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A stock-flow approach to investment requirements within balance-of-payments constrained growth

Esteban Pérez Caldentey
Leonardo Rojas Rodríguez

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Leonardo Rojas Rodríguez

This document has been prepared by Esteban Pérez Caldentey, coordinator of the Financing for Development Unit of the Economic Development Division of the Economic Commission for Latin America and the Caribbean (ECLAC), and Leonardo Rojas Rodríguez, student at the Universidad Nacional de Colombia.

The ideas contained here were developed during the internship of Leonardo Rojas Rodríguez at ECLAC from February to July 2020. The authors benefited greatly from comments provided by Martín Abeles, Christine Carton, Mario Cimoli, Juan Carlos Moreno-Brid, Wilson Peres, Gabriel Porcile, Thomas Palley, Tony Thirlwall and Matías Vernengo.

United Nations publication
LC/TS.2020/152
Distribution: L

Printed at United Nations, Santiago
S.20-00838

This publication should be cited as: E. Pérez Caldentey and L. Rojas Rodríguez, "A stock-flow approach to investment requirements within balance-of-payments constrained growth", *Project Documents* (LC/TS.2020/152), Santiago, Economic Commission for Latin America and the Caribbean (ECLAC), 2020.

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Introduction

Two important distinguishing features of non-mainstream economics is the role attributed to demand both in the short and the long-run and the importance of the external sector in setting limits or placing a restriction to economic growth. The importance of both ideas is tied to some extent to the fundamental idea that market economies are above all monetary or in Keynes' (1980) sense entrepreneur economies.

The restriction placed by the external sector in placing a limit to the expansion of demand is generally approached through a balance-of-payments constrained growth model. According to this model the long-run rate of growth of an economy is defined by the rate of growth consistent with balance-of-payments equilibrium. The rate of growth of an economy is equal to the rate of growth of the world and the export income elasticity, the rate of change of financial flows and the rate of change of the real exchange rate and its associated price elasticities divided by the income elasticity of imports. In its most simplified form. This long-run position is defined as that long-term growth rate of an economy that is determined by the long-term growth rate of the rest of the world multiplied by the income-elasticity ratio between the follower country's exports to the rest of the world and the income-elasticity of its demand for imports.

According to the balance-of-payments constrained growth model, an expansion of aggregate domestic demand, say a rise in domestic gross fromation of fixed capital, is effective in increasing the long-run rate of growth of an economy to the extent that the performance of external sector validates it. More precisely "countries face an external constraint when their performance in foreign markets and the response of the financial markets to this performance restrict growth to a rate lower than external conditions require".[1] The BOP constraint implies that the economy grows at a rate lower than the one compatible with full employment.

[1] McCombie and Thirlwall (1999, p. 49)

While the performance of the domestic economy is intertwined with that of the external sector, the balance-of-payments constraint to growth does not make explicit these relationships. This paper addresses this issue and proposes a framework to make explicit the investment requirements with balance-of-payments constrained growth. Following the logic of the balance-of-payments constrained growth model, the approach followed argues that the conditions in the external are causal link that determines variations in output and through variations in output, investment requirements. The underlying logic and workings of this framework is exemplified with the case of Latin America and the Caribbean.

The paper comprises four sections. The first section explains the relationship between growth, investment and exports with a focus on Latin American and Caribbean economies. The second section focusses on the interdependency between investment and exports. The third section develops a theoretical framework to explicitly bring to light the investment requirements consistent with the balance-of-payments constraint. This framework is tested empirically for a select group of Latin American economies. The fourth sections proposes to analyse the relationship between the performance of the domestic economy and the external sector using a stock-flow model that includes five sectors: households, firms, government, commercial banks and the external sector. In the model the behaviour of investment adapts to the requirements of the externals sector. Following an explanation of the logic of the stock-flow methodology the fifth section explain the most important equations of the model. Section six illustrates the workings of the model by explaining its causal structure and showing the results of a simulation consisting in a expansionary fiscal policy.

I. Growth, investment and exports

The growth performance of developing economies depends on the organization of the existing international financial architecture. Given the limitations of their productive structure, developing economies depend to a great extent on the availability of foreign exchange to cover their short and especially their long-term development needs. These include imports, interest payments as well as profit transfers. Given that they do not issue a reserve currency —a means of payment universally accepted— developing countries must earn foreign exchange through trade and by tapping on international capital markets. (See Pérez Caldentey and Moreno Brid, 2019).

Developing economies need to import capital equipment, machinery, raw materials and inputs such as oil and natural gas to build up their infrastructure, improve their productive capacity and increase their growth potential. As a result, their economic performance depends on the extent to which they can dispose of sufficient foreign exchange to finance their goods and services. In other words, their exports and their inflow of foreign capital must be commensurate to meet the import needs compatible with their requirements for social and economic development.

The balance-of-payments-constrained growth literature argues that the long term rate of growth is determined by the combined influence of its import requirements, the demand and composition of the economy, its exports, its capacity to attract the foreign capital and the evolution of the real exchange rate.

The balance-of-payments constrained rate of growth is expressed as:

$$(1)\ y_{bpc} = \frac{\theta\varepsilon z + (1-\theta)(f - p_d) + (1 + \theta\eta + \psi)(p_d - p_f - e)}{\pi}$$

Where,

z= rate of growth of the rest of the world; p_d, p_f, e= rates of growth of the domestically produced good, of the imported good and of the nominal exchange rate; η, ψ= price elasticities of demand for exports and imports; $(\eta, \psi < 0)$;ε, π = income elasticities of demand for exports and imports, $(\varepsilon, \pi > 0)$; $f - p_d$= rate of growth of financial flows in real terms; $\theta, (1-\theta)$= the share of exports as a proportion of total receipts (exports and financial flows (these include unilateral current transfers)).

Eq. (1) shows that balance-of-payments constrained growth depends on four sets of factors: external growth ($\theta \varepsilon z$), the rate of variation in relative prices (i.e., price competitiveness) $(1 + \theta\eta + \psi)(p_d - p_f - e)$, growth in financial flows $(1-\theta)(f - p_d)$, and the income elasticity of imports (π).

Developing countries must grow at rates commensurate with these external requirements. It is in this sense that they are balance of payments constrained. More precisely "countries face an external constraint when their performance in foreign markets and the response of the financial markets to this performance restrict growth to a rate lower than external conditions require".[2] The BOP constraint implies that the economy grows at a rate lower than the one compatible with full employment.

Or what is the same thing, long-term growth of an economy is balance-of-payments constrained if the rate of growth consistent with a balanced current account or more precisely with a balanced basic balance (current account plus net long-term flows) fall below the rate of growth determined by the maximum expansion of output from the supply side. This includes the growth of the labor force, the rate of accumulation of fixed capital, and the rate of growth of technical progress as a function of the rate of growth of output and Verdoorn's Law (McCombie, 2009). That is,

$$(2)\ y_p > y_{bpc} \geq y_a$$

Where y_p = growth in productive capacity (the maximum growth rate determined by supply);y_a = the rate of growth of current output; y_{bpc}= the rate of growth consistent with balance-of-payments equilibrium.

Balance-of-payments constrained growth implies the existence of excess capacity, low rates of accumulation and of technical progress and the existence of unemployment and underemployment. The degree and binding character of the balance-of-payments constrained depends on the characteristics of a given economy as well as of the existing external context. In fact, the external constraint manifests itself with particular strength, in those countries that do not issue a reserve currency but that are highly dependent on it for their productive development.

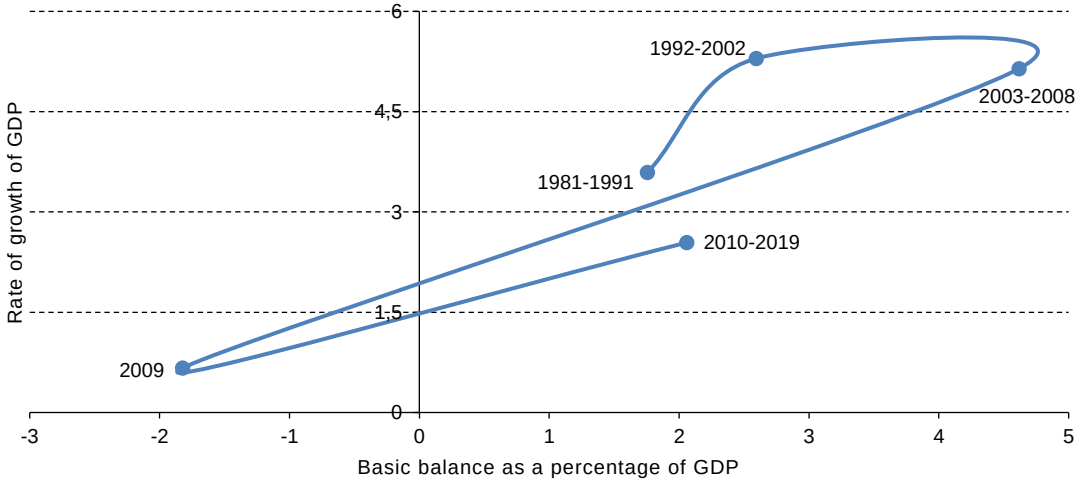
The most accurate expression of the balance-of-payments constraint is the basic balance (the current account plus long-term capital flows). As argued by McCombie y Thirlwall (1994, p. 454): "...the fundamental determinant of the external constraint is the 'basic'account of the balance of payments (i.e. the current account together with long-term capital flows" (See also McCombie and Thirlwall 1988, p. 48 and pp.. 85-86).

There are five ways in which the external constraint on growth can be eased: (i) a permanent increase in the rate of growth in external demand, (ii) a permanent improvement in the terms of trade, (iii) a persistent depreciation of the real exchange rate, (iv) the implementation of policies for structural change in the countries of the periphery, and (v) a permanent increase in the rate of growth in long-term financial flows.

[2] McCombie and Thirlwall (1999, p. 49)

The relationship between the basic balance of the balance of payments and the rate of growth of GDP for Latin America and the Caribbean in the aggregate shown below in Figure 1 for the period 1981-2019, is divided into 1981-1991, 1992-2002, 2003-2008, 2009 and 2010-2019. The figure shows a clear positive association between both variables.

Figure 1
Latin America and the Caribbean, Scatter plot between the rate of growth of GDP and the basic balance as percentage of GDP. 1981-2019
(In percentages)



Source: On the basis on IMF (2020) and ECLAC (2020)

II. The balance-of-payments constraint and the internal conditions for equilibrium

The balance-of-payments constraint approach to growth specifies the conditions for under full employment equilibrium in an open economy. This approach gives pre-eminence to exports over the rest of the autonomous components of aggregate demand. It is the only component of aggregate demand that can sustain an increase in economic growth over time. As put by Thirlwall (2013, pp.36-37):

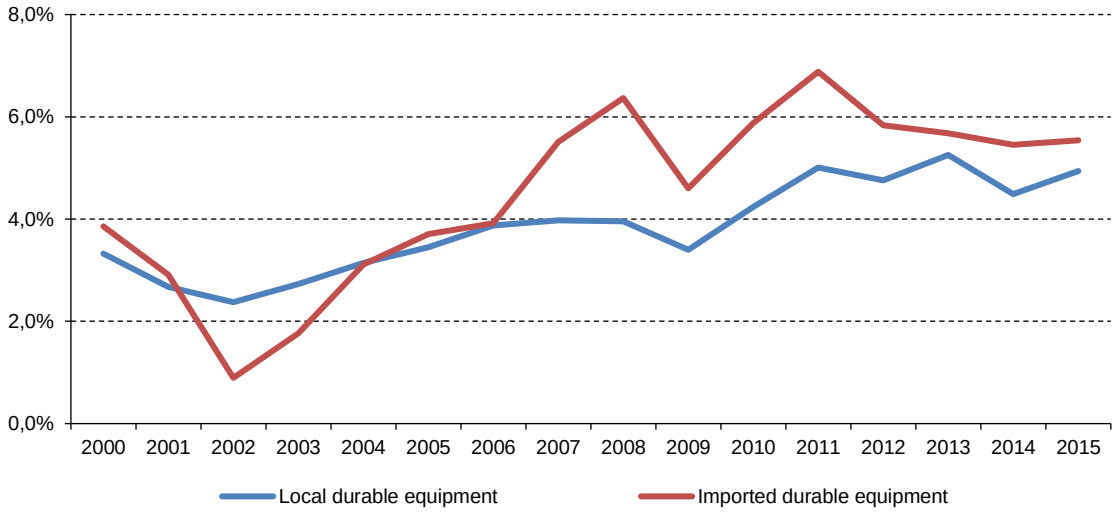
> "...fast export growth allows all other components of demand to grow faster because exports can pay for the import content of consumption, investment, government expenditure and exports themselves. Exports are unique in this respect compared to the growth of other components of aggregate demand. Second, fast export growth allows fast import growth which is important for developing countries that cannot produce for themselves many of the goods, particularly capital goods, required for development. So, fast export growth has both demand and supply- side effects conducive to growth".[3]

In the case of Latin America and the Caribbean, consumption and investment have a very high import content. This is not only the case of the smaller economies such as those of Central America and the Caribbean which due to size conditions and structural features are highly dependent on imports. This is also a characteristic of the larger economies of the region. The case of Argentina provides an illustrative example.

[3] Kaldor, 1981 (1989), p. 85 entertained a similar view "The importance of the Harrodian export/import propensity relation for industrial countries is that it determines how fast manufacturing output will grow, both absolutely and relatively to the GDP as a whole. As he puts it (2002, p. 53): "Exports differ from other components of demand.... Firstly, exports are the only true component of autonomous demand in an economic system, in the sense of demand emanating from outside the system...Secondly, exports are the only component of demand that can pay for the import requirements for growth..."

Figure 2 below shows the evolution of local and imported equipment as percentage of GDP for the period 2000-2015, for Argentina. Throughout most of the period imported durable equipment represents more than 50% of the total.

Figure 2
Argentina: machinery and equipment (local and imported) as percentage of GDP (2000-2015)
(Percentages)



Source: ECLAC (2018)

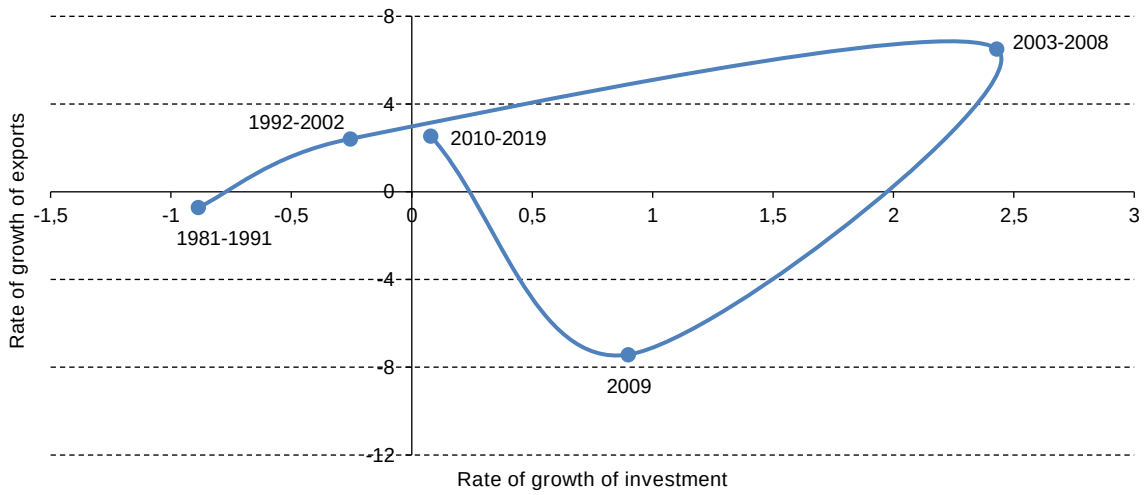
The close association between exports and investment is also revealed by the positive and association between both variables for the period 1981-2019 (Figure 3). These arguments point to a more general interrelation and compatibility between the conditions of internal and external demand.

More precisely, in an equilibrium position such as that defined by the balance-of-payments constraint approach to growth, the flow of income generated internally and that derived from external demand cannot be independent of each other. Either internal demand adjusts to conform with the external performance, or the other way around. (Godley and Cripps, 1883)

In the balance-of-payments constraint growth approach, internal conditions adapt to those of the external sector. This important idea is implicit in the balance of payments constraint approach (Thirlwall, 2002, p. 53: "If there are no export earnings to pay for the import content of other components of expenditure, demand will have to be constrained") but is rarely made explicit in the formal derivation of the model.

The following section suggests the need for an approach to specifying the domestic conditions, and in particular, the internal growth requirements, that are compatible with external sector equilibrium within the balance-of-payments constrained growth model.

Figure 3
Latin America and the Caribbean: Scatter plot between the rate of growth of exports and gross formation of fixed capital. 1981-2019
(Percentages)



Source: On the basis on IMF (2020) and ECLAC (2020)

III. Internal growth requirements consistent with the balance of payments constraint

Since the balance-of-payments constraint to growth establishes the conditions for long-run equilibrium, a useful starting point to define the internal growth requirements consistent this equilibrium, is to approach investment from its potential to create productive capacity. By definition, the rate of growth of productive capacity (p) is equal to the rate of growth of the supply of output (y^s). In turn the rate of growth of the supply of output can be expressed as being equal to the ratio between the investment coefficient (i) and the output-capital ratio (σ). That is,

$$(3)\ p = \ y^s = \frac{\delta Y^s}{Y^s} \equiv \frac{\frac{\delta K}{Y^s}}{\frac{\delta K}{\delta Y^s}} \equiv \frac{\delta K}{Y^s} * \frac{\delta Y^s}{\delta K} \equiv i\sigma$$

Where, δY and δK = increase in output and capital; and $\delta K = I$(investment); $i = \frac{\delta K}{Y} =$ investment coefficient; $\sigma = \frac{\delta Y}{\delta K} =$marginal output-capital ratio (Eltis, 2008)

We can then postulate that the rate of growth of output viewed from the side of expenditure (that is from the demand side) (y^d) is equal to the rate of growth of productive capacity (p) multiplied by the rate of capacity utilization (μ). The rate of capacity utilization is greater than 0 and smaller than 1. This is in line with the existence of slack capacity and unemployment which is part of the balance-of-payments constrained approach to growth (the rate of growth of demand is below the rate of growth of productive potential). That is,

$$(4)\ y^d = \ \mu p$$

Where, $\mu = rate\ \ of\ capacity\ utilization$; y $= rate\ of\ growth\ of\ output.$

$$1 > \mu > 0$$

Combining Eqs. (1) and (2) gives the equality between the rate of growth of supply (y^s) multiplied by the rate of capacity utilization (μ) and the rate of growth of demand (y^d),

$$(5)\ y^d = \mu y^s$$
$$\Leftrightarrow y^d = \mu i \sigma$$

According to Eq. (3) the rate of growth of demand (y^d) is equal to the product of the investment coefficient and the capital-output ratio ($i\sigma$) 'weighted' by the rate of capacity utilization (μ).

To finalize this model, following the balance-of-payments constraint approach, the rate of growth of output (from the demand side) can be postulated as depending on the fulfillment of equilibrium in the external sector. That is,

$$(6)\ y^d = y_{bpc} = \frac{\theta\varepsilon z + (1-\theta)(f - p_d) + (1 + \theta\eta + \psi)(p_d - p_f - e)}{\pi}$$

Combining Eqs. (3) and (4) yields the internal growth requirements that are consistent with the balance of payments approach to growth. That is,

$$(7)\ \mu i\sigma = \frac{\theta\varepsilon z + (1-\theta)(f - p_d) + (1 + \theta\eta + \psi)(p_d - p_f - e)}{\pi}$$

Following the general assumption that the current account is initially equal to zero, that is $\theta = 1$the exchange rate (E) is a constant and equal to 1 so that e =0 and domestic prices approximate foreign prices ($p_d = p_f$), the balance of payments constrained rate of growth is expressed as a function of the rate of growth of world income (y_{RW}) and the income elasticities for exports (ε) and imports (π). Thus, the conditions for the internal growth requirements to equal the rate of growth of output consistent with balance-of-payments equilibrium can be simplified to yield

$$(8)\ \mu\sigma i = \frac{\varepsilon}{\pi} y_{RW}$$

Where,

$$y_{RW} = rate\ of\ growthof\ world\ output$$

$$\varepsilon\ and\ \pi = export\ and\ impport\ elasticity\ of\ demand. \varepsilon, \pi > 0.$$

Eq. (8) has several implications worth detailing. Following the logic of the balance-of-payments constraint approach to growth, the investment requirements (i) is the endogenous variable and is a function of the rate of growth of output of the rest of the world (y_{RW}) and of the ratio of the export and import income elasticities ($\frac{\varepsilon}{\pi}$). It follows, that the greater is the rate of growth of the rest of the world (y_{RW}), the greater is the investment ratio (i) for any given level of capacity utilization (μ) and output-capital ratio (σ). That is demand drives investment.

Also, any change in the parameters in the left-hand side of eq. (6), whether it be in the rate of capacity utilization (μ) or in the output-capital ratio (σ) requires a change in the right-hand side of eq. (6) in either the rate of growth of output in the rest of the world (y_{RW}) or in the ratio of elasticities ($\frac{\varepsilon}{\pi}$). An increase (decrease) in the output-capital ratio (μ) implies improved (less) efficiency in the production of output as less (more) capital is needed to produce one unit of output and this implies necessarily a concomitant change in the elasticities ratio (either in the import or export income elasticity or through a combination of both).

Similarly, an increase in the capacity utilization rate (μ)can only be accommodated by an improved external performance. It can be postulated, for example, that the utilization capacity rate can be a function of fiscal policy and in particular of the rate of growth of government expenditure (g) relative to the rate of growth of the tax rate (τ).

$$(9)\ \mu = \frac{g}{\tau}$$

Substituting Eq. (9) in (8) yields,

$$(10)\ \sigma i\left(\frac{g}{\tau}\right) = \frac{\varepsilon}{\pi} y_{RW}$$

As shown in Eq. (6) an expansionary fiscal policy $\Delta\left(\frac{g}{\tau}\right)$ for a given investment ratio and output-capital ratio (σi) can be effective only to the extent that the external sector permits.[4]

Table 1 below provides an empirical corroboration of the relationship between investment requirements and the balance-of-payments constraint Eq. (8) for a selected group of economies of Latin America on the basis of available data for the period 1993-2017. The data for the income elasticity of imports and exports was obtained from ECLAC through econometric estimations. The output-capital ratios were obtained from the World Penn Tables. The rate of capacity utilization was assumed to be 0.7. As can be seen for the estimations, the investment ratio tends to to be near the actual investment ratio.

Table 1
Results of the estimation of investment requirements that are consistent with the balance-of-payments constraint for a selected group of Latin American economies. 1993-2017
(Percentages)

Countries	Effective Real Investment Growth (mean 1993-2017)	Estimated Real Investment Coefficient	Observed Real Investment Coefficient (1993-2017)	1/COR 1993-2017	Rate of growth of the rest of the world 1993-2017	Capacity utilization	Elasticity ratio (1993-2017)
Argentina	3.1	8.8	18.0	0.4	3.7	0.7	0.6
Brazil	2.4	9.7	18.7	0.3	3.7	0.8	0.6
Chile	6.3	20.8	23.7	0.4	3.7	0.7	1.4
Colombia	5.0	18.5	21.1	0.3	3.7	0.7	1.0
Ecuador	4.0	20.6	23.7	0.2	3.7	0.7	0.9
Guatemala	3.2	10.1	16.2	0.4	3.7	0.7	0.9
Honduras	4.1	20.7	27.2	0.3	3.7	0.7	1.4
Mexico	2.1	12.3	22.6	0.3	3.7	0.7	0.8
Nicaragua	4.2	27.7	26.4	0.3	3.7	0.7	1.4
Panama	9.6	19.5	36.3	0.5	3.7	0.8	1.9
Peru	6.5	22.4	21.6	0.3	3.7	0.7	1.4
Paraguay	2.5	16.4	21.1	0.3	3.7	0.7	1.0
El Salvador	1.8	11.6	17.8	0.5	3.7	0.7	1.1

Source: The elasticity coefficients were obtained from ECLAC's Division of Productive Development. The data for investment and the rate of growth of the rest of the world was obtained from the World Bank Development Indicators (2020). Data for Capacity Utilization and COR were obtained from the World Penn Tables.

[4] This conclusion can also be derived from Godley's stock-flow framework: "In the long run fiscal policy can only be used to sustain growth of real income and output in an open economy provided that foreign trade performance so permits. This is the most practical conclusion of our book." See, Godley and Cripps, 1983; and also Godley and Lavoie, 2007.

IV. A stock-flow approach to investment requirements

In order to have a better grasp of the interrelations between the internal and external conditions for growth, this paper develops a model built on two traditions in economic theory, that of stock-flow modeling developed by Wynne Godley and his associates (see, Godley and Cripps 1983; Godley and Lavoie, 2007) and the balance-of-payments constrained approach to growth developed mainly by Thirlwall and McCombie (Thirlwall, 1979; Thirlwall and McCombie, 1994). More precisely, the model presented intends to reflect the behavior of a peripheral economy in which growth is guided and restricted by the external sector. (See Perez Caldentey, 2007)

The stock-flow modeling tradition builds on 'a fundamental law in macroeconomics,' namely that stocks and flows must satisfy both the constraints of individuals and of the economy as a whole so that all constraints are mutually compatible.[5] These constraints are satisfied through the workings of definite relationships between both flows and stocks.

The approach proceeds from the logic that only certain configurations of transactions are mutually compatible for all economic agents. As a result, stock-flow modeling generally begins by specifying transactions, flow-of-funds and balance sheet matrices for a given set of economic sectors and variables. The transactions matrix deals with flows; the flow of funds and balance sheet matrices deal with stocks. Once the overall consistency is guaranteed, the approach proceeds to make behavioral assumptions about agents and parameters which allow the specification of a model.

The interaction between stocks and flows is crucial and the model must be solved in a sequential manner. In particular in this model, income flows, guided by fiscal and foreign trade performance, play the equilibrating role between the change in the stock of assets of the private sector and the sum of its sources.[6] In turn, stocks feedback on flows. The extent to which stocks can influence flows will depend

[5] See, Godley and Cripps (1983), p.18.
[6] Ibid. p.292.

on whether the combined effects of fiscal and foreign trade performance lead to an increase or a reduction in the net assets of the private sector.

The framework is presented in the form of stock-flow matrices that incorporate transaction between different agents (that is flows) and their corresponding balance sheet holding gains or losses (that is stocks). The rows of the matrices represent money transactions between agents for each good, service or asset considered in the model. A negative sign in a row signifies a source of expenditure and a positive sign a destination of expenditure. As a result, as Godley (1999, p. 394) points out "every flow comes from somewhere and goes somewhere." Thus to provide a consistent macroeconomic framework all rows must sum up to zero. The columns are defined by the sectors or agents considered in the model and represent their budget constraint. For this reason, they must also sum up to zero. The counterpart of the budget constraint of each sector is the generation of changes in stocks of assets and liabilities. These appear as changes in agents' balance sheets.

The stock-flow framework has several characteristics worth detailing. First, it is a consistency framework and thus does not require satisfying particular 'ex ante'equilibrium conditions. Second, as pointed by Backus et al. (1980), the money flows of goods, services and assets refer to sales and purchases during a discrete period of time (a quarter or a year). In this sense, the construction of the matrix allows for the introduction, in a given period, of patterns of evolutionary change. That is, it is an open system (Dow and Chick, 2002). From the reasoning underlying both these reasons, it follows that the framework does not impose an excessive burden on deductive reasoning but rather seeks to highlight the compatibility of defined configurations of transactions Godley (1983, p. 44).

The institutional and behavioral workings of the stock-flow framework model are as follows. The stock flow framework is divided in three sub matrices. The first shows the money transactions (a minus sign indicates the origin of a monetary flow and a plus sign the expenditure) of the economic agents. Their sum of rows is equal to 0. The second sub matrix represents the flow of funds (or savings), which is the counterpart of the transactions matrix. The columns of the transactions and flow balances sum up to zero. The third sub matrix is a stock matrix. It shows the balance sheets of the agents (or their accumulation accounts).

The framework considers one country, say country A and the rest of the world (i.e., external sector). The country in question comprises, in turn, five agents' households, firms, government, commercial banks and the external sector. Following (Tobin (1969 and Godley, 1999) the framework treats the capital and current account separately for firms. The capital account includes assets and debts and the current account production and income flows. (See table 2)

Table 2
The stock-flow matrix

Transactions matrix										
Private Sector							Public Sector		External Sector	$\sum$
		Households	Firms		Banks					
			Current	Capital	Current	Capital	Current	Capital		
[GDP]	Consumption	$-C_d$	$+C_s$							0
	Public Expenditure		$+G_s$				$-G_d$			0
	Investment		$-I_d$	$+I_s$						0
	Export		$+X_s$						$-X_d$	0
	Import		$-M_d$						$+M_s$	0
	Inventories		$+\Delta in_d$	$-\Delta in_d$						
	Taxes	$-T_s$					$+T_d$			0
	Wages	$+W_d$	$-W_s$							0
Interest on	Deposits	$+r_d(m_s^h)$	$+r_d(m_s^f)$		$-r_d(m_d)$					0
	Banks Bonds				$-r_{db}(D_{b_S})$		$+r_{db}(D_{b_d})$			0
	Treasury Bills				$+r_b(Bb_d)$		$-r_b(B_S)$		$+r_b(Brow_d)$	0
	Loans	$-r_l(Lh_d)$	$-r_l(Lf_d)$		$+r_l(L_s)$					0
	External Bonds						$+\left(r_{exb}(B_{ex_d})\right)$		$-(r_{exb} * B_{ex_s}) * E$	0
	Dividends	$+FD_{F_d} + FD_{b_d}$	$-FD_{F_d}$		$-FD_{b_d}$					0
Financial Balance			FB_h		FB_f	FB_b	FB_g		FB_{ex}	0
Flow of Funds										
Deposits		$-\Delta m_h$		$-\Delta m_h$		$+\Delta m_h$				0
Banks Bonds						$+\Delta D_{b_S}$	$-\Delta D_{b_S}$			0
Treasury Bills						$-\Delta Bb$		$+\Delta B$	$-\Delta Brow$	0
Loans		$+\Delta Lh$		$+\Delta Lf$		$-\Delta L$				0
External Bonds								$-\Delta B_{ex}$	$+\Delta B_{ex}$	
$\sum$		0	0	0	0	0	0	0	0	0
Balance Sheet Matrix										
Deposits		$+m_h$	$+m_h$		$-\Delta m_h$					0
Treasury Bills					$+Bb$		$-B$		$+Brow$	0
Loans		$-Lh$	$-Lf$		$+L$					0
Capital			$+K$							$+K$
External Bonds (Foreign Assets)							$+B_{ex}$		$-B_{ex}$	0
Wealth		$-Vh$	$-Vf$		$-Vb$		$-Vg$		$-Vex$	$-K$

Source: Authors' own.

V. A brief description of the behavior of the agents of the stock-flow model

A. Households

Households are described under a simple scheme, where consumption decisions, debt taking, and deposit-taking are represented based on current, past, and of course, expected income behavior. In this model, deposits are assumed to be the only asset in the hands of households. Therefore, there is a direct one-to-one relationship between deposits and household wealth. Households do not engage into arbitrage activities, and the interest rate relating to credit or deposits does not have a direct influence on the determination of real consumption. Concerning credit, it is assumed that it is demanded by households to finance consumption in excess of current disposable income.

Consumption decisions depend on expected income, and wealth, as described in the consumption equation. For its part disposable income is a weighted average of past and present disposable income multiplied by the rate of growth of productivity

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Table 3
Main equations for the household sector

Real consumption	$c = \alpha_1.(yd^e) + \alpha_2.(v\_1)$
Expected real regular disposable income	Wealth.$yd^e = \varepsilon.yd + (1-\varepsilon).(yd_{-1}).(1+gr^{pr})$

Source: Authors' own.
Where c = consumption; yd^e, yd= expected and actual disposable income; gr^{pr} = rate of growth of productivity. v = wealth.

B. Firms

The Firm is the institutional sector, which produces the real output of the economy.

The equations depicting the behavior of the firms are classified into four groups: real output, costing decisions, pricing decisions, and financial relations of the firm. This sector is represented in the second column of the Transaction Flow Matrix. The main equations of this sector are especially those that define the behavior of production and those of aggregate demand. Unlike Godley and Lavoie, the expectations of this economy are closely related to the development of the external sector.

Real output equation describes the actual production of each year, which is expressed as the sum of expected sales plus the difference between expected and maintained inventories in the previous period. The introduction of inventories, together with the treatment of employment within the model implies that the economy usually operates below full employment of its factors.

The expected sales of the economies are described in Expected real sales equation, where these are a function of a weighted average of both present and past sales, including variations in exports as a proxy for the behavior of the firms' expectations, as well as random shocks in the external sector.

On the other hand, it is important to include the investment function restricted by the balance of payments, which was developed above, and which remains the novel element within this model approach.

Table 4
Main equations for the firm sector

Real output	$y^s = s^e + in^e - in_{-1}$
Expected real sales	$s^e = ß \,.\, s + (1 - ß) \,.\, s_{-1} \,.\, (1 + \frac{\Delta x^d}{x_1^d} + ra)$
Investment Function	$i = \left(\eta_1 . \frac{g_{ex}}{\eta_4}\right) . \left(\frac{s_{-1}}{u.outputrate}\right)$

Source: Authors' own.
Notes: $y^s = real\ output$; s^e= expected real sales; in^e =long-inventory target; in = actual real inventories; s =actual real sales; i= real gross investment; x^d = real export demand; ra=random shocks; g_{ex} = growth of the rest of the world; u= capacity utilization.

C. Government

In this model, the government refers to the consolidated public sector. The central bank is part of the government. This sector maintains several important roles in the dynamics of the model. It functions as a lender to the commercial bank. It generates public expenditure but only through direct purchases from firms. There are no transfers to households, nor is cash held as an asset in the economy. The government issues bills to finance its deficits and buys foreign bonds (equivalent to international reserve assets) in which to invest its surpluses.

The most important equations for the government sector describe the public sector deficit dynamics. The public sector deficit is determined by the difference between government sector expenditures (public spending and interest payments on bills issued in the previous period) and its revenues (taxes and returns on foreign assets). The issuance of bonds is determined by the stock of public bonds plus the variation of the deficit if it is greater than zero. For its part the purchase of external bonds depends on the public deficit being less than zero (that is on a surplus).

Table 5
Main equations for the government sector

Public deficit	$DP = G + r_{b_1} . (B_{bs_{-1}} + B_{rows_{-1}}) - T - (r_{bex_{-1}} . B_{ex})$
New issues of bills	$B_s = B_{s_{-1}} + DP \; If \; B_{s_{-1}} + DP > 0$
	$B_s = 0 \quad If \; B_{s_{-1}} + DP \leq 0$
Demand for external bonds (Assets)	$B_{ex_d} = B_{ex_{d_{-1}}} + B_{s_{-1}} + PD \quad If \quad B_{s_{-1}} + PD > 0$
	$B_{ex_d} = B_{ex_{d_{-1}}} \quad If \quad B_{s_{-1}} + PD \leq 0$

Source: Authors' own.
Notes: $DP = public\ deficit$; $G = government\ expenditure$; r_{b1} = interest rate on bonds; B_{bs-1}, B_{rows-1} = issue of public bills; B_s = new issues of bills; T = taxes; B_{ex} = stock of foreign assets; $r_{bex-1} = interest\ earned\ on\ the\ stock\ of\ foreign\ assets.$ B_s = issue of new bills.

D. Commercial Banks

Money is the model is endogenous and the commercial banking sector responds passively to the demand for loans from households and firms, and it finances its negative balances through the issue of bonds bought directly by the government. Given that the role of this sector is secondary, it is not considered necessary to explain in detail the equations that determine its behavior.

E. Rest of the World

The institutional sector of the rest of the world is fundamental in this model since its behavior determines that of the domestic economy. More specifically, the external sector places a ceiling on the expansion of domestic absorption. The external sector is directly related to the firm through the trade balance and interest payments. It is related to the government through the current and capital accounts via capital flows, either through the purchase of domestic bills or sale of foreign assets.

In line with the balance-of-payments constraint approach to growth the dynamics of this sector is described by a set of equations in which overall GDP growth is taken as exogenous. Also, the import and export demands are specified as multiplicative functions of domestic and external income and of the real exchange rate.

In addition to the equations of export and import demand, it is important to mention the equation that defines external debt, whose variation is equivalent to the current account result but with the opposite sign. Finally, exchange rate variations are determined by the sensitivity of the excesses demand of international assets relative to the foreign assets supplied for the domestic economy.

Table 6
Main equations for the rest of the world

External debt	$B_{row} = B_{row_{-1}} - X^d + M^d + r_{b_{-1}} . (B_{row_{-1}}) - (r_{bex_{-1}} . b_{ex_{-1}}) . E$
Exchange rate	$E = E_{-1} . (1 + \alpha^E)$
Variation rate of the exchange rate	$\alpha^E = \alpha_0^E . (\frac{B_{ex_{d_{-1}}}}{E_{-1}} - B_{ex_{S_{-1}}})$

Source: Authors' own.
Notes: B_{row} = debt of the public government; M^d = import demand; X^d = export demand; r_{b1} = interest rate on bonds; b_{ex} = stock of foreign assets; $r_{bex-1} = interest\ earned\ on\ the\ stock\ of\ foreign\ assets.$ B_{exd} = demand for external bonds; B_{exs} = supply of external bonds; E = nominal exchange rate;

VI. The logic and causality of the model and some simulation results

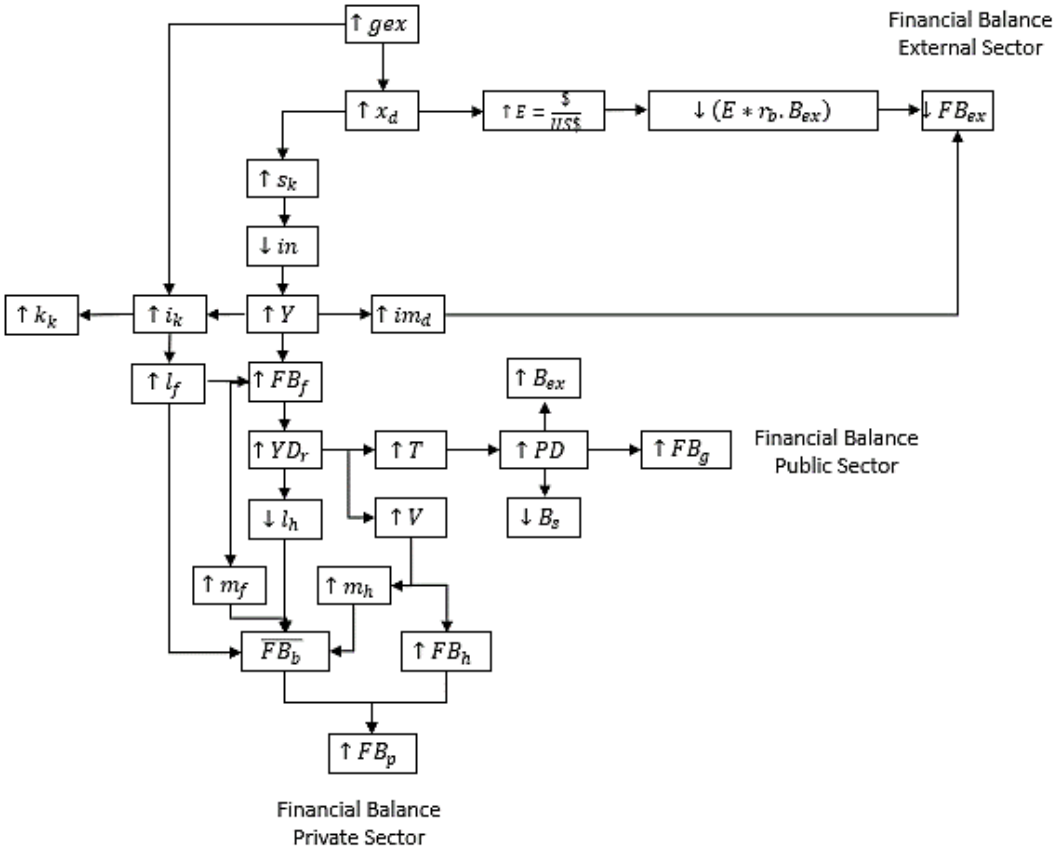
The underlying logic and causality of the model is depicted in Figure 4. It shows, how the dynamics of the model are generated by the growth of the rest of the world.

First, there are two direct channels through which the performance of the external sector determines the behavior of the domestic economy: the export and the investment channel. Exports have a direct impact on the exchange rate, which in turn has an impact on the returns on foreign assets held by the government, and thus an impact on the financial balance sheet of the external sector.

Exports also affect the level of aggregate demand in the economy, which impacts the stock of inventories and the economy's GDP as a whole, which in turn affects investment and real demand for imports.

It should be understood that part of the relationship between GDP and import demand is explained by investment, although this is not made explicit in figure 4. Changes in investment also have an effect on the capital stock of the economy. And imports also affect the balance sheet result of the external sector. Similarly, changes in the economy's output affect both the current level of employment as well as the full employment levels, since it is assumed that the latter depends in part on the economy's growth rate, as do other variables such as average labor productivity.

Figure 4
The functioning logic and causality of the model



Source: Authors' own.

Changes in real investment modify the level of loans demanded by firms. Variations in the economy's total income jointly with changes in loans impact the financial balances of firms, including the variations in business profits and therefore dividends, which impact the regular disposable income, which then directly affects the total tax collection as well as the wealth of households, and the loans demanded by households to finance their consumption.

Wealth in turn defines household deposits while firm deposits are affected by firm profits and firm loans. Ultimately, loans and deposits determine the financial balance of the commercial bank sector. On the other hand, the financial balance of households is the result of the direct effects of deposits and wealth, and the indirect effects associated with the latter. In turn, both balances define the financial balance of the private sector. Tax revenues impact the public deficit, which determines, in part, on the demand for international assets, and the issue of public bonds. This then determines the financial balance of the public sector.

The simulation of the model was performed using actual data for world GDP growth between 1960 and 2010 (World Bank, 2020). The observed values were introduced year by year to analyze the behavior of the model within a specific period. Thereafter, the average growth rate was maintained at a constant level. Based on this and the solution of the model, the behavior of the economy for the period 1960-2017 is estimated.

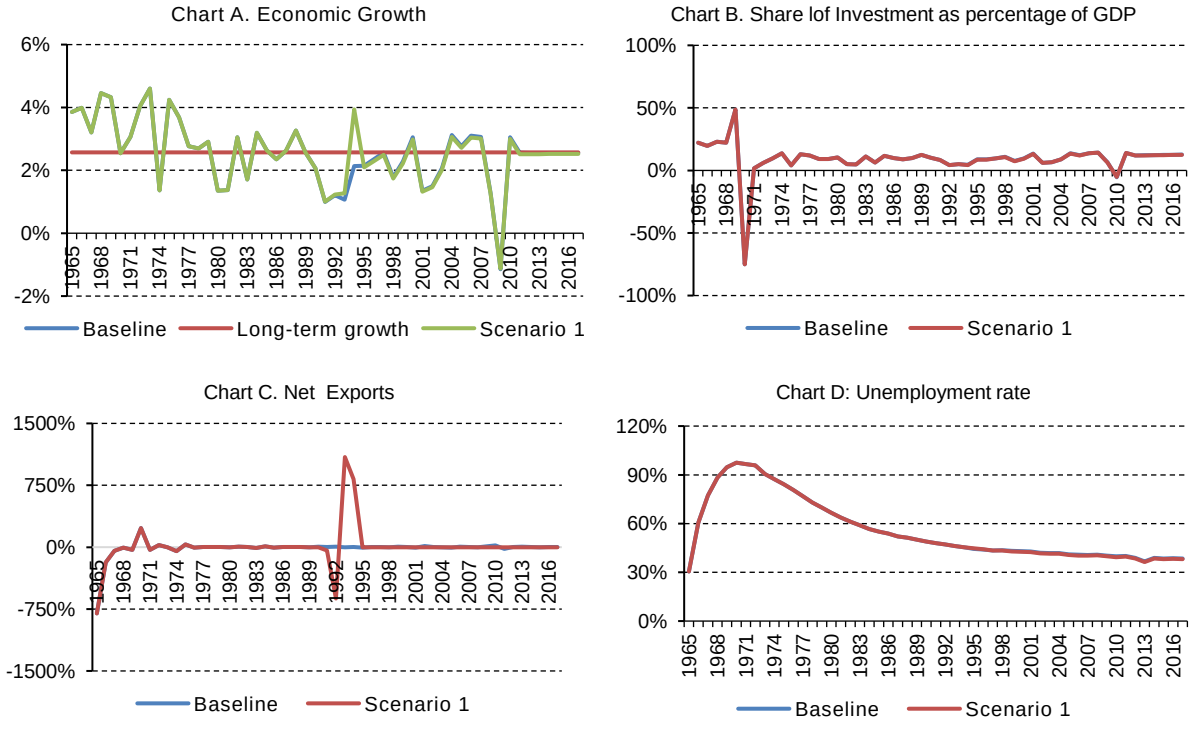
To illustrate the workings of the model, a counter cyclical government expenditure experiment was performed. This consists in the increase of public expenditure equivalent to a rate of 8 times the initial value. This exogenous shock is applied for the period between 1989-1994. In the baseline scenario, the growth rate of public expenditure was zero.

The behavior of four relevant variables in both the baseline scenario and scenario 1 (change in the rate of variation of public expenditure) are simulated in Figure 4 below. These include economic growth, the share of investment relative to GDP, the variation of net exports, and the unemployment rate.

The simulations show in the first place that the rate of growth of the steady-state is equivalent to Thirwall's law. That is, the rate of growth of the economy consistent with the balance of payments equilibrium is equal to the equilibrium growth. So even if we introduce the observed series of world growth, the behavior of the estimated economy is consistent with the theoretical approach of growth constrained by the balance-of-payments (figure 5, chart A).

As for the investment constrained by the balance of payments, a consistent behavior is observed, so that levels of economic growth above the long-term growth rate can induce high rates of participation of investment with respect to GDP. However, these are unsustainable, insofar as an important component of gross capital formation depends on the imports, an element that is reflected in the demand of imports (figure 5, chart B). As a result an excessive increase in investment results in an abrupt adjustment processes, as has been the historical case of peripheral economies, including those of Latin America and the Caribbean.

Figure 5
Simulation results for growth, investment as percentage of GDP, variations in net exports and the unemployment rate
(Percentages)



Source: Authors' own.

For its part, the variation in net exports in the baseline scenario remains consistent and tends to a level of equilibrium (figure 5, chart C). As far as the unemployment rate is concerned, the economy is very sensitive to decelerations in the rate of growth of the economy so, starting from a fairly low unemployment rate, the jobs destroyed by the process of deceleration of the economy are very important. However, the unemployment rate in the long term tends to stabilize and as the economy approaches its long-term growth the unemployment rate tends to equilibrate at a level consistent with the balance of payments equilibrium (figure 5, chart D).

As shown by the behavior of the four variables that are simulated, the impact of a counter cyclical fiscal policy irrespective of its importance is consistent with the underlying theory. Although it can generate a positive and important effect on growth, the impact on the share of investment as a percentage of GDP is very small, and given the implications on the debt burden and public deficit, it even implies that the impact on investment is below the level of the shock itself. For its part, the effect on net exports is quite conclusive, an increase in spending that is not explained by a growth in demand for exports translates into a statistically significant increase in imports which translates into a deficit. After adjusting the growth of public spending to its previous levels, net exports become positive, mainly due to the fall in imports. Finally, the impact on the unemployment rate is not statistically significant in its impact on growth, in part because a significant proportion of the additional demand leaks through imports.

In guise of conclusion, the simulation of this small and open economy using a Stock-Flow Consistent Model is consistent with the proposed conceptual framework that integrates the balance-of-payments constraint approach to growth with investment requirements developed in section 4 of this paper. On the one hand, Thirlwall's law continues to be a good approximation to the long-run equilibrium growth rate, and the investment function is constrained by the balance of payments. A good approximation to the behavior of this latter variable in peripheral economies is achieved, a result that reflects the close and inter wined relationships between the conditions of the productive structure and the impacts of the different components of aggregate demand.

Finally, it should be mentioned that within the underlying logic of the model public expenditure per se does not improve the growth of the economy, nor does it become a significant impact on gross capital formation. Increases in government expenditure can be effective as a means to expand growth as long as the external sector validates this policy. This result is in line with that put forward by Godley and Cripps (1983, p.283):"...in the long run fiscal policy can only be used to sustain growth of real income and output in an open economy provided that foreign trade performance so permits. This is the most practical conclusion of our book."

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Annex

Table A1
Literature review of stock-flow modelling with an external constraint to growth

Author	Region/Country	Kind of model	External Sector	Conclusions
Barbosa (2001)	Brazil	Growth	Thirlwall's Law thit liquidity constraint.	"Small open economies tend to adjust their current account, especially their trade balance, to the availability of external finance"
Bortz (2014)	Argentina	Growth	Two Economies	["The] results point towards the dismissal of the 'twin deficit' view, and support an active management of the exchange rate, in light of contradictory effects of fixed and flexible exchange rate regimes, according to the circumstances"
Campero Encinas (2019)	Bolivia	Growth	NA	The external shocks on hydrocarbons and minerals have low effects over the economy as consequences of the industrialization of these sectors.
Cano Ortiz (2019)	Colombia	Growth	ROW Linked with elasticities	A fiscal rule over the Government's structural deficit reduces the effects of external shocks on fiscal balance but increase negative effects over the aggregate demand.
Escobar (2016)	Colombia	Growth	ROW Linked with elasticities	A twin déficit is observed between the private and external sectors. There isn't evidence the corroborate that improves the American economy implied to improve the external outcome of the Colombian economy.
Fernández (2017)	Ecuador	Static	ROW with the same currency	The effects observed of fiscal policy are the common expected, but the reduction of public expenditure has more consequences on aggregate demand.
Nascimento & Silva (2016)	Brazil	Growth	NA	The results obtained "indicating they depend both on the neo-Kaleckian investment functions and on the simplifying assumptions that, a priori, create nirvanic financial conditions for the rentier class"
Guevara Castañeda (2017)	Colombia	Static	NA	The increase in the interest rate produces a redistribution of income from low-income households to households with top income.
Kappes & Milan	Brazil	Static	NA	"The a priori more expansionist (or less contractionist) rules present higher growth rates, ex post; there is an inverse relationship between government debt and firms' debt, with the former being higher under the first rule, and lower in the balanced budget rule, the opposite happening in the case of firms' debt"
Mazzi (2013)	Brazil	Growth	Thirlwall's Law with capital flows.	The impact over the economy of capital inflow dependent on the kind capital.
Mellini (2018)	Brazil	Growth	Twin Deficits	The hypothesis of twin deficits is corroborated and refute the statement about negative consequence by an increase in fiscal stance.
Michelerna & Guaita (2017)	Argentina	Growth	Thirlwall's Law	Increases of public expenditure generate positive effects over economic growth, but these increases are restrained by external constraints.
Perez Caldentey (2009)	CARICOM	Growth	Thirlwall's Law	"The model highlights the binding character of the external constraint and argues that government expenditures do not necessarily result in low growth or high debt levels. The outcome depends on the interaction between government, external, and the private sector, an interaction that is the basis for stockflow modelling"
Telechea (2018)	Latin America	Growth	Twin Deficits	The outcomes confirm the hypothesis of twin deficit with causality from external balance to fiscal balance.
Valdecantos (2016)	Latin America	Static	Thirlwall's Law	The impact of a different kind of external shocks over Latin American economies is dependent on the type of productive structure of themself.

Source: Authors' own.

According to the balance-of-payments constrained growth model, an expansion of aggregate domestic demand is effective in increasing the long-run rate of growth of an economy to the extent that the performance of the external sector validates it. While the performance of the domestic economy is intertwined with that of the external sector, the balance-of-payments constraint on growth does not make these relationships explicit. This document addresses this issue and proposes a framework to make explicit the investment requirements with balance-of-payments constrained growth. This is done in two steps. The document first develops a theoretical framework to explicitly bring to light the investment requirements consistent with the balance-of-payments constraint. Second, it proposes a stock-flow model comprising five sectors (households, firms, government, commercial banks, and the external sector) to analyse the relationships between the external sector and commercial banks and the performance of the domestic economy, including investment.

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LC/TS.2020/152