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New advances and controversies in the framework of balance-of-payments-constrained growth

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Abstract

This article surveys selected recent contributions and debates regarding fundamental aspects of the theory of balance-of-payments-constrained growth (BPCG). The survey focuses mainly on studies, from roughly the period since 2010, in four broad (and related) areas: whether and how relative prices and the real exchange rate affect export performance and long-run growth; the role of endogenous technological progress; the causes and consequences of structural change; and the dynamics of adjustment toward (or cycles around) a long-run growth equilibrium with a balance-of-payments constraint. The discussion also highlights the increasing incorporation of insights from other theoretical traditions (Kaleckian, Kaldorian, Schumpeterian, Goodwinian, and structuralist) into the BPCG framework. The survey suggests the need to clarify the underlying assumptions and policy implications of the BPCG model and to complement its focus on long-run growth rates with analyses of medium-run adjustments and level effects.

KEYWORDS

balance-of-payments-constrained growth, Goodwin cycles, real exchange rate, structural change, Thirlwall's law, Verdoorn's law

JEL CLASSIFICATION

E12, F32, F43, O19, O40

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1 | INTRODUCTION

The theory of *balance-of-payments-constrained growth* (BPCG), first developed by Thirlwall (1979), is a branch of post-Keynesian macroeconomic theory oriented toward long-run growth. The theory is built upon the premise that most countries are constrained to have either balanced trade or a sustainable rate of net capital inflows in the long run, and the further claim that this constraint places binding limits on the long-run rate of expansion of national income in the vast majority of nations. Like other post-Keynesian growth models (see Blecker & Setterfield, 2019; Lavoie, 2014), the BPCG framework assumes that aggregate demand drives output in the long run as well as the short run, while potential output on the supply side is endogenous and adjusts (within limits) in response to demand pressures or shortfalls. Unlike other post-Keynesian models, however, the BPCG approach is distinguished by a focus on external rather than internal sources of demand.

The BPCG framework can also be seen as a specific type of export-led growth model, which emphasizes the role of exports in relieving balance-of-payments (BP) constraints rather than other benefits of export activity (although those other benefits are recognized in some of the recent extensions of the model covered here). In its most parsimonious form, the BPCG model solves for what has become known as "Thirlwall's law": the long-run equilibrium growth rate consistent with BP equilibrium (hereafter referred to as the "BP-equilibrium growth rate") equals the ratio of the (long-run average) growth rate of exports to the income elasticity of demand for imports. In an alternative version of this law, the BP-equilibrium growth rate equals the (long-run average) growth rate of foreign (rest-of-world) income multiplied by the ratio of the home country's income elasticity of exports to its income elasticity of imports.

The origins of the BPCG model and its earlier extensions and applications have been well-surveyed elsewhere (for example, Blecker & Setterfield, 2019; McCombie, 2011; McCombie & Thirlwall, 1994; Setterfield, 2011; Thirlwall, 2011;),[1] and will be covered here only briefly and where relevant to more recent developments. The motive for the present survey is, rather, the tremendous outpouring of new models, empirical estimates, and theoretical debates related to the BPCG approach since (roughly) 2010. Because the BPCG literature has become quite vast, any survey of this type must inevitably be selective. The focus of this survey is on recent contributions to a set of core analytical issues in BPCG modeling, rather than exhaustive coverage of all recent applications.

Specifically, this survey covers four interconnected areas of fundamental importance: reconsidering the impact of relative prices, modeling the process of structural change, incorporating endogenous technological progress, and analyzing the dynamics of adjustment (including the role of income distribution and the possibility of cyclical dynamics). Much of this new research has integrated insights from other theoretical approaches, including the Kaleckian and Kaldorian branches of post-Keynesian macro theory, evolutionary and Schumpeterian economics, Goodwinian models of distributive cycles, and the Latin American structuralist approach in development economics. The original BPCG model of Thirlwall (1979) and many of its earlier extensions focused primarily (if not exclusively) on long-run steady-state analysis, considering only factors that can influence the BP-equilibrium growth rate. In contrast, the newer work surveyed here includes analysis of (among other things): "medium-run" periods in which steady-state assumptions are not imposed; the dynamics of the transition to (or cycles around) the long-run steady state; and effects of variables in levels rather than growth rates. This shift in focus away from an exclusive concentration on steady-state analysis has gone hand-in-hand with the renewed interest in relative price effects in the BPCG literature, since those effects are (at least to most BPCG theorists) more plausible outside of steady-state comparisons.

Given this focus, the present survey will not cover several areas that have featured prominently in past debates and discussions, or which have been covered extensively elsewhere. For example, this paper will not discuss the old controversy about whether some standard empirical tests of Thirlwall's law reflect a near-tautology (for recent iterations of this debate, see Blecker, 2016, 2021; Clavijo & Ros, 2015; McCombie, 2011, 2019; Pérez Caldentey, 2015; Razmi, 2016). This paper does not address models incorporating international capital flows and debt sustainability (Barbosa-Filho, 2001; Bhering et al., 2019; Blecker, 2013; Garcimartin et al., 2016; McCombie & Thirlwall, 1997; Moreno-Brid, 1998–99, 2003; Soukiazis et al., 2012, 2014; Thirlwall & Hussain, 1982)—a literature that has grown so large that it could require a separate survey. This survey will also not cover efforts to reconcile the BP-equilibrium growth rate with the "natural" rate of growth at which the employment rate stabilizes, or the empirical literature showing that the latter generally adjusts to the former and not the other way around. Those efforts are discussed in Blecker & Setterfield (2019) and Magacho & Spinola (2021), who build on earlier works including Palley (2002), Setterfield (2006, 2013b), McCombie (2011), Oreiro (2016), and Porcile & Spinola (2018), while the empirical evidence is assessed by León-Ledesma & Thirlwall (2000, 2002), León-Ledesma & Lanzafame (2010), and Lanzafame (2009, 2010, 2014).

Despite these and other omissions,[2] what *will* be covered here is quite substantial. Section 2 succinctly reviews the canonical BPCG model plus a few key extensions and connections that lay the groundwork for the more recent developments considered here. Section 3 discusses recent efforts to incorporate relative price or real exchange rate (RER) effects in BPCG models, in spite of the traditional focus on "non-price competition" in those models. This section also covers theoretical responses by defenders of the traditional emphasis on non-price competition and recent empirical estimates of relative price or RER effects on trade. Section 4 considers new efforts to include endogenous productivity growth, structural change, and cumulative causation in multisectoral BPCG models. Section 5 then examines the innovative new literature that seeks to integrate the BPCG approach with models of distribution-driven economic cycles inspired by Goodwin (1967)—a literature that also links to several of the approaches considered in earlier sections of the paper, and which contains important results about the dynamics of the adjustment process toward (or around) a long-run BPCG equilibrium. Finally, section 6 concludes.

2 | FOUNDATIONS AND KEY EXTENSIONS OF THE BPCG MODEL

To lay the foundations for the newer literature covered in sections 3–5, this section briefly reviews the original Thirlwall (1979) model and a few key extensions and connections that are essential for understanding that literature.[3]

2.1 | The canonical model

The canonical BPCG model assumes two goods that are imperfect substitutes: a domestic product, which can be either sold at home or exported, and a foreign-produced imported good. Similar to the Marshall-Lerner (ML) theorem, prices are assumed to be fixed in the seller's currency, which effectively means that supplies of exports and imports must be infinitely elastic. Thus, the model presumes what Branson (1983, p. 48) has called a "Keynesian small economy": one that is too small to influence foreign income but is not a price-taker in export markets.

In the simplest version, assuming no net capital (financial) flows or transfers in the long run, current account equilibrium requires balanced trade in goods and services:

$$PX = EP_f M \tag{1}$$

or, in growth rate form,

$$\hat{P} + \hat{X} = \hat{E} + \hat{P}_f + \hat{M} \tag{2}$$

where X is the quantity of exports, M is the quantity of imports, P is the domestic price level, P_f is the foreign (rest-of-world) price level (in foreign currency), E is the nominal exchange rate (in domestic currency per unit of foreign currency), and a circumflex (ˆ) indicates the rate of change of a variable in continuous time (for example, $\hat{X} = (dX/dt)/X = \dot{X}/X = d\ln X/dt$).

Using a conventional ("Cobb-Douglas") functional form, export demand is expressed as

$$X = X_0 \left(\frac{EP_f}{P}\right)^{\varepsilon_X} Y_f^{\eta_X} \tag{3}$$

where X_0 is a positive constant, Y_f is foreign income, and $\varepsilon_X > 0$ and $\eta_X > 0$ are the price and income elasticities of export demand, respectively (where the former is the absolute value of the true, negative price elasticity). Similarly, import demand is given by

$$M = M_0 \left(\frac{EP_f}{P}\right)^{-\varepsilon_M} Y^{\eta_M} \tag{4}$$

where M_0 is a positive constant and ε_M, $\eta_M > 0$ are the price and income elasticities of import demand, respectively (again, ε_M is defined to be the absolute value of the true price elasticity).

Let $q = EP_f/P$ be the RER defined as the relative price of foreign goods, so an increase implies a real depreciation of the home currency. Using this definition and converting to growth rate form, the export and import demand functions (3) and (4) become:

$$\hat{X} = \varepsilon_X \hat{q} + \eta_X \hat{Y}_f \tag{5}$$

$$\hat{M} = -\varepsilon_M \hat{q} + \eta_M \hat{Y} \tag{6}$$

where $\hat{q} = \hat{E} + \hat{P}_f - \hat{P}$ is the rate of real depreciation of the home currency. Substituting Equations (5) and (6) into (2) and rearranging, the condition for maintaining balanced trade in the long run can be expressed as:

$$(\varepsilon_X + \varepsilon_M - 1)\hat{q} - \eta_M \hat{Y} + \eta_X \hat{Y}_f = 0 \tag{7}$$

where $\varepsilon_X + \varepsilon_M - 1 > 0$ if the ML condition holds.

The key question then is which variable(s) adjust to make this equilibrium condition hold in the long run. In the basic model, foreign income growth $\hat{Y}_f$ and all of the elasticities are taken as exogenously given. Of course, one possibility is that the RER could do at least some of the

adjusting, as suggested by Houthakker & Magee (1969).[4] However, the BPCG approach assumes that "it is largely real income (and employment) that adjusts to bring the value of imports and exports into line with one another to preserve balance of payments equilibrium" (Thirlwall & Hussain, 1982, p. 498).

To ensure that the relative price (RER) change $\hat{q}$ has a negligible impact in the long run, either of two alternative assumptions can be adopted. If we assume "elasticity pessimism," we could postulate that the ML condition is not satisfied, and instead $\varepsilon_X + \varepsilon_M \approx 1$. Alternatively, if ML is satisfied so that $\varepsilon_X + \varepsilon_M > 1$, relative price effects can also be ruled out if the relative prices do not change significantly in the long run, in other words, $\hat{q} \approx 0$, an assumption that is equivalent to long-run relative purchasing power parity (LRR-PPP).

Making either of these assumptions, the relative price (RER) term drops out of Equation (7), which can then be solved for the BP-equilibrium growth rate:

$$\hat{Y}_B = \frac{\eta_X \hat{Y}_f}{\eta_M} \tag{8}$$

Furthermore, if $\hat{q} = 0$ holds, Equation (5) reduces to $\hat{X} = \eta_X \hat{Y}_f$ and (8) can be written as

$$\hat{Y}_B = \frac{\hat{X}}{\eta_M} \tag{9}$$

These two solutions represent alternative expressions of what has become known as "Thirlwall's law." In the terminology of Perraton (2003), Equation (8) can be called the "strong form" and (9) the "weak form" of this law. Either of these solutions assumes that the income elasticities are structural parameters that can be taken as exogenously given in a long-run analysis; models that allow the income elasticities to vary endogenously are considered below.

Most BPCG theorists have leaned toward elasticity pessimism, based on decades of empirical studies (surveyed by Bahmani et al., 2013) that have found mixed results (at best) for whether price elasticities are high enough to satisfy ML. However, if the price elasticities *are* high enough to satisfy ML, *and* if $\hat{q} \neq 0$ (LRR-PPP does not hold), then the following more general solution would apply:

$$\hat{Y}_B = \frac{(\varepsilon_X + \varepsilon_M - 1)\hat{q} + \eta_X \hat{Y}_f}{\eta_M} \tag{10}$$

Equation (10) is sometimes considered relevant to medium-run periods, if not to the very long run in which LRR-PPP is more likely to hold. Equations similar to (10) are also used in some analyses of the transition to a long-run equilibrium characterized by Thirlwall's law. Extensions of the BPCG approach along these lines are considered in later sections.

Conceptually, however, it is important to emphasize that "short run," "medium run," and "long run" are not exact lengths of time (in years or decades). Rather, they are analytical constructs that are defined by which variables are held constant or can vary and what equilibrium conditions apply. For example, relative prices and distributive shares may be exogenously given in the short run, endogenously adjusting in the medium run, and constant (at equilibrium levels) in the long run. Some models assume that BP equilibrium need only prevail in the long run, but others impose a BP equilibrium condition for the short or medium run for reasons discussed below.

2.2 | Industrial composition and global value chains

In spite of its emphasis on the demand-side effects of exports, the BPCG approach incorporates supply-side factors insofar as these influence the income elasticities or export growth rate. As McCombie (1989, p. 611) has stated, "it is the supply characteristics (which determine the degree of non-price competitiveness) that are crucial in determining a country's growth rate relative to that of the rest of the world." Hence, Thirlwall's law implies that a country may require supply-side industrial and innovation policies in order to relieve demand-side BP constraints on its growth.

A corollary of the importance of product quality and supply-side factors is that export composition matters to aggregate growth in the BPCG approach. The importance of what a country exports has been formalized by Araujo & Lima (2007) and Gouvêa & Lima (2010) in their model of the "multisectoral Thirlwall's law" (MSTL).[5] The original MSTL, which was designed to integrate Thirlwall's BPCG model with Pasinetti's (1981, 1993) model of structural change, can be specified in the following solution for the BP-equilibrium growth rate of per capita income for the global South (S) as a function of the per capita growth rate in the global North (N):[6]

$$\hat{y}_{pc}^{S} = \frac{\sum_{i=1}^{G} \xi \eta_{X,i}^{S} x_i^S a_i^S}{\sum_{i=1}^{G} \eta_{M,i}^{S} m_i^S a_i^S} \hat{y}_{pc}^{N} \tag{11}$$

where y_{pc} is per capita income (the ratio of aggregate income to population) and $\hat{y}_{pc}^{j}$ is its growth rate in country $j(j = N, S)$, ξ is the ratio of Northern to Southern population, $\eta_{X,i}$ and $\eta_{M,i}$ are the income elasticities of export and import demand for each good i, x_i^j is foreign per capita demand for country j exports of good i (exports divided by foreign population), m_i^j is per capita imports of good i in country j (imports divided by home population), a_i^j is the labor coefficient for producing good i in country j, G is the number of tradable goods,[7] and "population" is assumed to equal the employed labor force in each country for simplicity.

The numerator and denominator of the ratio on the right-hand side of Equation (11) are thus essentially weighted sums of the elasticities of demand for Southern exports and imports, respectively, where the weights are equivalent to either exports or imports as a share of output in each sector. Implicitly, these weights can change over time as consumer demand and labor productivity evolve, which implies that the MSTL growth rate is time-varying, and the relative growth rate of the South depends crucially on how its per capita exports to the North (x_i^S) evolve relative to per capita imports from the North (m_i^S).

Later authors such as Gouvêa & Lima (2013) have adopted a simplified version of the MSTL that is more useful for empirical estimation and has been utilized in subsequent theoretical extensions. In this version, the MSTL is expressed in terms of output growth rates of a home and foreign country and simple weighted averages of the income elasticities are used:

$$g_t^B = \left(\frac{\sum_{i=1}^{G} \alpha_{i,t} \eta_{X,i}}{\sum_{i=1}^{G} \beta_{i,t} \eta_{M,i}} \right) g_t^f, \sum_{i=1}^{G} \alpha_{i,t} = 1, \sum_{i=1}^{G} \beta_{i,t} = 1 \tag{12}$$

where g_t^B is the time-varying BP-equilibrium growth rate in discrete time ($g_t = \Delta Y_t / Y_{t-1}$), g_t^f is the foreign growth rate in discrete time, t represents time period, and $\alpha_{i,t}$ and $\beta_{i,t}$ are the shares of good i in total exports and imports, respectively. This version makes the time-varying nature of the

MSTL growth rate (g_t^B in Equation 12) more explicit and makes Thirlwall's law more applicable in a world characterized by ongoing structural change in the composition of countries' industries and trade (see Gouvêa & Lima, 2010; Rodrik, 2014; Szirmai, 2012).

From a policy perspective, the MSTL framework emphasizes the importance of increasing the shares $\alpha_{i,t}$ of exported goods with relatively high income elasticities $\eta_{X,i}$ and decreasing the shares $\beta_{i,t}$ of imported goods with relatively high income elasticities $\eta_{M,i}$. This approach also shifts the focus of BPCG analysis from the role of foreign income growth to industrial policies that a country could carry out internally:

Given the income elasticities of imports and exports, the original Thirlwall's Law implies that a country's growth rate will rise only when the growth rate of income outside it rises, whereas the Multi-Sectoral Thirlwall's Law implies that a country can still raise its growth rate even when such a rise in the growth of outside income does not occur, provided it can manage to change the sectoral composition of exports and/or imports accordingly. (Araujo & Lima, 2007, p. 767.)

Also, as we shall see in section 3, the MSTL approach provides a way for relative prices or RERs to influence the BP-equilibrium growth rate—by shifting the industry shares $\alpha_{i,t}$ and $\beta_{i,t}$—that does not rely on the conventional price elasticities of demand for exports and imports, and which does not require continuous real appreciations or depreciations in the long run.

The original MSTL framework of Araujo & Lima (2007) has been used in one important recent extension, which is designed to incorporate "global value chains" (GVCs) in a BPCG model. Trigg (2020) goes back to the Pasinettian roots of the original MSTL model and develops a formulation using input-output analysis. In this approach, it is possible to generalize the MSTL by incorporating trade in intermediate goods between any number of countries. This allows Trigg to model key aspects of contemporary trade, which usually go under the rubric of vertical specialization or offshoring. These aspects include imports of intermediate inputs used for export production as well as for production of domestic consumption goods, and the use of imports from one trading partner to produce exports destined for other trading partners' markets. Some earlier studies have incorporated imported intermediate goods in a more limited way,[8] but Trigg's analysis is far more general.

After presenting simpler examples involving two or three countries, Trigg (2020) derives the general solution for the BP-equilibrium growth rate of any given country j relative to another country k (in a world of $R > 2$ countries) as follows:

$$\frac{\hat{Y}^j}{\hat{Y}^k} = \xi^{k,j} \frac{\mathbf{n}^j \mathbf{c}^k}{\left(\sum_{\iota=1}^{R} \mathbf{n}^\iota - \mathbf{n}^j\right) \mathbf{c}^j} \tag{13}$$

where $\xi^{k,j}$ is the ratio of population (employment) in country k to country j, $\mathbf{n}^\iota$ is a $(1 \times GR)$ row vector of vertically integrated (direct and indirect) labor coefficients for intermediate goods exported by any country ι in all sectors and to all other countries, $\mathbf{c}^\iota$ is a $(GR \times 1)$ column vector of per capita (per worker) consumption coefficients for all goods (including both domestic products and goods imported from all other countries) for country ι, and again G is the number of goods. This approach, which Trigg (2020) calls the "Multi-Country Sectoral Thirlwall's Law" (MCSTL), reflects how much value added is included in a country's exports and imports, rather than the gross value of that trade. So, for example, if country j engages in assembly of imported intermediate goods for export with relatively little domestic value added contained in the exports, the coefficients in the $\mathbf{n}^j$ vector would be correspondingly low, and this would depress the country's

relative growth rate for any given level of foreign consumption (as reflected by the coefficients in $\mathbf{c}^k$) and other parameters.

2.3 | Cumulative causation and alternative time frames

The BPCG model grew out of the Kaldorian growth literature of the 1970s, which originally emphasized positive feedback mechanisms and what Myrdal (1957) called "cumulative causation." The core of the positive feedbacks in Kaldorian theory is Verdoorn's law, which portrays the growth rate of labor productivity as an increasing function of the growth rate of output. In linear form,

$$\hat{y} = \rho_0 + \rho_1 \hat{Y} \tag{14}$$

where $\hat{y}$ is the growth rate of labor productivity ($y = Y/L$), $\rho_0 > 0$ is a constant term, and the "Verdoorn coefficient" ρ_1 is (in most theoretical models and empirical estimates) a positive fraction ($0 < \rho_1 < 1$)—although there is considerable variation in estimates of ρ_1 at the country and sectoral level (Magacho & McCombie, 2018; Romero & McCombie, 2016). The standard interpretation was stated by Thirlwall (1983, p. 345): "The faster the rate of growth of manufacturing output, the faster will be the rate of growth of labor productivity in manufacturing owing to static and dynamic economies of scale, or increasing returns in the widest sense." McCombie & Spreafico (2016, p. 1122) clarify that increasing returns in this context are "broadly defined to also include induced technical progress."[9] Tavani & Zamparelli (2017) highlight the "Kaldor-Verdoorn law" in Equation (14) as a major post-Keynesian approach to endogenous technological change.

Originally, Verdoorn (1949) specified this relationship as pertaining only to productivity and output growth in the manufacturing sector (see Cornwall, 1977), but in the formalization of Kaldorian cumulative causation by Dixon & Thirlwall (1975), Verdoorn's law was applied to aggregate output (see also Setterfield, 2013a; Setterfield & Cornwall, 2002).[10] Here, we give a very brief presentation of the Dixon-Thirlwall model and its connection to BPCG and Thirlwall's law. Assuming that prices are set by a constant markup over unit labor costs (ULC),[11] prices increase at the same rate as ULC:

$$\hat{P} = \hat{W} - \hat{y} \tag{15}$$

Output growth is determined by the "elasticity of output growth with respect to export growth" (Dixon & Thirlwall, 1975, p. 204)—or what later authors (e.g., Blecker & Setterfield, 2019, p. 385) call the dynamic export multiplier—k_X times the export growth rate

$$\hat{Y} = k_X \hat{X} \tag{16}$$

and $k_X = 1$ if exports are a constant proportion of output in the long run.

Combining Equations (5) and (14)–(16), the model solves for the equilibrium growth rate with cumulative causation,

$$\hat{Y}_C = \frac{k_X \left[\varepsilon_X(\hat{E} + \hat{P}_f - \hat{W} + \rho_0) + \eta_X \hat{Y}_f\right]}{1 - k_X \varepsilon_X \rho_1} \tag{17}$$

where $\hat{E}$, $\hat{P}_f$, $\hat{W}$, and $\hat{Y}_f$ are taken as exogenously given (for alternative solutions under different assumptions, see Blecker, 2013; Setterfield, 2013a; Setterfield & Cornwall, 2002). The cumulative causation consists in the positive feedback loop in which increases (or decreases) in the following variables all drive each other in the same direction: $\uparrow \hat{X} \rightarrow \uparrow \hat{Y} \rightarrow \uparrow \hat{y} \rightarrow \uparrow \hat{q} \rightarrow \uparrow \hat{X}$. For an equilibrium $\hat{Y}_C > 0$ to be stable, a necessary assumption is that there cannot be too much cumulative causation: $k_X \varepsilon_X \rho_1 < 1$. If this condition does not hold, the country's growth rate would increase or decrease continuously in the long run (which Dixon & Thirlwall, 1975, deemed implausible).

Thirlwall & Dixon (1979) then demonstrated that the cumulative causation mechanism in their earlier model would not apply in the long run if the BP constraint (Equation 2) was imposed and the RER is assumed constant in the long run ($\hat{q} = 0$). In this case, Verdoorn effects have no impact on the growth of exports because the feedbacks from productivity growth to price competitiveness are blocked. Rather, with the BP constraint included in the model along with the import demand Equation (6), and assuming ($\hat{q} = 0$), the Thirlwall's law solutions in Equations (8) and (9) would apply instead of equation (17).

However, if one considers a "medium-run" time frame in which the RER can persistently change ($\hat{q} \neq 0$), then the Verdoorn relationship can affect the BP-equilibrium growth rate, as discussed in Blecker (2013) and Blecker & Setterfield (2019, pp. 459–461). Using Equations (14) and (15) and the definition of q in the equilibrium condition (7), we can solve for the BP-equilibrium growth rate with Verdoorn effects,

$$\hat{Y}_B = \frac{(\varepsilon_X + \varepsilon_M - 1)(\hat{E} + \hat{P}_f - \hat{W} + \rho_0) + \eta_X \hat{Y}_f}{\eta_M - \rho_1(\varepsilon_X + \varepsilon_M - 1)} \tag{18}$$

and a higher Verdoorn coefficient ρ_1 has a positive effect on $\hat{Y}_B$ assuming that the ML condition holds so that $\varepsilon_X + \varepsilon_M - 1 > 0$ and the numerator is positive. In this case, policies to enhance price competitiveness—including nominal currency depreciation, wage suppression, or promotion of productivity growth—could accelerate the economy's growth for as long as a real depreciation can be sustained, and thereby could increase the level of a country's output even if they do not affect its equilibrium growth rate in the very long run.

The idea that Kaldor-Verdoorn effects could operate in a medium-run time frame,[12] or during the transition to a long-run equilibrium governed by Thirlwall's law, has been formalized by Ribeiro et al. (2017a),[13] as well as others whose work will be discussed later. Ribeiro et al. (2017a) add several complexities to the basic BPCG framework, including imports of intermediate goods that are used in production of tradable goods (which can be seen as a simplified representation of GVCs). These authors also drop the assumption of a constant profit markup and instead make the markup rate endogenous. Following the open economy neo-Kaleckian models of Blecker (1989, 2002) and Sasaki et al. (2013),[14] Ribeiro et al. (2017a) assume that the markup rate is an increasing function of the RER, in other words, firms raise markups when there is a real depreciation and lower than in response to a real appreciation. This endogenous markup is then applied to the sum of unit labor costs and the unit costs of imported intermediate goods.

Ribeiro et al. (2017a) then analyze three time periods defined by varying assumptions about wages and productivity: in the short run, nominal wages and labor productivity grow at exogenously given rates; in the medium run, labor productivity grows according to Verdoorn's law (Equation 14) and the real wage adjusts partially (but only partially) to productivity growth, so that the wage share falls and price competitiveness improves when productivity growth accelerates; in the long run, the real wage adjusts fully to productivity growth so that the wage share is

constant, while the RER also stabilizes at a constant level so that $\hat{q} = 0$. In all three time periods, the rates of increase in foreign prices $\hat{P}_f$, foreign output growth $\hat{Y}_f$, and nominal depreciation $\hat{E}$ are exogenously given.

Ribeiro et al. (2017a) assume that the BP constraint (Equation 1 or 2 modified to include imports of consumption and intermediate goods) applies in all three time frames. This may be controversial, because Thirlwall's original rationale for assuming BP equilibrium was that it must hold in the long run, and it has generally been allowed that trade surpluses or deficits can arise in the short run. However, Ocampo (2016, pp. 212, 215) has argued that countries in Latin America and other developing regions are typically subject to "balance-of-payments dominance" because "external shocks, both positive and negative, are the essential determinants of short-term macroeconomic dynamics" to which those countries have to adjust at all times, and that what he calls "*medium-term* cycles" (italics in original) are driven largely by boom-bust cycles in capital inflows. BP dominance impels governments to adopt procyclical fiscal policies to prevent BP imbalances from growing too large, and hence could justify assuming the existence of a BP constraint in any time frame for a large range of emerging and developing nations.

On this implicit (but unstated) assumption, Ribeiro et al. (2017a) derive BP-equilibrium growth rates for each time horizon. In the short run, Verdoorn's law does not apply because productivity growth is exogenous, but price competitiveness (which changes at an exogenously given rate) affects the equilibrium growth rate. In the medium run, Verdoorn's law does apply, price competitiveness becomes endogenous, and cumulative causation effects can boost the BP-equilibrium growth rate. As long as the ML condition (modified to include imports of intermediate goods) holds and real wages do not adjust fully to productivity growth, a higher Verdoorn coefficient ρ_1 has a positive effect on the BP-equilibrium growth rate for the medium run. In the long run, however, all relative price effects are eliminated and both the wage share and RER are constant. Therefore, the long-run BP-equilibrium growth rate is the strong form of Thirlwall's law, modified to include the two types of imports:

$$\hat{Y}_B = \frac{\eta_X \hat{Y}_f}{\beta_{int} + (1 - \beta_{int})\eta_{con}} \tag{19}$$

where β_{int} is the share of intermediate goods in total imports, η_{con} is the income elasticity of demand for imports of final consumption goods, and the income elasticity of demand for imports of intermediate goods is unity ($\eta_{int} = 1$) on the assumption that such imports are in a fixed proportion to output. Although the long-run growth rate is thus independent of Verdoorn effects, nevertheless the long-run level of the growth path of output depends on the strength of those effects during the medium-run adjustment period.

Ribeiro et al. (2017a) thus provide a useful analytical classification of the conditions under which Kaldor-Verdoorn cumulative causation can affect BP-constrained growth, which they characterize as pertaining to a medium-run transition toward a long-run equilibrium governed by Thirlwall's law. However, Ribeiro et al. do not provide an explicit dynamic analysis of that transition process. Several studies that do provide such a dynamic analysis, while also incorporating endogenous labor productivity growth and income distribution, are discussed in section 5 below. Other efforts to reintroduce Verdoorn's law and cumulative causation into BPCG models are discussed in section 4.

3 | EFFECTS OF RELATIVE PRICES AND THE REAL EXCHANGE RATE

The BPCG approach traditionally has emphasized non-price competition, on the assumption that qualitative superiority and technological advantages are what matter most to export performance especially in the long run. In a typical statement of this view, McCombie (1985, 2004, p. 54) argued that "the expansion of exports … has more to do with such factors as quality, design and delivery dates than with price competitiveness." However, a number of recent works have challenged the standard BPCG assumption that price competition and RER depreciation are ineffective.

To understand this controversy, it is important to recall that the canonical BPCG model covered in section 2.1 implies that *continuous changes* in relative prices or the RER would be needed to have an impact on the long-run BP-equilibrium growth rate. For example, McCombie (2011, p. 358, emphasis in original) writes that "even if the Marshall-Lerner conditions are satisfied, to increase permanently the *growth* of exports and to reduce the growth of imports would require a *continuous* depreciation of the currency, which is implausible."

What distinguishes most of the new work on relative price and RER effects is that it mainly focuses on ways in which the *level*, rather than the rate of change, of the relative price or RER could affect the long-run equilibrium in a BPCG model. This new literature is motivated in part by a large set of empirical studies that have found statistically significant effects of levels of RERs (often relative to a measure of the equilibrium RER) or other measures of relative prices or costs on export performance or growth, either in developing countries or more globally, based on a wide variety of theoretical and empirical approaches. Such studies include Gala (2008), Rodrik (2008), Berg et al. (2012), Rapetti et al. (2012), Levy-Yeyati et al. (2013),[15] Missio et al. (2015), Razmi (2016), and Boggio & Barbieri (2017), among others. This literature has recently been surveyed by Rapetti (2020) and Demir & Razmi (2021), who also offer new empirical evidence of their own, generally confirming that RER undervaluation has positive effects on growth and that these effects are strongest in emerging and developing economies.[16] That said, it should be noted that a few empirical studies have found significant effects of rates of change in RERs or relative prices on the growth of exports and/or output (for example, Blecker & Razmi, 2010; León-Ledesma, 2002).

There are three main ways in which levels of relative prices or RERs have been introduced into BPCG models. One way is to assume that the RER affects the weighted-average income elasticities of demand for exports and imports by influencing the composition or diversification of a country's export (and/or domestic) industries in an MSTL framework.[17] The second way is to assume that the RER affects capital accumulation in export sectors, thereby permitting an increase in exports on the supply side. These two approaches are covered in the next two subsections, followed by discussions of critical responses and empirical estimates. A third way, which is to assume that the RER affects income elasticities at the sectoral level, is discussed in section 4.2 below.

3.1 | The RER and the composition of trade

Analysis of RER effects on the composition of a country's trade is usually based (explicitly or implicitly) on some version of the MSTL model, discussed in section 2.2 above. That is, a depreciated real exchange rate (or, depending on the model, lower relative labor costs) induces changes in the weights $\alpha_{j,t}$ and $\beta_{j,t}$ in Equation (12), such that the weights $\alpha_{j,t}$ on more sophisticated types of export products that have higher income elasticities increase, while the weights $\beta_{j,t}$ on similar types of imports decrease as domestic capabilities for producing such goods improve.

A particularly compelling version of this approach is found in Cimoli & Porcile (2014) and Cimoli et al. (2019).[18] These studies incorporate extensions of the Ricardian trade model with a continuum of goods, originally developed by Dornbusch et al. (1977) and later adapted by Cimoli (1988), Dosi et al. (1990), and Cimoli & Porcile (2010). Similar to Araujo & Lima (2007), Cimoli & Porcile (2014) and Cimoli et al. (2019) also draw upon the Latin American structuralist tradition, in which the home country is the global South (developing countries) and the foreign country is the global North (advanced economies). In what Thirlwall (2011) later recognized as an earlier antecedent of his BPCG model, Prebisch (1950) theorized that the growth rate of the South relative to the North would be determined by the ratio of the two regions' income elasticities of demand for their respective exports:

$$\frac{\hat{Y}^S}{\hat{Y}^N} = \frac{\eta_X^S}{\eta_X^N} \tag{20}$$

Since (in a two-region model) the South's import elasticity must equal the North's export elasticity ($\eta_M^S = \eta_X^N$), this relationship is equivalent to the strong form of Thirlwall's law in Equation (8), where the South is the home country and the North is the foreign country.

Focusing on the formulation in Cimoli et al. (2019), the authors assume a continuum of goods $z \in [0, 1]$, ranked in decreasing order of relative Southern labor productivity. The breakpoint between Southern and Northern exports is good z', such that goods 0 to z' are Southern exports and z' to 1 are Northern exports (the borderline good z' can be produced in both regions). Cimoli et al. also assume that the higher-numbered goods (Northern exports) are more complex and sophisticated products that have a higher "technological intensity" and, as a result, tend to have greater income elasticities of export demand. Although it does not follow directly from that assumption, the authors also assume that the relative income elasticity of aggregate Southern exports (η_X^S/η_X^N) is an increasing function of the proportion of goods produced in the South, z.[19]

In this model, the South will be able to export those goods z for which its relative productivity is not less than its relative wage:

$$\frac{y^S(z)}{y^N(z)} \geq \frac{W^S}{EW^N} \tag{21}$$

where $y^j(z)$ is output per worker-hour for good z in region $j (j = N, S)$, W^j is the nominal wage in region j, E is the nominal exchange rate measured in Southern currency per unit of Northern currency, and the cut-off good z' is determined by $y^S(z')/y^N(z') = W^S/EW^N$. Thus, a decrease in the Southern relative wage would allow the South to export a wider range of goods of greater sophistication (i.e., increase z'), and—under the assumption stated previously—would increase the South's relative income elasticity (in the aggregate) and hence raise its relative BP-equilibrium growth rate per Equation (20).

In Cimoli & Porcile (2014) and Cimoli et al. (2019), this set of relationships is embedded in a larger framework including endogenous technological progress (Verdoorn's law), North-South technological gaps, and—in the latter article—labor market effects (which determine the relative wage), resulting in complex dynamic systems with multiple feedbacks. Other models that include similar features in these respects will be discussed later. For present purposes, what is important is that Cimoli & Porcile (2014) and Cimoli et al. (2019) introduce effects of the level of the relative wage compared to relative productivity (or, equivalently, relative ULC) by having this variable

affect the composition and hence the relative income elasticities of exports in the South compared with the North.

In a related vein, Setterfield & Ozcelik (2018) argue for a form of hysteresis in which a "temporary but persistent shock to the nominal exchange rate" can have a lasting effect on the BP-equilibrium growth rate, in a framework they characterize as "time-varying balance of payments constrained growth (TV-BPCG)." To clarify, variations in the nominal exchange rate are equivalent to changes in the RER in this model, because the authors hold prices constant. In fact, they suppress the conventional RER effects on demand for exports and imports by assuming that the RER level is constant in the long run (although that level may shift across different long-run equilibria, as discussed below).

Setterfield & Ozcelik (2018) adopt a simplified version of the MSTL model in which there are two export sectors—manufacturing (1) and non-manufacturing (2)—but only one type of imports for simplicity. Designating the (time-varying) share of manufactures in exports as $\alpha_{1,t}$, the BP-equilibrium growth rate in discrete time is

$$g_t^B = \frac{\left[\alpha_{1,t}\eta_{X,1} + (1-\alpha_{1,t})\eta_{X,2}\right] g_t^f}{\eta_M} \tag{22}$$

The manufacturing share $\alpha_{1,t}$ is assumed to evolve as a stochastic function of the difference between the current exchange rate E and its initial level E_0:

$$\Delta\alpha_{1,t} = \Theta(E_t - E_0) \tag{23}$$

$$E_t = E_0 + \upsilon_t \tag{24}$$

$$\upsilon_t = \omega\upsilon_{t-1} + \nu_t, \nu_t \sim N(0, \sigma_\nu^2) \tag{25}$$

where $\Theta > 0$ and $\omega > 0$ are constants.[20]

If there is a persistent negative shock $\nu_t < 0$ to the nominal (also real) exchange rate that makes $\upsilon_t < 0$ and $E_t < E_0$, the currency will appreciate over several time periods, the manufacturing share will start to decline, and—assuming that the income elasticity is greater for manufactured exports than for other goods ($\eta_{X,1} > \eta_{X,2}$)—the BP-equilibrium growth rate in Equation (22) permanently declines. In fact, the actual growth rate falls even further than g_t^B in the short run; in the long run the actual rate recovers partially but converges to a new, lower g_t^B. This model thus demonstrates the possibility of overvaluation-induced "premature deindustrialization" that reduces the BP-equilibrium growth rate even after an overvaluation episode ends.

3.2 | The RER and capital accumulation in a small open economy

The second approach to incorporating the RER level changes the way that the export market is specified in the BPCG model to fit the case of a small price-taking country. Razmi (2016) argues

that many countries, especially (but not exclusively) in the developing world, can be characterized as small economies that take export prices (as well as import prices) as given. Such countries face an infinitely elastic demand curve for their exports, and their exports are supply-constrained. Razmi then constructs a generalized model that nests the standard Thirlwall's law solution and an alternative solution for a pure small country as special cases.[21] What we present here is not the complete model from Razmi (2016), but rather a simplified version for the small country case based on Blecker (2016) and Blecker & Setterfield (2019, pp. 494–495).

Razmi's export function can be written in growth rate form as

$$\hat{X} = \delta_X \hat{P} + \gamma_X \hat{K} \tag{26}$$

where δ_X and γ_X are the elasticities of export supply with respect to the domestic price level and capital stock respectively. Razmi specifies imports as demand-determined, the same as in the traditional BPCG model, and assumes balanced trade. Thus, using Equations (2), (6), and (26) along with the assumption of LRR-PPP ($\hat{q} = \hat{E} + \hat{P}_f - \hat{P} = 0$), we can solve for the BP-equilibrium growth rate for a small country[22]

$$\hat{Y}_{SC} = \frac{\delta_X \hat{E} + \gamma_X \hat{K}(q)}{\eta_M} \tag{27}$$

where the capital accumulation rate is assumed to be an increasing function of the level of the RER, $\hat{K}'(q) > 0$.

A positive association of investment rates with RER undervaluation has been found in several empirical studies (Dávila-Fernández & Sordi, 2019b; Demir & Razmi, 2021; Libman et al., 2019; Razmi et al., 2012);[23] these positive effects are usually found to be strongest in developing countries, but those are precisely the ones most likely to be characterized by the small country model. In this case, a lower value of the home currency (rise in q) raises the BP-equilibrium growth rate by making capital accumulate faster, thereby enabling more rapid expansion of export supply. However, it should be noted that Dávila-Fernández & Sordi (2019b) find bi-directional causality between capital and exports.

3.3 | Critical Responses

All of these arguments in support of a lower real value of the currency (or lower relative prices or costs) as a factor promoting long-run growth have been challenged on both theoretical and empirical ground by defenders of the focus on non-price competition in the traditional BPCG approach, such as Romero & McCombie (2018) and Ribeiro et al. (2016, 2017a, 2017b, 2020). Among other things, Ribeiro et al. (2020) point out that most of the empirical literature focuses on what are really medium-run growth effects (during periods of around 4 to 10 years), rather than the long-run, steady-state growth rates emphasized in Thirlwall's law. However, even if the growth rate effects do not last beyond a decade or two, they could certainly influence the long-run level of the growth trajectory.

On the theoretical side, Ribeiro et al. (2017b) note that the competitive benefits of RER depreciation can be offset by increased costs of imported intermediate goods in domestic currency as well as redistributive effects (raising the profit share and lowering the wage share) of the depreciation. The redistributive effects in turn have a different impact depending on whether an economy has

wage-led or profit-led demand. If demand is profit-led, so that the increase in the profit share has an expansionary impact on national income, then the rise in the profit share has a positive income effect on demand for imports, which offsets the positive relative price effect of the depreciation on net exports (as recognized by Blecker, 1999). In this case, the depreciation is definitely expansionary, but may not improve the trade balance (and hence may not relieve the BP constraint). If demand is wage-led, so that the increase in the profit share is contractionary, then there is a negative income effect on imports, which makes the depreciation more effective for improving net exports but the net effect on national income can be contractionary (as noted by Blecker, 1999; Krugman & Taylor, 1978). The preceding is mainly a short-run analysis, but it makes clear that the impact of RER depreciation on both national income and net exports is ambiguous in general and depends on the parameters of a country's distributional and demand regimes.[24]

Ribeiro et al. (2016) take similar considerations into account in explicitly modeling the impact of an RER depreciation on the BP-equilibrium growth rate in different time frames (short, medium, and long run). For the long run, Ribeiro et al. (2016) propose a model in which the ratio of the income elasticities η_X/η_M, which appears in the strong version of Thirlwall's law in Equation (8), depends on the wage share of national income and the inverse of the technological gap (the ratio of the technological capabilities of the South to those of the North), both of which are endogenous variables that are affected by the RER. The model is too complex to present in detail here, but a few key assumptions may be noted.

First, greater relative technological capabilities in the South (the home country) improve the relative quality of Southern products and hence raise the South's ratio of income elasticities η_X/η_M. Second, a real depreciation increases the profit share, thereby making income distribution more unequal. Third, the distributive shares affect consumption patterns of workers and capitalists in various offsetting ways, which depend partly on the source of a distributional shift (changes in real wages versus labor productivity), with an ultimately ambiguous impact on the income elasticities. Fourth, income distribution has a nonlinear, inverse-U shaped relationship to the ratio of Southern technological capabilities: at a low initial level of the wage share, an increase in the wage share leads to more innovation as firms respond to increased labor costs and Southern relative capabilities increase, but at a high initial level, firms lack incentives (and funds) to innovate as the wage share increases further and hence the technological level of the South falls relative to the North.

The model is then reduced to a system of two simultaneous differential equations in the wage share and the inverse technological gap, where the equation for the latter is nonlinear and multiple equilibria can arise. Without attempting to explain the dynamics in any detail, a few important cases may be noted. First, at the unstable (saddle point) equilibrium with an initially low wage share, a real depreciation has perverse effects as it sets in motion a self-reinforcing decline in the wage share and innovation. Therefore, in this situation, "a currency appreciation seems to be the most recommended policy measure for a for a country to boost technological catch-up and reach a more equal income distribution" because it "increases the wage share, which intensifies technological changes and propels growth" (Ribeiro et al., 2016, p. 560). In contrast, if the South starts at the stable equilibrium in the region with a high initial wage share, a real depreciation has offsetting effects in accelerating technological progress (which is "profit-led" in this region) but diminishing the wage share (which worsens inequality); these changes in turn have opposite effect on the elasticity ratio η_X/η_M and hence the BP-equilibrium growth rate $\hat{Y}_B$ can either rise or fall. Thus, Ribeiro et al. (2016) conclude that the effects of RER depreciation on long-run growth are theoretically ambiguous, as they depend both on the parameters of the economy and initial conditions.

3.4 | Empirical estimates

Traditionally, the BPCG approach has relied on estimates of the price elasticities in export and import demand functions like Equations (5) and (6) to assess whether the ML condition is satisfied and hence whether relative price changes—if they occur at all in the long run—would affect the BP-equilibrium growth rate. Since those estimates have been covered extensively elsewhere (for example, Bahmani et al., 2013; Bussière et al., 2020),[25] we turn here instead to alternative empirical methodologies that have explored other routes through which relative prices or the RER could affect the growth of exports, imports, and output.

Tests of the role of relative ULC in determining export performance are found in Boggio & Barbieri (2017). These authors do not adopt a BPCG specification; instead they frame their analysis in terms of the theoretical model of export-led growth of Beckerman (1962), which they interpret as equivalent to a "replicator equation" approach from evolutionary biology. Boggio and Barbieri also draw upon the evolutionary-Schumpeterian approaches to international competitiveness of Amendola et al. (1993), Verspagen (1993), Amable & Verspagen (1995), and Verspagen & Wakelin (1997), among others. In their empirical estimates, Boggio and Barbieri use data for 33 countries to test whether increases in national shares of global export markets for goods are affected by relative manufacturing ULC in either levels or rates of change, and find that only the levels are statistically significant.[26]

Another study that explicitly compares rates of change versus levels for relative price effects is Razmi (2016). Razmi includes the rate of change in the relative export price and the log level of RER undervaluation (calculated using the method of Rodrik, 2008) in panel data regressions for output growth in a sample of 167 countries. Although the results vary in the estimates using ordinary least squares (OLS), in the estimates that use the general method of moments (GMM) to control for endogeneity both of these variables are statistically significant and have the expected signs (negative and positive, respectively).

Nevertheless, other economists have found insignificant effects of RERs or relative prices on exports and imports. For example, Romero & McCombie (2018) integrate the evolutionary-Schumpeterian approach to the determinants of export performance of Fagerberg (1988), Greenhalgh (1990), Amable & Verspagen (1995), and Wakelin (1998) into a BPCG model by postulating that exports and imports should be explained by the relative technological (non-price) competitiveness of the home country relative to the foreign country, T/T_f, along with measures of industrial capacity and the usual income and price variables. Romero & McCombie (2018) use total factor productivity (TFP), estimated at the industry-country level, as a proxy for non-price competitiveness or qualitative advantages (T and T_f).

Romero & McCombie (2018) use industry-level data for 13 sectors in seven European countries for 4-year time periods between 1984 and 2006 and employ systems GMM to control for simultaneity. Once TFP is included in the estimated equations, the relative price variables become statistically insignificant for both exports and imports. In contrast, the TFP variables are significant at the 10% level or better in most of the estimates and are generally stronger for high-tech industries compared with low-tech industries. The capacity variable has negligible effects and is never significant, but the income elasticity remains positive and significant in all estimates.[27] As expected, income elasticities are generally higher for exports of high-tech sectors compared with low-tech ones.

Bottega & Romero (2021) adopt a similar conceptual approach to Romero & McCombie (2018) while also drawing on other recent studies of technology and trade such as Madsen (2008) and

Ang et al. (2015). However, Bottega & Romero (2021) use more direct measures of technological competitiveness (T and T_f) based on patent data instead of TFP estimates. These authors employ industry-level data for 15 countries in the sample period 1976–2012 and use both system GMM and panel error correction methods as a sensitivity test. One of their major findings is that the estimated income elasticities drop considerably once their measures of T and T_f are included in the regressions, suggesting that technological competitiveness is an omitted variable in studies that have found higher income elasticities. In regard to price competitiveness, Bottega and Romero find that it is statistically insignificant in most of their estimates for all industries, especially when technological competitiveness is included, but it is significant in split samples for "high technology" and "low technology" industries—especially the latter when the innovation variables are included. Overall, Bottega & Romero (2021, p. 182) conclude that "non-price and technological competitiveness are more relevant for the export performance of high-tech products, while price competitiveness is a more determinant factor for the exports of low-tech products."

Ribeiro et al. (2020) test the hypotheses of Ribeiro et al. (2016, 2017b), which imply that the effects of RER depreciation on growth should be ambiguous once the impacts on income distribution and technological innovation are taken into account. The sample consists of data for 54 developing countries averaged over 4-year periods between 1990 and 2010. The authors use four alternative econometric methods (pooled OLS, panel fixed effects, difference GMM, and systems GMM) as a robustness check. Their baseline estimates (which include a standard set of controls) show positive effects of real undervaluation (also calculated based on Rodrik, 2008) on per capita income growth, which are qualitatively similar to the results in previous studies (and statistically significant using two of the four methods). However, once the wage share and a measure of technological capabilities (labor productivity relative to the US level) are included in the regressions, the RER undervaluation variable becomes mostly insignificant (except using pooled OLS). Ribeiro et al. (2020) also find robust evidence for Verdoorn effects in driving labor productivity growth and that RER undervaluation significantly reduces the wage share.

Still different conclusions about RER effects emerge from the work of Caglayan & Demir (2019), who use trade data disaggregated by commodity type and country group (North and South). Following the categorization of Lall (2000), Caglayan and Demir divide the goods into five types: primary products and four types of manufactures (low-skill, medium-skill, high-skill, and resource-intensive). They estimate bilateral trade flows between 172 countries over the period 1962–2012. The authors use an empirical approach based on the gravity model of trade (see Feenstra, 2016), rather than the demand functions typically used in BPCG models; this allows them to control for many covariates that are known to explain trade flows, which are not usually controlled for in estimated demand functions.

In their full sample of countries, Caglayan & Demir (2019) find that a higher RER (real depreciation) has a significantly positive effect on total, medium-skill, low-skill, and resource-intensive exports, but not on high-skill or primary exports. In the samples disaggregated by country group, the authors report that RER depreciation has a positive effect on total exports in all directions except South-North. For high-skill goods, RER depreciation increases exports only in the South-North direction and this effect is significant only at the 10% level. "Regarding medium-skill goods, RER depreciation increases exports in all directions, but the strongest effect is again in the South-North direction. The findings for high- and medium-skill goods suggest a potentially stronger development channel effect in developing than developed countries." (Caglayan & Demir, 2019, p. 1647)

The findings of Caglayan & Demir (2019) thus suggest cautious optimism in regard to the prospects for an RER depreciation to boost at least some manufactured exports of developing

countries. However, the effects on South-North trade are strongest for certain types of goods (medium-skill and resource-intensive manufactures), statistically weaker for high-skill exports, and insignificant for other goods (low-skill manufactures and primary commodities as well as total exports). Whether the positive effects are sufficient to increase the weighted-average income elasticity of total Southern exports remains to be seen, especially since the effects are strongest in the middle of the technological spectrum and weaker for high-skill manufactures. Furthermore, the weaker effects of the RER on high-skill exports compared with medium-skill and resource-intensive goods—similar to the finding of Bottega & Romero (2021) about high-tech versus low-tech exports—suggest that RER undervaluation may be a better strategy for developing countries to achieve middle income status than for such countries to escape from the "middle income trap."

To conclude this discussion, one way to reconcile these divergent findings is to suggest that what studies such as Romero & McCombie (2018) and Ribeiro et al. (2020) really show is not so much that RERs are unimportant, but rather that they are (at least in part) channels for conveying the effects of deeper, underlying causes such as income distribution and technological competitiveness. Also, it is important to caution that the data samples used in these studies may be picking up short-run or medium-run effects of RERs and relative prices, rather than the long-run effects emphasized in Thirlwall's law.

4 | MODELS WITH ENDOGENOUS PRODUCTIVITY GROWTH AND STRUCTURAL CHANGE

As discussed earlier, Verdoorn's law and Kaldorian cumulative causation (Dixon & Thirlwall, 1975; Setterfield & Cornwall, 2002) play no role in standard solutions of the BPCG model. On the assumption that relative price effects are negligible in the long run, Thirlwall's law reflects only non-price competitiveness as embodied in the income elasticities of export and import demand. However, several recent contributions have re-integrated Kaldorian cumulative causation into the BPCG framework, based on disaggregated models that also incorporate structural change. In this section, we will start with the model of Araujo (2013), which includes Verdoorn's law and relative price effects at the industry level in an MSTL framework. Then, we will turn to models that make the income elasticities endogenous at the sectoral level and link their evolution to either the RER or labor productivity growth.[28]

4.1 | Cumulative causation with structural change

Araujo (2013) incorporates Kaldor-Verdoorn feedback effects of output growth onto productivity growth into the original MSTL model of Araujo & Lima (2007). The model in Araujo (2013) is disaggregated so that the Verdoorn effects differ across industries and goods.[29] Drawing upon Pasinetti (1981) and Araujo & Teixeira (2003), Araujo (2013) includes an explicit treatment of the evolution of per capita consumption on the demand side and ULC (labor coefficients multiplied by wage rates) on the supply side,[30] all specified at the level of the individual good or industry. Compared to the earlier works on structural change, the innovation in Araujo (2013) is that the labor coefficients not only decay as labor productivity increases, but the rate of decay (rate of productivity growth) is endogenous via Verdoorn's law. In relation to the BPCG literature, Araujo (2013) stands out for focusing on a medium-run time frame in which relative prices are changing, on the presumption that such changes can influence the level of the long-run trend of output even

if they do not affect the long-run equilibrium growth rate. This implies that the endogenous rates of productivity growth at the sectoral level affect the price competitiveness of home country goods relative to foreign products, which in turn affects the BP-equilibrium growth rate.

As in the original MSTL model, the analysis is conducted from the perspective of the global South, which trades with the advanced economies in the North. The results in Araujo (2013) can be summarized in the following expression for the BP-equilibrium growth rate of per capita income in country S, conditional on the growth rate of per capital income in N, in the medium run:

$$\hat{y}^S_{pc} = \frac{\sum_{i=1}^{G} \xi \eta^S_{X,i} x^S_i a^S_i}{\sum_{i=1}^{G} \eta^S_{M,i} m^S_i a^S_i} \hat{y}^N_{pc} + \frac{\sum_{i=1}^{G} a^S_i \left[(\xi \varepsilon^S_{X,i} x^S_i + \varepsilon^S_{M,i} m^S_i)(\hat{y}^S_i - \hat{y}^N_i - \hat{E}) + (m^S_i - \xi x^S_i)\hat{y}^S_i \right]}{\sum_{i=1}^{G} \eta^S_{M,i} m^S_i a^S_i} \tag{28}$$

where the notation is generally the same as for Equation (11) except that price elasticities for individual goods ($\varepsilon^j_{X,i}$ and $\varepsilon^j_{M,i}$), labor productivity growth rates $\hat{y}^j_i$, and the rate of nominal depreciation $\hat{E}$ are now included. Note that the rate of productivity growth for good i in country j, $\hat{y}^j_i$, is the negative of the rate of change (decay) in the corresponding labor coefficient a^j_i (since $y^j_i = 1/a^j_i$). Also recall that "population" is assumed to equal the employed labor force in each country for simplicity.

The first term on the right-hand side of Equation (28) can be recognized as the original MSTL solution of Araujo & Lima (2007), shown in Equation (11) above.[31] The second term reflects the (positive) impact of relative South-North productivity growth, which operates mainly through a relative price channel (and hence depends on the price elasticities, which are defined here to be positive), at the industry level.[32] The role of relative productivity growth is highlighted by the simplifying assumptions that nominal wages increase at the same rate in both countries and that profit markups remain constant. The impact of relative productivity growth does not appear in the standard MSTL model because of the assumption of LRR-PPP. In Equation (28), the relative productivity effects are strongest in industries that have the highest price elasticities.

The productivity growth rates in Equation (28) are endogenous and determined as follows. For goods that are only produced for domestic consumption in the South (because $P^S_i \geq EP^N_i$), productivity grows according to the sectoral Verdoorn relationship

$$\hat{y}^S_i = \rho^S_{0,i} + \rho^S_{1,i}(\hat{c}^S_i + \hat{L}^S) \tag{29}$$

which is linked only to the growth of domestic demand for that product ($\hat{c}^S_i + \hat{L}^S$), where $\hat{c}^S_i$ is the growth rate of per capita consumption of good i and $\hat{L}^S$ is the growth rate of population (which assumed for simplicity to be the same as the employed labor force), all in the South. However, for goods that are exported (because $P^S_i < EP^N_i$), productivity grows according to an augmented sectoral Verdoorn equation, which includes the impact of foreign (N) variables:

$$\hat{y}^S_i = \frac{\rho^S_{0,i} + \rho^S_{1,i}\left[\theta^S_i \hat{c}^S_i - (1-\theta^S_i)\varepsilon^S_{X,i}\rho^N_{0,i} + \Omega^N_i \hat{y}^N_{pc} + (1-\theta^S_i)(\eta^S_{X,i} - 1)\hat{L}^S + \hat{L}^S\right]}{1 - (1-\theta^S_i)\varepsilon^S_{X,i}\rho^S_{1,i}} \tag{30}$$

where θ^S_i is the share of domestic consumption in total production of good i in the South, $(1-\theta^S_i)$ is the share of exports, $\Omega^N_i = (1-\theta^S_i)(\eta^N_i - \varepsilon^S_{X,i}\rho^N_{1,i}\kappa^N_i)$, κ^N_i is the sensitivity of the growth rate of

demand to the growth rate of per capita income for each good i in the North, and it is assumed that $\hat{E} = 0$ and $1 - (1 - \theta_i^S)\varepsilon_{X,i}^S \rho_{1,i}^S > 0$.

One important point to note here is the negative effect of higher productivity growth in the North on productivity growth in the South, which can be seen in the negative signs of the terms multiplying the Northern Verdoorn coefficients, $\rho_{0,i}^N$ and $\rho_{1,i}^N$. Faster productivity growth in the North makes Northern products more competitive, thereby taking global market share away from Southern exports and reducing the endogenous productivity gains for the South. Of course, by the same logic, faster productivity growth in the South would also reduce productivity gains for the North, if the model was reformulated from the Northern perspective.

4.2 | Integrating Verdoorn's law and endogenizing income elasticities

In addition to endogenizing productivity growth using Verdoorn's law, a number of recent studies have also made the sectoral income elasticities endogenous instead of treating them as exogenously given parameters.[33] Some of these studies focus on RER effects. We have already noted (in section 3.1 above) that the aggregate (weighted-average) income elasticities can change in response to changes in the RER insofar as this variable affects the industrial composition of a country's trade. Following Garcimartín et al. (2012), Missio & Jayme (2012), Cimoli et al. (2013), Ferrari et al. (2013), and Missio et al. (2017), we can add several reasons why the RER might also affect industry-level elasticities. First, a competitive RER could stimulate more technological innovation in domestic industries producing tradable goods (Missio & Jayme, 2012). Second, the RER could induce technological upgrading of those industries' products, leading to what Garcimartín et al. (2012) call a "sophistication effect." Third, a competitive RER could lead to the development of new products, or what Missio & Jayme (2012) call a "diversification effect." All three of these mechanisms could potentially lead to increased income elasticities for many of a country's exports (and decreased income elasticities for imports of goods for which domestic substitutes become available). Missio et al. (2017) assume that industry-level income elasticities for exports (imports) are increasing (decreasing) functions of the RER in an extension of the model from Araujo (2013). However, it may be doubtful that these effects are linear (as Missio et al., 2017 assume), because an extremely undervalued currency (very high RER) could make a country's existing products highly competitive and thereby lessen incentives for innovation, upgrading, and diversification.

Another approach to endogenizing industry-level income elasticities is found in Magacho & McCombie (2020), who also consider structural change with endogenous productivity (Verdoorn effects) at the sectoral level. The difference in Magacho & McCombie (2020) is that the income elasticities depend on qualitative competitiveness, which is assumed to be associated with labor productivity, rather than on price competitiveness or the RER. Magacho & McCombie (2020) follow Setterfield (2011) in assuming that increases in labor productivity are correlated with improvements in product quality, which should enhance the non-price competitiveness of the goods produced in an industry. Whereas Setterfield's analysis was conducted at the aggregate level, Magacho and McCombie develop a disaggregated model in which the income elasticities for individual goods change over time at rates governed by industry-level relative productivity growth at home and abroad:[34]

$$\hat{\eta}_{X,i} = \zeta_i(\hat{y}_i - \hat{y}_i^f) \tag{31}$$

$$\hat{\eta}_{M,i} = \zeta_i(\hat{y}_i^f - \hat{y}_i) \tag{32}$$

Thus, as productivity rises in the home country relative to the foreign country, home goods should improve their relative quality, and hence the corresponding income elasticities should rise for exported goods and fall for imported ones. The parameters $\zeta_i > 0$ are assumed to be the same for exports and imports (home and foreign products) for simplicity, but they do vary by industry.

Similar to Araujo (2013), Magacho & McCombie (2020) assume that the Verdoorn's law relationships differ by industry

$$\hat{y}_i = \rho_{i,0} + \rho_{i,1}\hat{Y} \tag{33}$$

$$\hat{y}_i^f = \rho_{i,0} + \rho_{i,1}\hat{Y}_f \tag{34}$$

but in the basic version of the model the coefficients do not differ across countries.[35] Also, referring to the generalized MSTL solution in Equation (12), Magacho & McCombie (2020) observe that the sectoral weights (shares of each good i in the value of total exports or imports) will change at the rates

$$\hat{\alpha}_i = \hat{P}_{X,i} - \hat{P}_X + \hat{X}_i - \hat{X} = (\hat{P}_i - \hat{P}) + (\eta_{X,i} - \eta_X)\hat{Y}_f \tag{35}$$

$$\hat{\beta}_i = \hat{P}_{M,i} - \hat{P}_M + \hat{M}_i - \hat{M} = (\hat{P}_i - \hat{P}) + (\eta_{M,i} - \eta_M)\hat{Y}_f \tag{36}$$

for exports and imports respectively, where $P_{X,i}$ and $P_{M,i}$ are the prices of individual traded goods, P_X and P_M are "general" (weighted-average) price indexes for all exports and imports, P or P_i represents world prices (of all goods or individual goods) measured in a common currency (so that the exchange rate can be ignored), and time subscripts are suppressed. These equations represent demand-driven changes in the weights on the various traded goods over time.

Putting all these elements together, the model solves for the change in the BP-equilibrium growth rate as a function of (among other things) relative income elasticities and relative home and foreign growth rates at the sectoral level:[36]

$$\begin{aligned} d\hat{Y}_B = {} & \textstyle\sum_i \frac{\alpha_i \eta_{X,i}}{\eta_M} \left[(\hat{P}_i - \hat{P}) + (\eta_{X,i} - \eta_X)\hat{Y}_f + \zeta_i \rho_{1,i}(\hat{Y}_i - \hat{Y}_{f,i})\right]\hat{Y}_f \\ & - \textstyle\sum_i \frac{\beta_i \eta_{M,i}}{\eta_M} \left[(\hat{P}_i - \hat{P}) + (\eta_{M,i} - \eta_M)\hat{Y}_f - \zeta_i \rho_{1,i}(\hat{Y}_i - \hat{Y}_{f,i})\right] \frac{\eta_X}{\eta_M}\hat{Y}_f + \frac{\eta_X}{\eta_M} d\hat{Y}_f \end{aligned} \tag{37}$$

Thus, the BP-equilibrium growth rate evolves over time depending (in part) on structural change in the economy, as reflected in the growth of domestic industries relative to their foreign counterparts, and also in proportion to the differences between the sectoral income elasticities and their respective economy-wide weighted averages (η_X and η_M).

Assuming (again in the most basic version of the model) that faster growth of one sector does not come at the expense of slower growth in other sectors,[37] under plausible assumptions the

effect on the change in the BP-equilibrium growth rate is

$$\frac{\partial(d\hat{Y}_B)}{\partial\hat{Y}_i} = \zeta_i\rho_{1,i}\left[\alpha_i\eta_{X,i} + \beta_i\eta_{M,i}\frac{\eta_X}{\eta_M}\right]\left(\frac{\hat{Y}_f}{\eta_M}\right) \tag{38}$$

which shows that the long-term growth rate of a country accelerates when the sectors under consideration grow faster. However, this acceleration in the BPCG rate depends on the sectoral Verdoorn coefficient and the sectoral income elasticities of demand for imports and exports. The greater are the Verdoorn coefficient and the income elasticities of the sector under consideration, the greater is the impact on the BPCG rate. (Magacho & McCombie, 2020, p. 643.)

The key implication is that there need not be an initial acceleration of *aggregate* growth in order to launch a process of cumulative causation; rather, *structural change* (in the form of one sector growing faster relative to others domestically) can potentially launch such a process, providing that the sector has relatively strong Verdoorn feedback effects combined with a relatively high income elasticity of demand for its products. The authors thus highlight the need to focus industrial policies on sectors that present these favorable characteristics. However, Magacho and McCombie exclude the possibility that RER depreciation (in levels) could have a positive impact on such structural change, as emphasized in several studies cited earlier.

5 | DISTRIBUTIVE CYCLES, UNEVEN DEVELOPMENT, AND THE ADJUSTMENT PROCESS

A relatively new literature has brought the analysis of distributive cycles, founded on the seminal work of Goodwin (1967), into the BPCG framework. The Goodwin approach, which was later extended by authors such as Barbosa-Filho & Taylor (2006), Franke et al. (2006), and Flaschel & Landesmann (2008), seeks to explain counterclockwise rotations of the wage share of national income and some measure of economic activity (usually, either the employment rate or rate of capacity utilization). In Goodwinian models, economic growth (capital accumulation or investment demand) is driven by profitability, and rapid growth fosters higher employment (or utilization). However, higher employment (or utilization) squeezes profits by empowering labor in the bargaining process, thereby making wages increase faster and cutting into profits, eventually causing an economic downturn. These dynamics are then reversed in a recession: once labor's bargaining position is weakened by higher unemployment so that the wage share eventually falls, profits rebound, and output and employment in turn recover. The resulting dynamics may generate various types of cyclical behavior, such as limit cycles, closed orbits, and damped or explosive cycles, depending on the characteristics of a given model and the assumed parameter values, but this qualitative "Goodwin pattern" (Flaschel et al., 2020) is common to all Goodwinian models.

In BPCG models that incorporate Goodwinian cyclical dynamics, some version of Thirlwall's law remains the long-run, steady-state equilibrium of the economy. However, these models put much more emphasis on the transition process toward that equilibrium (or cyclical oscillations around it), whether that process is stable or unstable, and if it exhibits persistent or damped cycles. Notably, these models bring labor market dynamics and the functional (wage-profit) distribution of income into the analysis of that transition. These models also link to several of the other strands of literature covered above, since they all make labor productivity endogenous, some

incorporate relative price effects, and others feature structural differences between the global North and South. The newer Goodwin-Thirlwall syntheses draw upon several earlier sources, including Pugno (1998), Barbosa-Filho (2001), La Marca (2010), Dávila-Fernández & Libânio (2016), and Garcimartín et al. (2016), among others.[38] Rather than trace all these roots, however, we will focus here on several leading exemplars of the most recent contributions.

5.1 | Labor market dynamics, income distribution, export capacity, and path dependency

Dávila-Fernández & Sordi (2019a, 2019b) present a series of models that integrate Goodwin cycles into the BPCG framework. One distinctive feature of their approach is to model endogenous productivity growth as determined by the rate of capacity utilization, where the latter is reflected in the output-capital ratio, $u = Y/K$:

$$\hat{y} = Q(u), Q' > 0 \tag{39}$$

Clearly, this differs from the standard Verdoorn's law approach discussed earlier, where productivity growth depends instead on the growth rate of output $\hat{Y}$. Dávila-Fernández & Sordi (2019a, pp. 218–219) justify this formulation by a general Kaldorian approach in which there are "increasing returns" as output increases; they also note that their specification reflects the widely recognized procyclical behavior of labor productivity. Dávila-Fernández & Sordi (2019b) clarify that their approach focuses on workers producing more output using a given set of machines when utilization is high, rather than firms adopting labor-saving innovations in response to tighter labor market conditions.

Dávila-Fernández & Sordi (2019a) assume that capital accumulation is driven by the profit rate $r = (1 - \psi)u$, where ψ is the wage share:

$$\hat{K} = (1 - \psi)u \tag{40}$$

on the assumption that all profits are saved and invested (there are no savings out of wages). Dávila-Fernández & Sordi (2019a) ignore relative price effects and assume that exports and imports are driven only by foreign and domestic income, respectively, with constant income elasticities η_X and η_M; hence, the long-run equilibrium growth rate corresponds to the strong form of Thirlwall's law in Equation (8). They also assume a variant of the Phillips curve in which the rate of increase in the real wage w depends on the employment rate (the ratio $e = L/\Lambda$, where now L is employed labor or labor demand, Λ is the labor supply, and $L \leq \Lambda$):

$$\hat{w} = F(e) \tag{41}$$

Combining these elements with equations representing the rates of change in the employment and utilization rates and the wage share ($\hat{e}$, $\hat{u}$, and $\hat{\psi}$), the authors derive a dynamic system of three simultaneous differential equations in the variables e, u, and ψ, with the following properties:

- There exists a unique long-run equilibrium (e^*, u^*, ψ^*) at which the strong version of Thirlwall's law hold: $\hat{Y}_B = (\eta_X/\eta_M)\hat{Y}_f$.

- If the sensitivity of the real wage to the employment rate evaluated at the long-run equilibrium $F'(e^*)$ is sufficiently low, the long-run equilibrium is locally asymptotically stable.
- If the sensitivity $F'(e^*)$ is sufficiently high and lies in a certain critical range, then the Hopf Bifurcation Theorem implies that "the dynamic system … has a family of periodic solutions" (p. 221) in which there is a three-dimensional limit cycle and the variables e, u, and ψ all exhibit regular periodic fluctuations around their equilibrium values (as demonstrated by numerical simulations).

Either way, the economy does not permanently deviate from the BPCG solution, but depending on the strength of the wage response to labor market tightness, the economy may either converge to that solution or oscillate endlessly around it.

This modeling approach is further extended by Dávila-Fernández & Sordi (2019b). They assume an independent investment function in the spirit of Bhaduri & Marglin (1990) with separate effects of distribution and utilization

$$I/K = H(\psi, u), H_\psi < 0, H_u > 0 \tag{42}$$

but in their dynamic analysis they appear to use the Robinsonian specification

$$I/K = h(r) = h[(1-\psi)u], h_r > 0 \tag{42'}$$

which they in turn linearize for mathematical convenience. The authors use the saving function

$$S/K = s(1-\psi)u \tag{43}$$

where profits are saved with the marginal propensity s $(0 < s < 1)$ and again there are no savings out of wages. This specification allows the authors to consider disequilibrium situations in which $X - M = S - I \neq 0$. Dávila-Fernández & Sordi (2019b) also modify the real-wage Phillips curve to include the rate of change in the employment rate

$$\hat{w} = F(e, \hat{e}) \tag{44}$$

where both partial derivatives are positive.

In addition, Dávila-Fernández & Sordi (2019b) make exports a function of the capital stock as well as foreign income, thus combining the emphasis of Razmi (2016) on export supply capacity with the more traditional emphasis of Thirlwall (1979) on foreign demand growth. In growth rate form, this hybrid export function can be expressed as

$$\hat{X} = \gamma_X \hat{K} + \eta_X \hat{Y}_f \tag{45}$$

This, of course, allows for dynamic feedbacks from capital accumulation $\hat{K} = I/K$ to export growth and hence to relieving the BP constraints otherwise imposed by increased imports when the domestic economy expands faster. Nevertheless, it must be assumed that $\gamma_X < 1$ to rule out explosive growth. The authors provide empirical support for this export function using panel cointegration techniques for a sample of 19 OECD countries estimated using dynamic ordinary least squares (DOLS). The analysis shows that the three series (exports, foreign income, and capital stock) are cointegrated, with a USD 100 rise in capital associated

with an increase in exports in the range of USD 3.5–4.1, and panel causality tests indicate bidirectional pairwise causality between all three variables. Relative price or RER effects are not considered.

Combining this specification of exports with the rest of the model, the authors again derive a three-variable dynamic system in e, u, and ψ. They show that this system has a unique long-run equilibrium solution in which $X - M = S - I = 0$ and the following modified version of Thirlwall's law holds:

$$\hat{Y}_B = \left(\frac{\eta_X}{\eta_M - \gamma_X}\right)\hat{Y}_f \tag{46}$$

Thus, a higher capital elasticity of exports (γ_X)—or what Dávila-Fernández & Sordi (2019b, p. 264) call "a reorientation of capital accumulation towards exports"—increases the BP-equilibrium growth rate. The authors then analyze the system dynamics in terms of the strength of the profitability effect on investment, h_r. Depending on the magnitude of this effect, the equilibrium (e^*, u^*, ψ^*) may be locally asymptotically stable; otherwise, in the neighborhood of a certain critical value for h_r, the Hopf Bifurcation Theorem implies persistent cyclical behavior (limit cycles)—as again demonstrated using numerical simulations.

Dávila-Fernández & Sordi (2019b) also discuss whether this type of model can generate path dependency, in which different initial conditions can lead to divergent outcomes. The model just described implies a limited form of path dependency: in the case where cycles exist, their amplitude can be sensitive to initial conditions. To allow for more complex dynamics, Dávila-Fernández & Sordi (2019b, p. 266) insert "a non-linear forcing term in the capital accumulation function," to represent the Schumpeterian idea of periodic investment cycles driven by innovation waves (attributed to Goodwin, 1951). Specifically, Equation (42′) becomes

$$I/K = -h_0 + h_1 r + h_2 \cos(h_3 t) \tag{42″}$$

where h_0, h_1, h_2, and h_3 are all positive parameters. In this case, "a non-linear system with a 'natural' oscillation frequency interacts with an external 'force' resulting in a chaotic attractor," and "Very small differences in the initial conditions give rise to widely different [cyclical] trajectories" after sufficient time passes (Dávila-Fernández & Sordi, 2019b, pp. 266–267). In other words, this formulation of a Goodwin-Schumpeter-Thirlwall synthesis yields true path dependency as well as cyclical fluctuations around a long-run BPCG equilibrium path.

In a further extension of their approach, Dávila-Fernández & Sordi (2021) propose that the BP-equilibrium growth rate (Thirlwall's law) can be reconceptualized as a "center of gravity" instead of a "binding constraint." Drawing upon a new reinterpretation of Kalecki's theory of economic cycles by Sordi (2006) and Franke (2018), who emphasize lags in investment decisions, Dávila-Fernández & Sordi (2021) construct a model of asymmetrical cycles around the BP-equilibrium growth rate, in which (under certain conditions) actual growth is more often below that equilibrium rate than above it. However, as their earlier work and the articles surveyed in the next two subsections show, the dynamics around the Thirlwall's law equilibrium can be very sensitive to model specification and the relative strength of different effects.

5.2 | Relative price effects, distributional dynamics, and BP adjustment

A different approach to integrating Goodwin cycles with BPCG is found in Nishi (2019), who allows a role for relative prices in the adjustment to a long-run BP equilibrium. Nishi starts, however, by postulating the post-Keynesian view that national income (rather than the RER) is the variable that adjusts in response to a trade imbalance. Nishi's specification is:[39]

$$\frac{d\hat{Y}}{dt} = \varphi\left(\hat{P} + \hat{X} - \hat{E} - \hat{P}_f - \hat{M}\right) \tag{47}$$

where $\varphi > 0$ is a positive constant representing the speed of adjustment, the export and import demand functions are given by Equations (5) and (6), and capital flows are not explicitly modeled.

Although the RER is not the adjusting variable *per se*, it nevertheless changes endogenously in response to variations in output growth and the employment rate, and—assuming that the ML condition is satisfied—the evolution of the RER affects the adjustment process through its impact on price competitiveness and hence on quantities of exports and imports. Long-run BP equilibrium requires that $d\hat{Y}/dt = 0$, in which case Thirlwall's law including RER effects in Equation (10) applies—although Nishi also considers the special cases where ML is not satisfied or LRR-PPP holds, so that RER effects are eliminated.

A few other key features of Nishi's model are as follows. First, he assumes a conflict model of inflation[40] in which nominal wages and prices adjust in response to deviations of the realized wage share from workers' and firms' targets for the wage share (ψ_W and ψ_C, respectively), where the worker's target in turn is an increasing function of the employment rate:

$$\hat{W} = (1-\mu)[\psi_W(e) - \psi], \psi'_W(e) > 0 \tag{48}$$

$$\hat{P} = \mu(\psi - \psi_C) \tag{49}$$

Here, the parameter μ $(0 < \mu < 1)$ represents the relative bargaining strength of firms compared to workers, $\psi_W(e) > \psi_C$ is assumed in order to generate positive inflation, and Nishi refers to the impact of the employment rate on wage inflation $(1-\mu)\psi'_W(e)$ as the "profit-squeeze effect." Of course, the definition of the wage share implies that $\hat{\psi} = \hat{W} - \hat{y} - \hat{P}$, and Nishi assumes that productivity growth is an increasing function of the employment rate

$$\hat{y} = \Phi(e), \Phi'(e) > 0 \tag{50}$$

because firms accelerate the rate of labor-saving technological progress in response to tighter labor-market conditions. Hence an increase in the employment rate can either increase or decrease the wage share, depending on whether the profit-squeeze effect $(1-\mu)\psi'_W(e)$ is greater or less than the response of labor-saving technological progress $\Phi'(e)$, with different impacts on price competitiveness in each case (negative and positive, respectively). Changes in the employment rate in turn are driven by the changes in output (which depend on BP disequilibrium), adjusted for changes in labor productivity $\hat{y}$ and labor supply $\lambda = \hat{\Lambda}$ (where the latter is exogenously given):

$$\hat{e} = \hat{L} - \hat{\Lambda} = \hat{Y} - \hat{y} - \hat{\Lambda} = \varphi(\hat{P} + \hat{X} - \hat{E} - \hat{P}_f - \hat{M}) - \Phi(e) - \lambda \tag{51}$$

Putting all of this together, Nishi (2019) solves for a dynamic system in the three variables e, ψ, and $\hat{Y}$, which yields an economically meaningful steady-state solution under certain restrictions. This solution, if it exists, ensures that output growth follows a modified Thirlwall's law that allows for endogenous changes in domestic prices[41]

$$\hat{Y}^* = \frac{(\varepsilon_X + \varepsilon_M - 1)\left[\hat{E} + \hat{P}_f - \mu(\psi^* - \psi_C)\right] + \eta_X \hat{Y}_f}{\eta_M} \tag{52}$$

where the steady-state wage share is given by

$$\psi^* = (1-\mu)\psi_W(e^*) + \mu\psi_C - \Phi(e^*) \tag{53}$$

and output grows at an endogenous "natural rate" (which converges to the BP-equilibrium rate through adjustment of the employment rate, which in turn determines productivity growth)

$$\hat{Y}^* = \Phi(e^*) + \lambda. \tag{54}$$

Several types of dynamics can then result, depending especially on whether the profit-squeeze effect is stronger or weaker than the responsiveness of labor-saving technological change:

- Case A: Labor-saving technological change is stronger, $\Phi'(e^*) > (1-\mu)\psi'_W(e^*)$. In this case, faster growth and higher employment have a positive feedback effect on price competitiveness, and hence increase the trade balance and further raise the growth and employment rates unless import demand rises fast enough. The equilibrium is locally stable if the income elasticity of imports η_M is sufficiently large, and locally unstable otherwise. Since a higher η_M implies a lower BP-equilibrium growth rate, this result implies the possible existence of a trade-off between faster steady-state growth and greater macroeconomic stability (faster growth could be explosive, if η_M is too low).
- Case B: The profit-squeeze is stronger, $\Phi'(e^*) < (1-\mu)\psi'_W(e^*)$. This case can generate a Goodwinian limit cycle provided that the income elasticity of imports η_M is not too large and the speed of adjustment of the growth rate φ lies within a certain range. In this case, faster growth and higher employment have a negative feedback effect on price competitiveness, so the trade balance is reduced, which in turn reduces output growth. However, as in any Goodwinian model, slower growth translates into lower employment and a falling wage share, which in this case improves competitiveness causing the trade balance to increase and growth to rise again, and this process then repeats itself. Thus, the rotations are counterclockwise in $\psi \times \hat{Y}$ and $\psi \times e$ space but clockwise in $e \times \hat{Y}$ space. Under other parameter conditions, however, the equilibrium can become unstable with explosive cycles.
- Case C: The elasticities do not satisfy the ML condition ($\varepsilon_X + \varepsilon_M = 1$) *or* the profit-squeeze effect and labor-saving technological change response are equally strong [$\Phi'(e^*) = (1-\mu)\psi'_W(e^*)$]. In the first situation, changes in price competitiveness have no impact, and in the latter situation, such changes do not occur in response to variations in growth and employment because the two effects on the wage share are exactly offsetting. With relative price effects thus eliminated from the adjustment process, the remaining feedbacks in the model are all stabilizing, and the equilibrium becomes locally stable.

Thus, Nishi (2019) shows that Goodwinian limit cycles can potentially emerge when the adjustment process in a BPCG model includes relative price (RER) effects along with a strong profit-squeeze effect, but other types of system dynamics are also possible. His analysis is also important for showcasing the potential importance of relative prices in the adjustment process, even when income growth is the main adjusting variable, and for identifying the factors that can make such an adjustment either stable or unstable and cyclical or acyclical. Like Dávila-Fernández & Sordi (2019a, 2019b), Nishi (2019) identifies ways in which income distribution can be an intervening variable in the BPCG adjustment process, but through a different channel (price competitiveness instead of capital accumulation).

5.3 | Technological catch-up and uneven development in a Goodwin-Thirlwall model

As earlier sections have shown, the BPCG model has frequently been applied to the case of uneven development (unequal growth) between the global North and South. One pathbreaking contribution in this regard was the North-South BPCG model of Dutt (2002), which depicted a North characterized by a neo-Kaleckian economy with markup pricing, excess capacity, and an independent investment function, and a South characterized by a classical-Lewis economy with a fixed real wage, supply-determined output, and saving-driven growth. A key implication of Dutt's model is that the South's terms of trade, reflected in the inverse of the RER for the South P_S/EP_N, must adjust endogenously in order for the global system to reach its long-run equilibrium. The growth of the North is essentially self-driven, determined by domestic saving and investment propensities and income distribution in the North. However, since the South must import capital goods from the North, the growth rate of the South depends on its terms of trade (which determine the region's purchasing power over imported capital goods) as well as the Southern profit share and saving rate out of profits. Sasaki (2021) has recently extended Dutt's model by, among other things, considering cases where Northern demand can be either profit-led or wage-led, instead of only the latter, but does not introduce Goodwin cycles.

Spinola (2020) has developed an expanded version of the Dutt (2002) model that does allow for Goodwinian cycles and also adds other features of relevance for analyzing North-South uneven development. In the spirit of Cimoli & Porcile (2014) and Cimoli et al. (2019), Spinola focuses on the productivity gap between the two regions, defined in logarithmic terms as $\Gamma = \ln(y_N/y_S)$. The larger this gap, the greater is the potential for Southern catch-up, as reflected in the productivity growth function

$$\hat{y}_S = \rho_3 + \rho_4\Gamma \tag{55}$$

which is written in linear form for mathematical convenience. The magnitude of the catch-up parameter $\rho_4 > 0$ "depends on learning efforts and the absorptive capacity of the [Southern] economy" (Spinola, 2020, p. 223), as suggested by scholars of technological change such as Verspagen (1993), and turns out to be crucial for the dynamics of the system as discussed below.

The South's real wage w_S evolves according to what Spinola calls a "wage curve" (following Blanchflower & Oswald, 1994), which is essentially a linearized version of the real-wage Phillips curve used by Dávila-Fernández & Sordi (2019a):

$$\hat{w}_S = f_0 + f_1 e_S \tag{56}$$

where $e_S = L_S/\Lambda_S$ is the employment rate in the South. Also in regard to the labor market, Spinola adds another structural feature for the Southern economy, by incorporating "surplus labor" in the sense of Lewis (1954). Spinola models this process by assuming that the labor supply responds positively to the wage share and negatively to the profit share in the modern sector of the South (which is the only Southern sector modeled explicitly):

$$\lambda_S = \hat{\Lambda}_S = l_0 - l_1(1 - \psi_S) \tag{57}$$

Combining all these elements and other relationships more similar to the original specifications in Dutt (2002) and the labor market dynamics in Dávila-Fernández & Sordi (2019a), Spinola (2020) derives a dynamic system of four simultaneous differential equations in the Southern employment rate e_S, Southern wage share ψ_S, the North-South productivity gap Γ, and the South's terms of trade P_S/P_N (where the nominal exchange rate has been normalized to $E = 1$). Analyzing the dynamics of the system under reasonable parameter restrictions, Spinola finds that the long-run equilibrium is stable and exhibits damped cycles, but not limit cycles.

Spinola (2020) then considers three alternative scenarios: a baseline scenario in which (by construction) the gap Γ remains constant in the long run; a "lagging-behind" scenario in which Γ increases in the long run; and a "catching-up" scenario in which Γ decreases in the long run. In all three scenarios, e_S and ψ_S exhibit cyclical fluctuations that are damped, but otherwise Goodwinian (the wage share is the "predator" variable that follows the employment rate "prey"). In the baseline, P_S/P_N cycles around a constant trend, but in the lagging-behind scenario it falls secularly with damped fluctuations, while in the catching-up scenario it rises secularly with damped cycles around a rising trend. The two latter scenarios are generated by different assumptions about several parameters, including crucially the catching-up scenario has a higher ρ_4 coefficient reflecting greater absorptive capacity and economic diversification in the South.

6 | CONCLUSIONS

Recent work in the BPCG framework has incorporated several key theoretical elements that were not included—or in some cases were deliberately excluded—in the original formulations of the model. These features include structural change (shifts in the industry composition of trade), endogenous technological progress (usually, but not always, modeled using Verdoorn's law), and long-run changes in the income elasticities of demand for exports and imports (at least the weighted-average aggregate elasticities, and possibly also the sectoral ones). Moreover, the new literature has reconsidered a more important role for relative prices or RERs, at least in the medium run and possibly in the long run. While some of these analyses (e.g., Nishi, 2019) rely on the standard price elasticities of demand and assume that the ML condition holds, most of the new analyses of relative price or RER effects assume that they operate through other channels, for example, by inducing compositional shifts, causing changes in income elasticities, or stimulating capital accumulation. Although, more or less by definition, any BPCG model has some version of Thirlwall's law as its long-run equilibrium solution, the new literature focuses more on medium-run periods in which relative price adjustments and cumulative causation processes are more likely to operate. Furthermore, at least some branches of the new literature are paying more attention to the stability or instability of the BP-equilibrium growth rate, and have opened up the possibility of chronic cyclical fluctuations around that equilibrium rather than viewing it as a strong attractor for stable adjustments.

In spite of all these advances, there remain considerable areas of controversy that will undoubtedly be the subject of much research in the foreseeable future. As this survey has shown, the new theoretical models differ greatly on whether they admit relative price or RER effects, while empirical studies remain divided in their findings about such effects. Nevertheless, the emphasis on medium-run adjustments and transitional dynamics in much of the new literature does point to potential ways of reconciling the seemingly opposed views. Especially, it is possible that some factors (for example, levels of relative prices or RERs) could have a significant impact in the medium term even if they do not affect the BP-equilibrium growth rate in the very long term.[42] Such factors could affect the long-run levels of growth paths, even if they do not affect long-run equilibrium growth rates. An even deeper question, which remains to be answered, is whether the BP-equilibrium growth rate itself is a predetermined constraint, or if it evolves endogenously through time during the dynamic process that leads an economy to converge to (or possibly cycle around) a long-run growth path. Some of the new literature seems to suggest the latter, which opens up the door to more types of policy interventions (for example, exchange rate or industrial policies) that could have a lasting impact in the long run.

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ENDNOTES

[1] See also the reprints of original articles on the BPCG model in McCombie and Thirlwall (2004) and the newer essays collected in Soukiazis & Cerqueira (2012) and Palley et al. (2021).

[2] Another omission is the Brazilian New Developmentalist approach, which overlaps with BPCG in emphasizing export promotion, endogenous productivity, and structural change (see Bresser Pereira et al., 2015; Gabriel et al., 2016; Oreiro, 2016; Oreiro et al., 2020). Nevertheless, New Developmentalism rejects the idea of a binding BP constraint and instead argues that long-run growth depends especially on the level of the real exchange rate relative to an "industrial equilibrium" rate. New Developmentalism is thus a distinctive approach that deserves a more thorough discussion than can be included here, but several studies from that paradigm are cited where relevant. Studies on certain new applied topics, such as incorporating ecological constraints and institutional change (e.g., Althouse et al., 2020; Dávila-Fernandez & Sordi, 2020; Guarini & Porcile, 2016; Porcile et al., 2021), are also not included because of space constraints. Also, this survey makes no effort to address the voluminous empirical literature on estimating BPCG models for individual countries. Thirlwall (2011) surveyed that literature up to about 2010. A recent contribution that is particularly innovative in its econometric methodology is Felipe et al. (2019).

[3] For more comprehensive presentations, see McCombie & Thirlwall (1994) and Blecker & Setterfield (2019).

[4] In the extreme, one could envision a "neoclassical" solution in which the home country grows at an exogenously given "natural rate," $\hat{Y} = \hat{Y}_n$, in the long run, and solve equation (7) for the equilibrium rate of real depreciation: $\hat{q}^* = \frac{\eta_M \hat{Y}_n - \eta_X \hat{Y}_f}{\varepsilon_X + \varepsilon_M - 1}$ However, this would require a continual real depreciation or appreciation of the currency, which would violate purchasing power parity—unless $\eta_M \hat{Y}_n = \eta_X \hat{Y}_f$, which could occur only by pure coincidence.

[5] See also Hausmann et al. (2007), who argue that "What you export matters" for boosting a country's weighted-average average productivity level and long-run growth in a neoclassical framework.

[6] Following Pasinetti (1981), Araujo & Lima (2007) use U for underdeveloped and A for advanced. We substitute the more common South-North terminology here for consistency with the rest of this paper, and we do the same in our discussion of Araujo (2013) in section 4.1, below.

[7] In the original model of Araujo & Lima (2007), there are n sectors where the nth sector is the household sector, which supplies labor, and the tradable goods are numbered 1 to $n-1$; here, we assume there are G tradable goods and households are not modeled explicitly.

[8] For example, Blecker & Ibarra (2013) and Ibarra & Blecker (2016) assume that imports of intermediate goods are a function of exports, while Ribeiro et al. (2017a, 2017b) assume that such imports are in a fixed proportion to domestic output.

[9] McCombie & Spreafico (2016) compare Verdoorn's law with the "technical progress function" of Kaldor (1957, 1961) and Kaldor & Mirrlees (1962), and also show that estimates of the former are not subject to the critique of estimating an identity which applies to an aggregate Cobb-Douglas production function. According to McCombie & Spreafico (2016, p. 1123), the Verdoorn coefficient ρ_1 reflects "the effect of induced technical progress and dynamic and static economies of scale." More recently, Basu & Budhiraja (2021) analyze the meaning of ρ_1 using a constant elasticity of substitution (CES) production function, which they modify to include either external economies of scale or endogenous technological progress. In their model, the Verdoorn coefficient ρ_1 exclusively reflects external economies or endogenous technology only with a Leontief production function in which the elasticity of substitution (σ) is zero—although this is, in fact, the type of technology assumed in most heterodox macro models including BPCG models (for example, Dávila-Fernández & Sordi, 2019a, 2019b). If $\sigma > 0$, ρ_1 can reflect other factors such as the elasticity of labor supply, and with Cobb-Douglas ($\sigma = 1$), ρ_1 is determined only by that elasticity and is independent of either external economies or endogenous technology. A meta-analysis of empirical estimates of σ by Gechert et al. (2021) finds that, after correcting for publication bias, use of cross-country variation, and omission of the first-order condition for capital, the best estimate is approximately 0.3, which is much closer to Leontief than to Cobb-Douglas. McCombie & Spreafico (2016) note that Kaldor (1961) was among the critics of neoclassical production functions who did not believe that it was possible separate changes in capital-labor proportions from the introduction of technological innovations. For other perspectives on the underpinnings of Verdoorn's law, see, among many others, Fingleton & McCombie (1998) and Romero & Britto (2017).

[10] As the title of their article suggests, the original Dixon-Thirlwall (1975) model was intended to represent "regional growth-rate differences" within nations, for which a BP constraint would not exist. Nevertheless, subsequent interpretations and estimates of the model (for example, León-Ledesma, 2002; Setterfield & Cornwall, 2002) have applied it to national economies.

[11] Dixon & Thirlwall (1975) allowed for continuous change in the markup factor (one plus the markup rate), but most subsequent expositions have assumed that markups are constant in the long run (for example, Blecker, 2013; Setterfield, 2013a; Setterfield & Cornwall, 2002).

[12] Ribeiro et al. (2017a) refer to this as the "medium-to-long run" to emphasize its transitional character, but we shall refer to it as the medium run for simplicity.

[13] This brief account of Ribeiro et al. (2017a) builds on a longer presentation in Blecker & Setterfield (2019, pp. 502–510). Ribeiro et al. (2017a) in turn draw upon earlier works on the adjustment process in BPCG models, including Pugno (1998) and Porcile & Lima (2010).

[14] Ribeiro et al. (2017a) do not adopt other features of neo-Kaleckian models, such as the typical specifications of investment and saving functions, and they do not address Kaleckian cyclical dynamics of the type analyzed by Franke (2018).

[15] Levy-Yeyati et al. (2013) focus specifically exchange market intervention aimed at avoiding overvaluation or promoting undervaluation, rather than the level of the RER per se.

[16] Nevertheless, these surveys also reveal that the evidence is more mixed on some aspects of the RER-growth relationship, for example, whether it is asymmetrical between overvaluations and undervaluations and whether the impact of an undervaluation is nonlinear.

[17] Presumably, if relative prices affect the weighted-average income elasticities, they should also influence the weighted-average price elasticities. This point has received little if any attention in the BPCG literature, perhaps because of its emphasis on income effects and typical assumption of LRR-PPP.

[18] Other studies that have recognized compositional effects of RER changes include Ferrari et al. (2013), Missio et al. (2017), Oreiro (2016), and Oreiro et al. (2020), among others.

[19] Even if the goods are numbered in increasing order of their income elasticities, as z' rises, the *average* income elasticity increases in *both* regions, so the impact on the ratio η_X^S/η_X^N is ambiguous. Hence, the positive relationship between z' and η_X^S/η_X^N has to be considered a separate assumption.

[20] Here N means the normal distribution, not the North as in the rest of this article. The N is missing from the published chapter due to an inadvertent typographical error.

[21] For a critique of Razmi's approach, see McCombie (2019).

[22] Holding foreign prices constant for simplicity, so that $\hat{P}_f = 0$, LRR-PPP (which has to hold for a small, price-taking country) implies $\hat{E} = \hat{P}$, i.e., the nominal depreciation rate has to equal the domestic inflation rate, so the exchange rate and domestic price level are effectively interchangeable in this solution. However, Razmi does not put much emphasis on the rate of nominal depreciation ($\hat{E}$) here.

[23] Also, Levy-Yeyati et al. (2013) found that exchange market intervention aimed at lowering currency values had a positive effect on real gross capital formation as a percentage of GDP.

[24] See also Porcile & Yajima (2019) on BPCG modeling with wage-led versus profit-led demand.

[25] Bussière et al. (2020) find that, when partial pass-through of exchange rate changes into prices is taken into account, an expanded ML condition does hold for most countries even though the estimated elasticities of the quantities traded with respect to prices are relatively small.

[26] Boggio & Barbieri (2017) point out that Kaldor had originally defined a country's international price competitiveness as depending on "the *level* of its industrial costs relatively to other industrial exporters" (Kaldor, 1971 [1989], p. 504, emphasis added)—not the rate of change in those costs.

[27] Note that the interpretation of the income elasticities in Romero & McCombie (2018) differs from the conventional one. Because intra-industry non-price competitiveness is reflected in the T/T_f ratios at the industry level, the income elasticities η_X and η_M only capture inter-industry non-price competitiveness.

[28] For an evolutionary analysis of endogenous technological change and the balance of payments in an agent-based framework, see Dosi et al. (2019).

[29] This approach is supported by a large empirical literature which has found that Verdoorn effects do indeed vary substantially across industries as well as countries. See, for example, Romero & McCombie (2016), Romero & Britto (2017), and Magacho & McCombie (2018). The disaggregated approach assumes that the increasing returns and external economies reflected in the Verdoorn coefficient may be observed at the industry level, for example, either because of economies of scale and induced innovation that occur within firms in a given sector, or because of externalities and spillovers that are internal to industries even though they are external to individual firms. Such an approach would, however, miss any intersectoral feedback effects that operate at the macroeconomic level, as suggested by an anonymous referee.

[30] Araujo (2013) assumes that prices are set by markups over ULC, but the markups remain constant and hence play no role in the dynamics.

[31] On the simplifying assumption that the population equals the employed labor force, the terms $\xi x_i^S a_i^S$ and $m_i^S a_i^S$ are ratios of exports and imports (respectively) to output in each sector in the Southern economy.

[32] Since the price elasticities $\varepsilon_{X,i}^j$ and $\varepsilon_{M,i}^j$ are defined to be positive (absolute values) in this paper, we have reversed the signs on the difference in productivity growth rates and the rate of change in nominal E in the numerator of the second term on the right-hand side of Equation (28).

[33] These efforts to endogenize income elasticities should not be confused with an earlier literature, which debated whether income elasticities adjust to make BP-equilibrium consistent with an exogenously given natural rate of growth (see Krugman, 1989; McCombie, 2011; Thirlwall, 1991). In the new literature discussed here, the natural rate of growth is also endogenous because labor productivity growth is endogenous.

[34] Aside from using a disaggregated model, Magacho and McCombie also deviate from Setterfield in assuming that changes in income elasticities depend on the growth rates of productivity rather than productivity levels.

[35] In an extended version, the authors allow the constant terms (exogenous components of productivity growth) to differ across countries and also allow for more rapid catch-up in productivity by countries that have larger technological gaps to begin with.

[36] In addition to rewriting this equation using the notation of this article, we have corrected a few typos in Equation (3.9) of the published version of Magacho & McCombie (2020). The corrections were confirmed in email correspondence from Guilherme Magacho, August 24, 2020.

[37] In another extended version of the model, Magacho & McCombie (2020) also analyze the case in which faster growth of one industry is matched by slower growth of another industry.

[38] See also Spinola (2021) for an expanded version of the La Marca (2010) model. These articles both consider economic cycles in open economies, but do not use a BPCG approach.

[39] This specification builds on earlier work by Garcimartín et al. (2016) and Dávila-Fernández & Libânio (2016), among others; it also has strong similarities to the empirical model of Alonso & Garcimartín (1998–99). In contrast, Dosi et al. (2019) assume that the exchange rate adjusts in response to current account imbalances.

[40] Conflict models of inflation are surveyed in Lavoie (2014) and Blecker & Setterfield (2019); see also Sasaki et al. (2013) for a model of conflict-driven inflation in an open economy.

[41] Of course, if LRR-PPP holds ($\hat{q} = 0$), or if the ML condition is not satisfied so that $\varepsilon_X + \varepsilon_M \approx 1$, this solution becomes simply the strong form of Thirlwall's law in Equation (8).

[42] Bhering et al. (2019) make an argument along these lines for the impact of capital flows.

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