 0.18 to 0. 30.

The second macroprudential measure applied concerns the composition of the foreign exchange currency market. The foreign exchange market structure is crucial in determining the behavior of nominal exchange rates (Daigle and Lavoie, 2011). A higher proportion of speculators – i.e., trend-followers – can turn the foreign exchange market into an asset-like market with procyclical performance. The simulation of this measure seeks to explore the implications of a reduction in speculators in favor of fundamental traders – i.e., those who pay less attention to trends and focus on macroeconomic fundamentals. In this sense, this second measure aims at reducing the destabilizing effects of foreign exchange speculators in the era of financial globalization.

[25] See, De Freitas (2021) & Schonerwald (2021).

This measure is highly relevant to the current Latin American and Caribbean context. In the last decade, emerging markets including many Latin American economies liberalized their foreign exchange markets and, partly, as a result, of this experienced a growing level of volatility in the exchange rate. This can represent a source of instability given the increasing foreign debt in government sector and the corporate sector coupled with the existence of increasing of currency mismatches in the developing world (Perez Caldentey et al., 2019; Nalin and Yajima, 2021).

The third macroprudential measure contemplated is the establishment of a *de jure* cap on the private sector. The establishment of restrictions on foreign currency-denominated lending to tackle systemic risk is well documented in the case of Latin America and the Caribbean (See Pérez Caldentey, Nalín, and Rojas, 2021). To evaluate the outcomes of such policy, the simulation consists in a reduction of the proportion of foreign debt in the private sector's balance sheet by increasing the corresponding parameter from 0.74 to 0.95 (See equation 31 above). The main implication of this policy is the private sector's preference towards domestically issued debt. With this measure in place foreign debt is reduced from 26% to 5%.

This section also shows that these measures are more effective when combined with a sustainability rule developed by UNCTAD, that takes, into account, both the domestic and external constraints for government expenditure (Schonerwald Da Silva, 2021).

Table 5

Individual impact of selected macroprudential measures on the nominal exchange rate (NER), sovereign and corporate risk ($EMBI$ and $CEMBI$), total debt-to-GDP and private debt-to-GDP ratio, currency mismatch, profits-to-sales, investment confidence and the investment-to-GDP ratio (2016-2023)

	NER	NER Vol.	EMBI	CEMBI	Debt-to-GDP	Private Debt-to-GDP	Mismatch	Profit-to-Sales	Investment Confidence	Investment -to-GDP
Increase in Retained Profits	Depreciation	L	L	L	H	L	L	H	H	H
Reduction of speculators in the foreign exchange market	Appreciation	L	H	N	H	L	H	L	L	L
Reduction in external debt	Appreciation	H	H	N	L	L	L	N	N	N
UNCTAD's debt sustainability rule	Appreciation	L	L	N	L	N	L	N	N	N

Source: authors' own elaboration

Note: L= lower; H= higher; N=neutral

Table 6

Combined impact of selected macroprudential measures on the nominal exchange rate (NER), sovereign and corporate risk ($EMBI$ and $CEMBI$), total debt-to-GDP and private debt-to-GDP ratio, currency mismatch, profits-to-sales, investment confidence and the investment-to-GDP ratio (2016-2023)

	NER	NER Vol.	EMBI	CEMBI	Govt Debt-to-GDP	Private Debt-to-GDP	Mismatch	Profit-to-Sales	Investment Confidence	Investment -to-GDP
Increase in Retained Profits & Reduction in FX Leverage	Appreciation	L	L	L	H	L	L	H	H	H
Higher in Retained Profits & Reduction in FX speculators	Appreciation	L	H	L	H	L	L	H	H	H
Increase in Retained Profits & Sustainability Rule	Appreciation	L	L	L	H	L	L	H	H	H

Source: authors' own elaboration

Note: L= lower; H= higher; N=neutral

Tables 5 and 6 below summarize the individual and combined simulation results of applying the above macroprudential measures on the evolution of selected variables including the nominal exchange rate (NER), sovereign and corporate risk ($EMBI$ and $CEMBI$), total debt-to-GDP and private debt-to-GDP ratio, currency mismatch, profits-to-sales, investment confidence and the investment-to-GDP ratio. For the sake of completeness, tables 5 and 6 also show the impact of UNCTAD's government sustainability rule on the evolution of these variables. The impacts over time are traced in figures 1a-1d and 2a-2d below.

The analysis shows that an increase in retained earnings reigns in nominal exchange rate depreciation, lowers risk perceptions and narrows currency mismatches. At the same time, this measure improves the profit-to-sales ratio and increases investment-to-GDP. The sequence of effects of the increase in retained earnings are traced in figures 1a-1d and 2a-2d.

Higher retained earnings imply less reliance on corporate debt and thus a reduction in the corporate risk index ($CEMBI$). The reduction of $CEMBI$ has significant implications for the system. On the one hand, the lower level of risk reduces the corporate interest rate, which decreases the total amount of interest paid on debt. As a result, benefits per unit of sales are higher. On the other hand, lower corporate risk ($CEMBI$) and higher benefits raise the investment confidence index which has a positive effect on the investment-to-GDP ratio. The results show that the increase in the investment-to-GDP ratio is three percentage points of GDP higher relative to the base scenario. In a similar way, the private debt-to-GDP ratio which in the baseline scenario averages 17% of GDP over the period 2016-2021, drops to 7%, resulting from increased retained earnings.

The second measure applied (the reduction in foreign exchange speculators) is effective in tackling currency depreciation and volatility yet does not lead to an improvement in corporate investment. Figure 2a shows that this measure leads to a more appreciated and stable nominal exchange rate relative to the other measures. Visual inspection of the impact of this measure also illustrates that the gap between the evolution of the nominal exchange rate (NER) using this macroprudential measure and the evolution of the nominal exchange rate (NER) with the other macroprudential measures tends to widen over time. suggesting the ability of the former to tackle depreciation.

The analysis of the volatility index – calculated as the rolling standard deviation of the nominal exchange rate (NER) – also suggests the reduction in chartist traders is positive for currency stabilization. Benefits materialize mainly during times of crisis, such as during the 2020 COVID-19 episode, when volatility is on average reduced by 50% in the case of the reduction in foreign exchange speculators relative to the impact of using other macroprudential measures.

However, currency appreciation and stability do not guarantee an overall improvement in the business cycle. One of the effects derived from a reduction in foreign

exchange speculators is the observed higher level of debt and the consequent increase in sovereign risk ($EMBI$) relative to the baseline scenario.

This results from the role played by reserve accumulation in emerging market economies including in Latin America and the Caribbean in maintaining macroeconomic stability (See Pérez Caldentey, Abeles and Kreiter, 2021). In the present model the initial stock of international assets held by the central bank is 6.6 times higher than the total foreign debt in the private and public sectors. Within this context, a depreciating exchange rate generates capital gains on foreign reserves, and according to the specification of the model described above, the central bank uses those gains to relax the government's budget constraint.

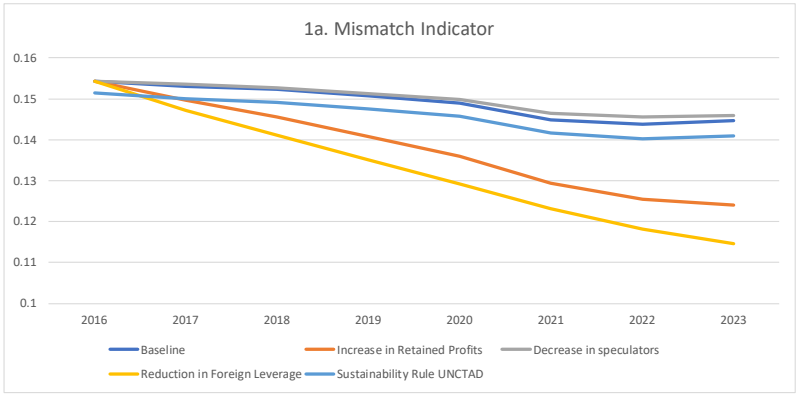
This in turn could result in an expansion of the debt-to-GDP ratio and an increase in sovereign risk ($EMBI$) (Eq. 14 includes the debt-to-GDP ratio is among the determinants of $EMBI$). The degree to which $EMBI$ increases in response to a rise in the debt-to-GDP ratio depends on historical patterns. The more a country has been prone to debt mismanagement and crisis, the more sensitive is the $EMBI$ to increases in the debt-to-GDP ratio. A similar logic can be applied to describe the effects of an exchange rate appreciation.

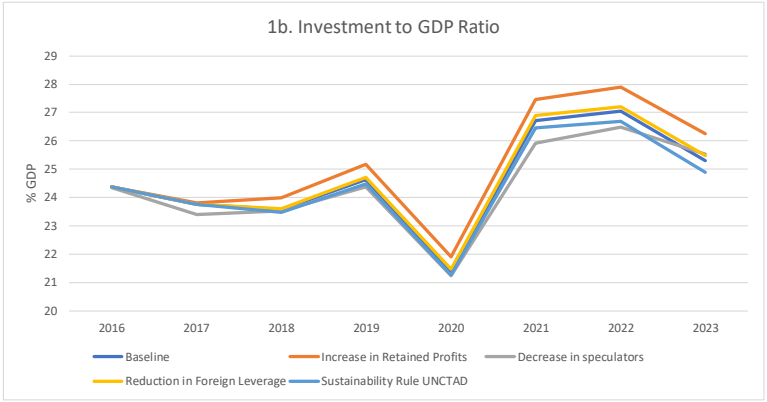
The reduction in foreign exchange speculators does not generate significant changes in private investment. A decrease in foreign exchange speculators yields the lowest investment-to-GDP ratio among the different macroprudential measures applied (See figure 1b).

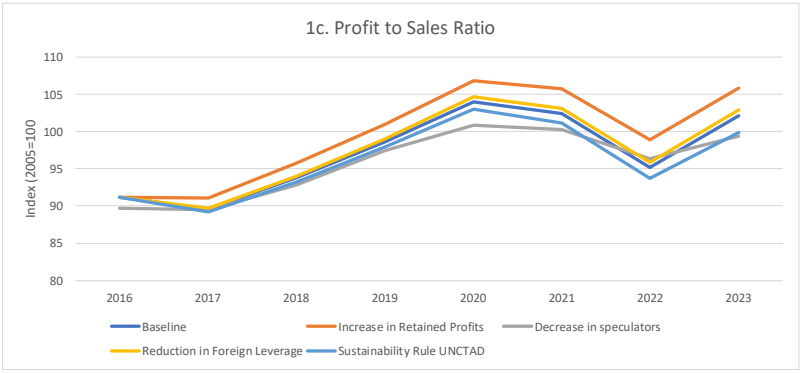
The third macroprudential measure contemplated, the *de jure* external debt cap for the private sector, reduces the currency mismatch but does not result in a positive externality to the rest of the system. Note that the overall level of debt issued by the private sector does not change. There is only a change in its composition from foreign to domestic securities. Since there is mechanism to reduce the demand for finance of the private sector, domestic debt markets will absorb the proportion of debt not issued in foreign currency. As a result, the outcome resulting from imposing an external debt cap resemble that of the baseline scenario. This underscores the importance of confronting the problem of private debt by reducing the financial needs of the private sector rather than by changing its composition.

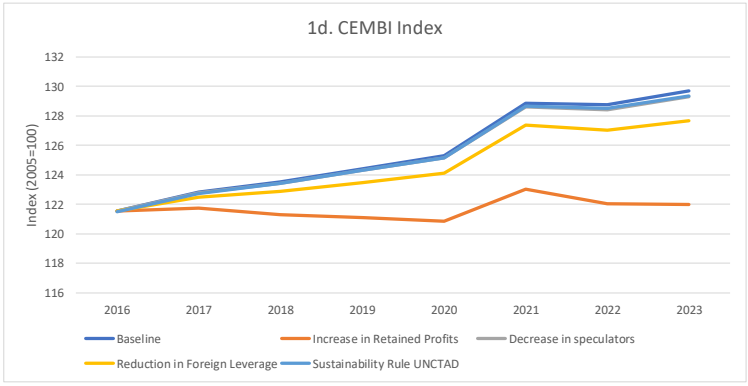
Finally, the introduction of UNCTAD's fiscal sustainability rule lowers debt levels relative to the other scenarios and, in turn, reduces perceived sovereign risk ($EMBI$). According to this rule the growth rate for public expenditure is determined by the elasticity to the domestic economic growth; the sustainability rule of debt in domestic currency; and the sustainability rule of debt in foreign currency.

Figures 1a-1d
Evolution of the individual impact of selected macroprudential measures on currency mismatch, investment-to-GDP, profits-to-sales, investment confidence and CEMBI
2016-2023



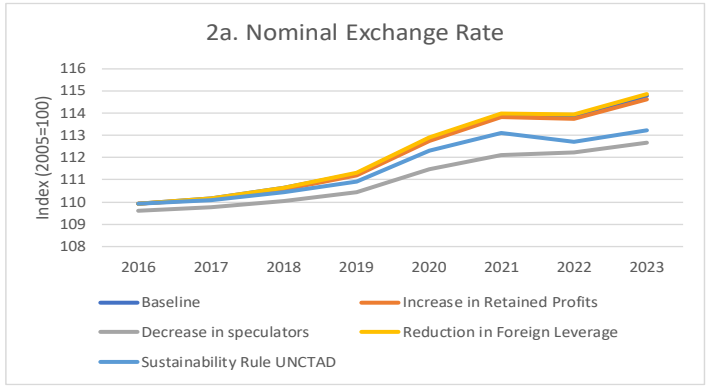


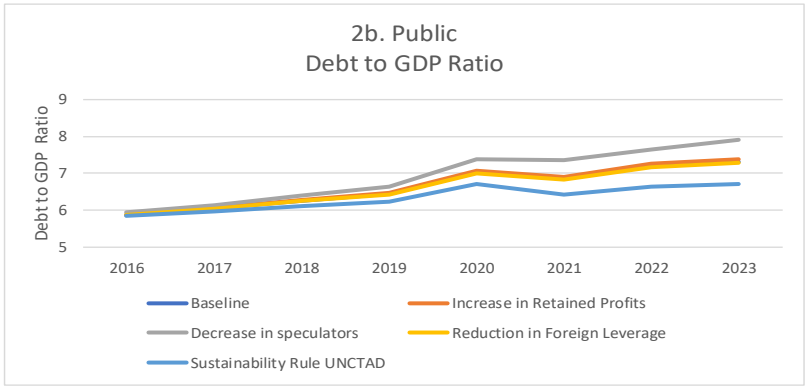


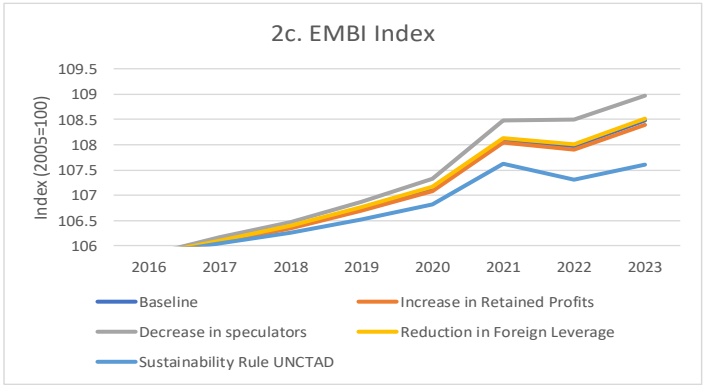


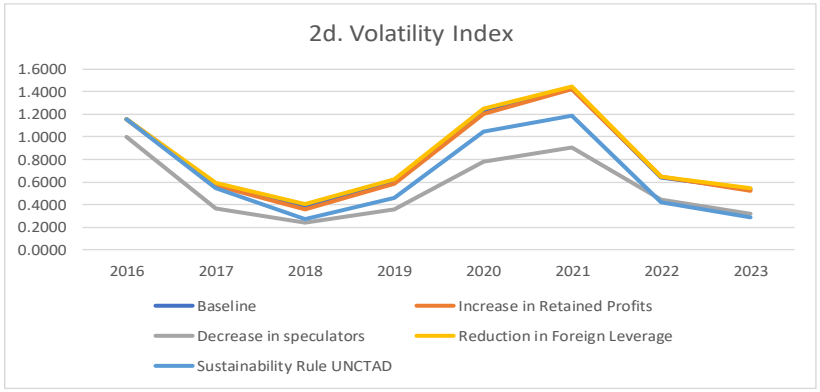
Source: author's own elaboration

Figures 2a-2d
Evolution of the individual impact of selected macroprudential measures on the nominal exchange rate (NER), public debt-to-GDP ratio, $EMBI$ index and volatility index
2016-2023









Source: author's own elaboration

Given the implementation of the sustainability rules starting in 2016, the existence of a negative gap between the rate of growth of government expenditures and interest payments in local currency ($g - i^g$) leads to a reduction of the former to ensure the sustainability of public debt in domestic currency. With the positive gap between the rate of growth of exports and interest payments in foreign currency ($x - i^{g\$}$) for several years, from 2016 to 2019, allows for greater space in public spending. This occurs in the 2016-2019 period. The opposite result prevails in 2020 when the growth rate of exports decreases relative to the interest rate of the government's foreign currency liabilities. With this rule in place the public debt grows at a much lower rate than in the other scenarios and registers the lowest debt-to-GDP ratio.

The application of the UNCTAD debt sustainability rule also slightly reduces currency mismatch. The lower public consumption leads to an insufficient supply of domestic public debt, and, in turn, the private sector allocates its savings shift towards foreign assets. In other words, the private sector is forced to accumulate higher foreign reserves, improving the mismatch indicator. However, no significant effects are perceived for the other variables that are considered in this exercise.

Up until this stage, the model simulation shows the impact of each individual macroprudential measure separately, and that of the UNCTAD's debt sustainability rule. A more realistic approach is to combine different macroprudential measures treating these as complementary rather than as substitutes. As a first approximation the analysis combined the most effective of the three macroprudential measures considered (the increase in retained earnings) with each of the other measures and, also with UNCTAD's debt sustainability rule.

Among the three policy combinations considered ((i) the increase in retained profits and reduction of foreign leverage: (ii) the increase in retained profits and reduction in FX speculators; and (iii) the increase in retained profits and implementation of the fiscal sustainability rule) the increase in retained profits jointly with the fiscal sustainability rule provides the best results for exchange rate stability, public and private debt behavior, risk, and investment. The investment-to-GDP ratio, the investment confidence index, and the profit-to-sales reach their highest levels thanks to lower financing needs resulting from increased retained profits.

These indicators benefit from extended periods of lower private debt – which only adjust upward in 2021 due to the rapid recovery in the 2020 shock – and a contained level of public debt (1% of GDP higher than the baseline scenario). Also, with the combination of retained profits and fiscal sustainability rule, the mismatch is lower than the baseline scenario. All in all, there also exist positive spillovers on the financial side of the simulation. The exchange rate appreciates and shows a more stable path over time. In turn, lower debt, and greater nominal exchange rate (NER) stability positively impact risk premiums as both $EMBI$ and $CEMBI$ decrease.

Similar results in the nominal exchange rate (NER) and its volatility, and risk (EMBI and CEMBI) are observed when combining the increase in retained profits with a reduction of foreign leverage in the private sector

Indeed, the empirical results show a more appreciated and less volatile nominal exchange rate (NER) and a lower $EMBI$. The reduction of total private debt and currency mismatch generates a much lower level of $CEMBI$. These results translate into improvements in the investment ratio to GDP, the investment confidence index, and the proportion of profit to sales ratio.

However, investment to GDP reaches a lower level in comparison to the scenario combining higher retained profits with the fiscal sustainability rule due to the higher profit-to-sales and investment confidence.

Overall, relative to the baseline scenario, the combination of increased retained profits and the reduction of foreign leverage substantially improves the performance of the economy under the circumstances of an external shock, such as the COVID-related crisis.

Finally, the increase in retained profits and the reduction if foreign exchange speculation presents ambiguous results since the decrease in exchange market participation and its adverse effects on debt and risk (discussed above) far outweigh the benefits of retained earnings in the private sector.

VI. Conclusion

This paper presents a baseline macroeconomic model for Latin America and the Caribbean to analyse and evaluate macroprudential guidelines and policies. This model is based on the idea that the growth of Latin American and Caribbean economies is balance-of-payments constrained and that the external constraint is financial. The binding character of the external constraint is also reflected in the introduction of a fiscal sustainability rule developed by UNCTAD that emphasizes the relationship between the external constraint and debt accumulation.

The model specification captures the dominant transmission mechanisms (in place since the 2000s and particularly since the Global Financial Crisis 2008-2009) between the external and domestic sectors of the economy, and between real and monetary/financial variables that are specific to the Latin American and Caribbean case. These transmission mechanisms describe a financial cycle that can evolve over time without being characterized by alternating booms and busts.

The analysis of macroprudential policies builds from a critical reading of the mainstream and, especially, post-Keynesian literature on financial regulation. The paper

argues that the use of macroprudential policies should not only prevent systemic crises but should also be a permanent component of the management of the business cycle.

The paper exemplifies the usefulness of the model by tracing the effects of three macroprudential measures that focus on the external sector: an increase retained earnings, a cap on foreign currency borrower, and, also, a limit on foreign exchange speculation. The results show that these measures, and in particular, an increase in retained earnings, can mitigate the fluctuations of the business cycle. The results tend to improve with the UNCTAD debt sustainability rule. The baseline model is flexible enough to incorporate other macroprudential measures described in the text and can thus serve as a tool for policy makers to evaluate their impact and usefulness.

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Annex 1 Debt sustainability rules

Debt sustainability rule in domestic currency.

Following Carlos Schonerwald Da Silva(2021) concerning the domestic level, the central issue is the debt to GDP ratio. The sustainability of public debt in domestic currency can be expressed as follows

$$\Delta d = \frac{G - T}{Y} - \frac{\Delta M}{PY} - (\beta - \pi + g).d. \quad (I.)$$

Where

$$\Delta d = Change\ in\ domestic\ debt - GDP\ ratio$$

$$\frac{G - T}{Y} = Primary\ deficit$$

$$\frac{\Delta M}{PY} = Change\ in\ import - GDP\ ratio$$

$$i^g = Average\ of\ liabilities\ cost\ of\ Government$$

$$\pi = Change\ in\ domestic\ prices$$

$$g = Domestic\ growth\ rate$$

$$d = Stock\ level\ of\ debt - GDP\ ratio$$

This equation following Bhering(2021) can be re-expressed as

$$\Delta d = \frac{G + F - T}{Y} - \left(\frac{g - i^g}{1 + g}\right).d \quad (I.a.)$$

Where

$$F = Transfers\ from\ government\ to\ other\ sectors$$

As mentioned by Schonerwald(2021), the second part of the equation $(I.a.)$ $\left(\frac{g-i^g}{1+g}\right).d$ is the well-known snowball effect, so this part of the equation will largely determine the sustainability of foreign currency public debt according to the gap between $g - i^g$.

In the case of our model, we take equation (Ia.) as a starting point to formulate the sustainability rule and obtain the following equation

$$gr_{g_2} = \left(\frac{g_{-1} - i^{g}{}_{-1}}{1 + g_{-1}}\right).d_{-1} - \frac{G_{-1} + F_{-1} - T_{-1}}{Y_{-1}} \quad (II.)$$

Where

$$gr_{g_2} = Sustainability\ rule$$

Given the role assigned to the government in the framework of macroprudential policies, this rule determines a part of the growth rate of public expenditure for each period according to the behavior of public debt concerning the gap between the two parts of the equation $(II.)$.

Foreign currency debt sustainability rule.

Following Schonerwald(2021) we start from the equation of the Balance of Payments

$$X - M + RMT + NIFA + D + FDI + PI - \Delta R = 0 \ (III)$$

Where

$$X = Exports$$

$$M = Imports$$

$$RMT = Remmitences$$

$$NIFA = Net\ Income\ from\ Abroad$$

$$D = Net\ Debt\ (both\ in\ local\ and\ foreign\ currency)$$

$$FDI = Foreign\ Direct\ Investment$$

$$PI = Portfolio\ Investment$$

$$\Delta R = Variation\ of\ Reserves$$

From where you can get to

$$\Delta NEL = M - X - RMT - NIFA \quad (IV.)$$

Where

$$\Delta NEL = Variation\ of\ The\ Net\ External\ Liabilities$$

And

$$\Delta nel = \frac{NEL}{X + RMT}$$

The change in foreign liabilities can be restated as follows

$$nel = \frac{M - X - RMT - NIFA}{X + RMT} - nel\left(\frac{\Delta(X + RMT)}{X + RMT}\right) (VI.)$$

And finally, following Bhering(2021) the above equation can be expressed as a function of the growth rates of exports (x) and the average interest rate of the economy's liabilities (r).

$$\Delta nel = \frac{M - X - RMT - NIFA}{X + RMT} - \left(\frac{x - r}{1 + x}\right).nel\ (VII.)$$

The behavior of the foreign debt will therefore depend on the second part of the equation $(VII.)$ $\left(\frac{x-r}{1+x}\right).nel$, and the gap $x - r$.

In the case of our model, we take equation $(VII.)$ as a starting point to formulate the sustainability rule and obtain the following equation

$$gr_{g_2} = \left(\frac{x - i^{g\$}}{1 + x}\right).nel - \frac{M - X}{X}\ (VIII.)$$

This gives the following equation for the variation of public expenditure

$$gr_g = \varphi_0 + \varphi_1(gr_y) + \xi_{gr_2}.gr_{g_2} + \xi_{gr_3}.gr_{g_3} \quad (\mathbf{71})$$

Where

ξ_{gr_2}, ξ_{gr_3} *are elasticity parameters. In the baseline scenario their values are zero.*

Annex: debt sustainability rules

Debt sustainability rule in domestic currency.

Following Carlos Schonerwald Da Silva(2021) concerning the domestic level, the central issue is the debt to GDP ratio. The sustainability of public debt in domestic currency can be expressed as follows

$$\Delta d = \frac{G - T}{Y} - \frac{\Delta M}{PY} - (\beta - \pi + g).d. \quad (I.)$$

Where

$$\Delta d = Change\ in\ domestic\ debt - GDP\ ratio$$

$$\frac{G - T}{Y} = Primary\ deficit$$

$$\frac{\Delta M}{PY} = Change\ in\ import - GDP\ ratio$$

$$i^g = Average\ of\ liabilities\ cost\ of\ Government$$

$$\pi = Change\ in\ domestic\ prices$$

$$g = Domestic\ growth\ rate$$

$$d = Stock\ level\ of\ debt - GDP\ ratio$$

This equation following Bhering(2021) can be re-expressed as

$$\Delta d = \frac{G + F - T}{Y} - \left(\frac{g - i^g}{1 + g}\right).d \quad (I.a.)$$

Where

$$F = Transfers\ from\ government\ to\ other\ sectors$$

As mentioned by Schonerwald(2021), the second part of the equation $(I.a.)$ $\left(\frac{g-i^g}{1+g}\right).d$ is the well-known snowball effect, so this part of the equation will largely determine the sustainability of foreign currency public debt according to the gap between $g - i^g$.

In the case of our model, we take equation (Ia.) as a starting point to formulate the sustainability rule and obtain the following equation

$$gr_{g_2} = \left(\frac{g_{-1} - i^{g}{}_{-1}}{1 + g_{-1}}\right).d_{-1} - \frac{G_{-1} + F_{-1} - T_{-1}}{Y_{-1}} \quad (II.)$$

Where

$$gr_{g_2} = Sustainability\ rule$$

Given the role assigned to the government in the framework of macroprudential policies, this rule determines a part of the growth rate of public expenditure for each period according to the behavior of public debt concerning the gap between the two parts of the equation $(II.)$.

Foreign currency debt sustainability rule.

Following Schonerwald(2021) we start from the equation of the Balance of Payments

$$X - M + RMT + NIFA + D + FDI + PI - \Delta R = 0 \ (III)$$

Where

$$X = Exports$$

$$M = Imports$$

$$RMT = Remmitences$$

$$NIFA = Net\ Income\ from\ Abroad$$

$$D = Net\ Debt\ (both\ in\ local\ and\ foreign\ currency)$$

$$FDI = Foreign\ Direct\ Investment$$

$$PI = Portfolio\ Investment$$

$$\Delta R = Variation\ of\ Reserves$$

From where you can get to

$$\Delta NEL = M - X - RMT - NIFA \quad (IV.)$$

Where

$$\Delta NEL = Variation\ of\ The\ Net\ External\ Liabilities$$

And

$$\Delta nel = \frac{NEL}{X + RMT}$$

The change in foreign liabilities can be restated as follows

$$nel = \frac{M - X - RMT - NIFA}{X + RMT} - nel\left(\frac{\Delta(X + RMT)}{X + RMT}\right) (VI.)$$

And finally, following Bhering(2021) the above equation can be expressed as a function of the growth rates of exports (x) and the average interest rate of the economy's liabilities (r).

$$\Delta nel = \frac{M - X - RMT - NIFA}{X + RMT} - \left(\frac{x - r}{1 + x}\right).nel\ (VII.)$$

The behavior of the foreign debt will therefore depend on the second part of the equation $(VII.)$ $\left(\frac{x-r}{1+x}\right).nel$, and the gap $x - r$.

In the case of our model, we take equation $(VII.)$ as a starting point to formulate the sustainability rule and obtain the following equation

$$gr_{g_2} = \left(\frac{x - i^{g\$}}{1 + x}\right).nel - \frac{M - X}{X}\ (VIII.)$$

This gives the following equation for the variation of public expenditure

$$gr_g = \varphi_0 + \varphi_1(gr_y) + \xi_{gr_2}.gr_{g_2} + \xi_{gr_3}.gr_{g_3} \quad (\mathbf{71})$$

Where

ξ_{gr_2}, ξ_{gr_3} *are sesibilities. In the baseline scenario their values are zero.*