Competitiveness and dynamic cumulative causation in an export-led growing economy

Competitiveness and *dynamic* cumulative causation in an export-led growing economy*

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Abstract

The role of the real exchange rate in explaining long-run processes of catching-up and falling-behind continues to be a question of central importance among alternative theories of growth and distribution. Existing empirical evidence suggests a positive association between exchange rates in levels and growth, especially in developing countries, though a currency depreciation has adverse effects. While these two elements have been separately incorporated into demand-led growth theories, a comprehensive assessment of the dynamic interaction between them is still missing. This article attempts to fill such a gap in the literature by developing an export-led growth model in which *price* and *non-price* competitiveness respond to the level and variation of the real exchange rate. In equilibrium, relative prices and the fundamentals of the productive structure are simultaneously determined. A more depreciated exchange rate and higher non-price competitiveness are associated with a higher rate of growth. It is shown that the interplay between a destabilising force from the goods market, and a stabilising mechanism from the labour market, might give rise to persistent and endogenous long-run cycles of structural change. The model is used to revisit the historical experience of East Asia (EA) and Latin America (LA) in the post-war period. We show our system fits crucial stylised facts, particularly the tendency of LA to have a more appreciated RER, its lower non-price competitiveness and dynamic economies of scale, and stronger distributive conflict, resulting in less growth and greater volatility.

Keywords: *Structural change; North-South; Competitiveness; Exchange rates; Cumulative causation*

JEL: *F43; O11; O40.*

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1 Introduction

An old concern among development economists regards the real exchange rate (RER) importance for economic growth. In general terms, the two main mechanisms through which it might affect the economic performance of a country or region are the short-run aggregate demand channel and the long-run development channel. While the earlier literature focused on macroeconomic effects through the first of them, the rise of China has renewed the interest in exploring more long-term mechanisms (for a comprehensive review of the literature, see Rapetti, 2020; Demir and Razmi, 2021). The existing empirical evidence suggests a positive association between exchange rates in levels and growth, especially in developing countries, although currency depreciations have adverse effects. These two elements have been separately incorporated into demand-led growth theories. However, to the best of our knowledge, a comprehensive assessment of the dynamic interaction between them is still missing. This article attempts to fill such a gap in the literature by developing a stylised North-South (or export-led) growth model in which price and non-price competitiveness respond to the level and variation of the real exchange rate.

Over the past forty-five years, Dixon and Thirlwall (1975) model of *static* cumulative causation has offered a useful baseline framework for studying the RER-growth relationship (e.g. Pugno, 1996; Boggio, 2003; Blecker and Setterfield, 2019, pp. 388-395). The essence of the argument is that once a region gains a growth advantage, there will be a tendency to maintain it through increasing returns that growth itself induces. Taking their contribution as a starting point, we provide a novel representation of *dynamic* cumulative causation that takes into account the interaction between goods and labour markets as well as the interplay of price and non-price competitiveness. We show that, in equilibrium, the real exchange rate and the capacity of the productive structure to respond to changes in foreign demand are simultaneously determined. A more depreciated exchange rate and higher non-price competitiveness are associated with a higher growth rate, leading firms to hire more workers and, thus, increase the steady-state employment rate. Still, the economy is never in a state of rest. The interplay between a destabilising force from the goods market, and a stabilising mechanism, from the labour market may give rise to persistent and bounded fluctuations conditional to the intensity of the distributive conflict.

Endogenous and persistent long-run cycles of structural change have the following rationale. An increase in the rate of growth of exports leads to higher output, which in turn is associated with rising labour productivity through the presence of dynamic economies of scale, i.e. the so-called Kaldor-Verdoorn's law. As more workers are hired to match sales projections, we initially observe an increase in their bargaining power, damaging the profitability of an investment. Firms respond by increasing their search for labour-saving production techniques. The sum of these two processes results in firms producing more with less labour, subsequently reducing the bargaining power of the latter. Weaker and less combative workers are related to a lower rate of inflation, and, as a result, the real exchange rate depreciates. A more undervalued currency, in levels, impulses exports in two ways: on the one hand, if sustained for a sufficiently long time, it allows firms to better plan incursions into foreign markets; on the other hand, there are positive externalities that lead to increases in non-price competitiveness.

Such a process of cumulative causation is unstable, as it should be. Growth trajectories are balanced in three different ways. First, the currency depreciation in itself damages growth in line with the empirical studies previously mentioned. Second, accelerating growth is associated with rising employment. As workers' bargaining power increases, they can obtain increases in real wages above labour productivity gains. If firms respond by rising prices, the real exchange rate may appreciate in levels, which means lower price competitiveness. Third, adjusting to the new conditions imposed by change is costly, meaning that non-price competitiveness cannot grow without limits, and price externalities decrease over time. For instance, new technologies depend on the sum of past innovations. As the productivity frontier expands, it becomes more challenging to be innovative because the techno-economic paradigm saturates as it reaches maturity (an argument in line with Perez, 2010, among others).

The remainder of the paper is organised as follows. The next section provides a brief overview of the related literature. Section 3 develops a stylised model in which the world is divided between North and South. The first stands for a foreign country or the rest of the world. The latter corresponds to the domestic economy. Section 4 brings a closer look into the transmission channels using numerical simulations. It is shown that the obtained long-run cycles are not merely a formal curiosity, being very much likely to emerge for a set of parameters in line with empirical evidence. Finally, the model is used to revisit the historical experience of East Asia (EA) and Latin America (LA) in the post-war period. We show our system fits crucial stylised facts, particularly the tendency of LA to have a more appreciated RER, its lower non-price competitiveness and dynamic economies of scale, and stronger distributive conflict, resulting in less growth and greater volatility. Furthermore, we demonstrate that, with the introduction of Schumpeterian innovation waves, the model generates more complex dynamics, including irregular long-run fluctuations and sensitivity to initial conditions, similar to those observed in actual data. We conclude with some final considerations.

2 An overview of the related literature

This Section presents a brief overview of the related literature to situate our contribution in the field better. However, it goes beyond the scope of the paper to provide a comprehensive survey of the RER-growth relationship as well as the cumulative causation family of models. Textbook presentations of the latter can be found, for example, in Blecker and Setterfield (2019). Regarding the former, the reader is invited to see Demir and Razmi (2021). Rapetti (2020) provides a systematic survey of recent developments alongside panel regressions using data from the Penn World Table.

As argued in the Introduction of this paper, Dixon and Thirlwall (1975) model of *static* cumulative causation has consolidated itself over the past three decades as a useful baseline framework to study international competitiveness related issues. Building on Beckerman (1962) and Kaldor (1971), their model is static in the sense that the system admits a stable attractor as an equilibrium solution (see, for example, Setterfield, 2011; Blecker, 2013). Despite its simplicity, the elegance and flexibility of this representation caught the attention of a great number of researchers. A large number of scholars have generalised its formulation in different directions and, in particular, to assess different channels through which relative prices matter for international growth differences. For instance, authors such as Ribeiro et al. (2016, 2017) and Porcile et al. (2021) have investigated the role of the RER to growth by differentiating between short- and long-term effects. While they provide an interesting assessment of price and non-price competitiveness exploring the effects of intermediate consumption, they maintained a somehow static approach to cumulative causation, allowing for minor adjustments towards equilibrium. Furthermore, in their representation, the labour market is not adequately included, leaving little room for a more comprehensive assessment of the distributive conflict. In similar lines, Romero (2019) proposed a growth model that embeds Schumpeterian insights into the Kaldorian narrative. Once more, labour markets are only implicitly included in the discussion that continues to be fundamentally static, anchored in the concept of a stable equilibrium solution.

Differences in the sectoral composition of the economy and cumulative causation have been explored in the seminal article by Araújo (2013). Building on a Pasinettian set-up to explain uneven development, the author disaggregated trade such that non-price competitiveness responds to both the dynamics between and within different production activities. A multisectoral cumulative causation model that allows for the interplay between price and non-price competitiveness can be found in Missio et al. (2017), with some variations in Magacho and McCombie (2020). In this framework, a reconciliation between cumulative causation and balance-of-payments constrained views is shown to hold. Through Kaldor-Verdoorn's law, technical progress was endogenised, and the role played by aggregate demand to foster structural change is also highlighted. While this view offers a significant qualitative improvement concerning traditional macroeconomic models, out of equilibrium dynamics depend on exogenous stochastic shocks, leaving the picture somehow incomplete.[1]

Pugno (1996) was perhaps the first to provide a proper dynamic representation of the Dixon-Thirlwall narrative. Adopting a growth-cycle framework, as in Goodwin (1967), he showed how price competitiveness evolves and impacts growth, conditional to the intensity of the distributive conflict (see also Nishi, 2019). On the other hand, Boggio (2003) and Boggio and Barbieri (2017) provided a disequilibrium representation using the replicator equation. In all these cases, the labour market is explicitly formalised. They seem, nonetheless, to be more concerned with cost or price competitiveness than with aspects related to the complexity or quality of goods and services produced, i.e. non-price competitiveness. We believe this is an essential element that must be included in the discussion in light of the empirical evidence that suggests a positive association between exchange rates in levels and growth, although a currency depreciation seems to have adverse effects.

A recent study closer in spirit and form to ours is Cimoli et al. (2019). They presented a North-South technology-gap model that combined Schumpeterian features regarding technical and structural change with the Keynesian principle of effective demand in the context of a balance-of-payments constrained economy. Similarly to the present paper, it is acknowledged that innovation, relative productivity, and wages co-evolve and may generate different convergence or divergence trajectories, depending on the calibration strategy. Valuable insights are provided contrasting the experiences of Asia and LA after the oil shocks of the 1970s. Their system, nonetheless, does not differentiate between the adverse effects of RER devaluations and the potential benefits of a more depreciated currency in levels. Furthermore, they do not distinguish different channels through which price competitiveness might affect long-run growth. Finally, by relying on the traditional static approach to cumulative causation, there is room for only minor adjustments towards equilibrium.

The model developed in the next Section takes into account the interaction between goods and labour markets, as well as the interplay between price and non-price competitiveness to provide a novel and *dynamic* representation of cumulative causation. We focus on three main channels through which the RER might affect economic performance:

1. Downward adjustments of the value of a country's money relative to the international currency are recessive. This effect means that any devaluation process intrinsically reduces output growth through the dynamic Keynesian multiplier.

[1] How to obtain growth and fluctuations in a framework where structural change is endogenous to the system was R. Goodwin's life-long research program (see Punzo, 2006). The bridge between structure and dynamics was built investigating stable multisectoral production systems, similar to the approach in Araújo (2013). In this respect, our contribution provides a weaker representation of structural change but a more robust view of cumulative causation in the form of endogenous long-run cycles in price and non-price competitiveness.

2. Stable relative prices over a sufficiently long time horizon allow domestic firms to better plan incursions into foreign markets, thus, resulting in higher exports.

3. The RER, in levels, influences resource allocation, especially in developing countries. Even though it is only implicitly embodied in the model, the idea is that a more depreciated currency increases the profitability of tradables over non-tradables. Given that the former is associated with increasing returns to scale, price competitiveness might foster non-price competitiveness. We shall refer to this mechanism as the "structural change" channel.

It might be helpful to think about the last two effects in the following terms. First, a stable and more depreciated exchange rate makes exporting easier and more challenging to import. Hence, a certain country might start to export or substitute imports because it is cheaper to produce domestically, though production quality is likely low. In a second moment, such a depreciation may compensate for asymmetric information problems and allow for processes of learning-by-doing or learning-by-exporting, especially in developing economies.

3 The model

Suppose the world is divided in two regions, open to international trade, that produce goods and services which are imperfect substitutes. We will refer to the domestic economy as *South* while *North* stands for the rest of the world. Our discussion is based on the perspective of the South region. Of course, this classification is artificial. Still, it finds common ground in similar distinctions in the literature of uneven development (as in Botta, 2009; Sasaki, 2021; Cimoli et al., 2019) or Centre-Periphery (see Cimoli and Porcile, 2014). For presentation purposes, the model is divided into five blocks of equations:

1. Price competitiveness

2. Non-price competitiveness

3. Demand conditions

4. Supply conditions

5. Distributive conditions

An overview of the main transmission channels is depicted in Fig. 1, which summarises the co-evolution of both dimensions of competitiveness. The resulting 3-dimensional dynamic system has the rate of employment, the RER, and non-price competitiveness as endogenous variables. As we will show, the model generates endogenous and persistent fluctuations. Such a feature should be interpreted as a dynamic representation of long-run processes of cumulative causation. Structural change is a slow-motion endogenous, though intermittent, phenomenon and a natural dynamic property of cumulative causation (e.g. Punzo, 2006; Araújo, 2013). Given that the cycles we obtain imply a profound transformation of the economy's fundamentals – contemplating the interplay between goods and labour markets – we shall refer to them as long-run cycles of structural change. Hence, we should not see the latter only as changes in non-price competitiveness. Instead, it includes slow-motion waves in employment rates, the pace of capital accumulation, trade-income elasticities, price conditions and income distribution.[2]

[2]We want to emphasise the difference between the "structural change" channel – in which price conditions influence non-price competitiveness – and long-run cycles of structural change – that refer to the system

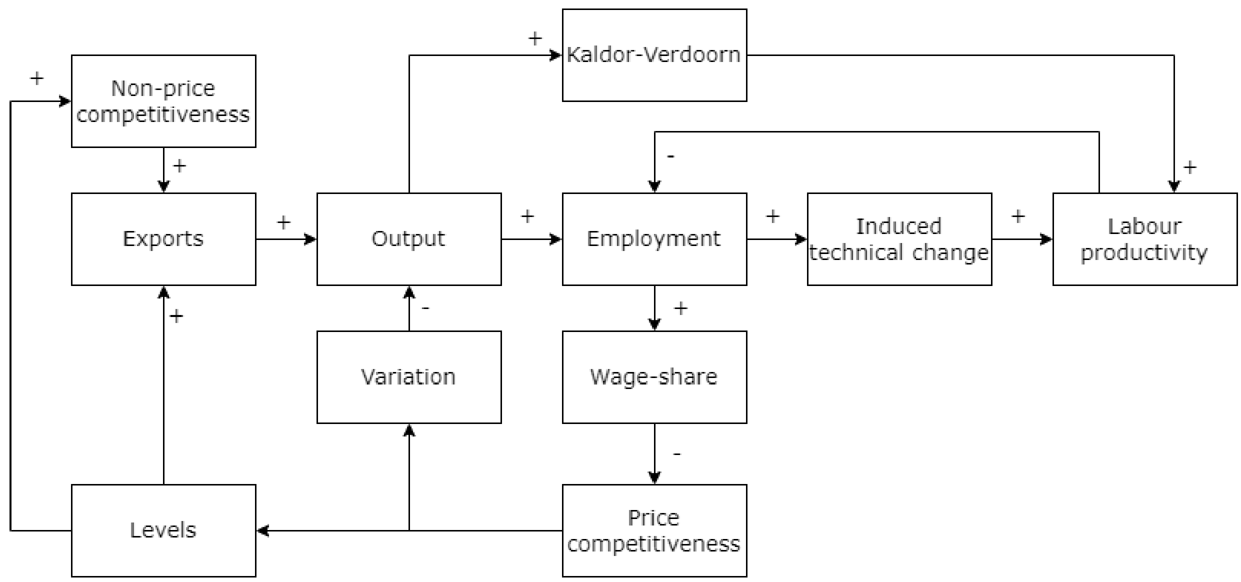


Figure 1: Co-evolution of price and non-price competitiveness.

3.1 Price competitiveness

To keep the exercise as simple as possible, suppose the nominal exchange rate is constant and equal to one. Then, price competitiveness, θ, is captured by the RER, that is, the ratio between foreign or North, p_N, and domestic or South prices, p_S. Hence, the terms-of-trade stand for a synonymous of the real exchange rate. In reality, we know the nominal exchange rate responds to monetary policy and risk perceptions. However, introducing Central Banks at this analysis stage would complicate the exercise without adding much to our story. If we manage to convince the reader of the usefulness of our approach, future research should increase the realism of the model. Unless explicitly stated otherwise, for any generic variable x, we indicate $\dot{x}$ as its time derivative. For a given quality, the goal is to supply at the lowest price:

$$\theta = \frac{p_N}{p_S} \tag{1}$$

Log-differentiating Eq. (1), we obtain that variations of this dimension of competitiveness respond to the difference in the respective rates of growth in the two regions:

$$\frac{\dot{\theta}}{\theta} = \frac{\dot{p}_N}{p_N} - \frac{\dot{p}_S}{p_S} \tag{2}$$

such that an increase in domestic prices relatively to those in the North results in a less competitive South region.

3.2 Non-price competitiveness

Following a similar structure as in the previous case, non-price competitiveness, ρ, is given by the ratio between quality characteristics of the good produced in the domestic economy, μ_S, and the same indicator in the North region, μ_N. Notice that while in the previous case the goal was to offer the lowest possible price, here firms aim, for a given price, to supply

as a whole never being in a state of rest, engaged in dynamic cumulative causation. We thank one of the reviewers for pointing this out to us. This difference is subtle but has important implications for the reading of the paper and the interpretation of our results.

at the highest quality:

$$\rho = \frac{\mu_S}{\mu_N} \tag{3}$$

Log-differentiating Eq. (3), we obtain that variations in non-price competitiveness respond to the difference in the rate of growth of the respective index in the two regions:

$$\frac{\dot{\rho}}{\rho} = \frac{\dot{\mu}_S}{\mu_S} - \frac{\dot{\mu}_N}{\mu_N} \tag{4}$$

Hence, non-price competitiveness in the South will increase as long as characteristics of its goods and services, such as their technical sophistication or quality, grow faster than in the foreign economy.

We assume, however, that once a non-price advantage is gained, it is increasingly more difficult to enlarge the gap further. That is because new technologies depend on the sum of past innovation breakthroughs. As the productivity frontier expands, the current techno-economic paradigm reaches maturity, and it becomes more challenging to be innovative (e.g. Perez, 2010). The existence of an international system of property rights, for example, imposes an increasing fee for the introduction of new goods, services or practices into the system because innovation today depends on past patented creations (see Pagano, 2014). Moreover, the capital stock of a country consists of a complex web of interlocking parts. The increase in the scale of production necessary to handle manufacturing more diversified goods and services brings costs in terms of the reorganisation of corporations, management of tangible and intangible assets, labour and legal issues, among others (Hannan et al., 2004; Andreoni and Chang, 2019).

Therefore, we suppose:

$$\begin{aligned} \frac{\dot{\mu}_S}{\mu_S} &= \beta_{\mu_S} - \beta\rho \\ \frac{\dot{\mu}_N}{\mu_N} &= \beta_{\mu_N} + \beta\rho \end{aligned} \tag{5}$$

where $\beta_{\mu_S} > 0$ and $\beta_{\mu_N} > 0$ capture the exogenous factors that impact non-price competitiveness in each individual country, and $\beta > 0$ stands as the rate of decreasing returns of product creation or differentiation. To maintain a parsimonious number of parameters in the model, we suppose the latter is equal in both regions. Given that in a Centre-Periphery (or North-South) system, the two regions are most likely to respond differently to changes in non-price factors, a more critical reader might correctly point out that such an assumption is perhaps too strong. While we acknowledge this fact and agree that future research exploring the issue should be encouraged, the simplification above is algebraically convenient without compromising our main narrative.

Having said that, we would like to emphasise that the expression above does not embody ex-ante asymmetries between the two countries. North and South respond in a symmetric way to changes in non-price competitiveness. On the one hand, from the definition of ρ, see Eq. (3), an increase in this variable means μ_S is growing faster than μ_N. Therefore, the first expression in (5) shows that it becomes more difficult to the South region to continue increasing the quality gap, $\frac{\partial \dot{\mu_S}/\mu_S}{\partial \rho} < 0$, while the second expression shows that the North country benefits from the expansion in the technological frontier, $\frac{\partial \dot{\mu_N}/\mu_N}{\partial \rho} > 0$. On the other hand and analogously, a reduction in ρ results from μ_N growing faster than μ_S. Hence, as time passes by, the space for the North to deepen the gap is reduced while more opportunities for the South become available. This behavioural relationship can be understood as a simple representation of diffusion and catch-up dynamics in the technological-gap literature.[3]

Substituting (5) into Eq. (4), we have that the variation of non-price competitiveness is a quadratic function of current non-price attributes of the respective production structures:

$$\frac{\dot{\rho}}{\rho} = \beta_{\mu_S} - \beta_{\mu_N} - 2\beta\rho \tag{6}$$

such that $\dot{\rho}$ draws a inverted-U shaped function in ρ. It is important to notice that this non-linearity was not imposed in an *ad hoc* fashion, being rather a convenient result of simple and standard algebraic manipulation of Eq. (3).

3.3 Demand conditions

From the aggregate demand identity we have that:

$$Y = C + I + X - \theta M \tag{7}$$

where Y is output, C stands for consumption, I is investment, X are exports, and M correspond to imports. It immediately follows that a RER depreciation is associated with an increase in price competitiveness but, *ceteris paribus*, will result in a contraction of aggregate demand.

As an export-led growth model, we follow a more Kaldorian approach and recognise that exports differ from other demand components because they result from demand emanating from outside the system. The major part of consumption and investment is dependent on the growth of income itself (e.g. Thirlwall, 2002, p. 83). Hence, we assume:

$$\begin{aligned} C &= cY \\ I &= hY \\ M &= mY \end{aligned} \tag{8}$$

where c, h, and m are the marginal propensities to consume, invest, and import, respectively, such that all $\in [0, 1]$. Implicitly, we are imposing that the income elasticity of imports is equal to one. This hypothesis is not very accurate from an empirical point of view. Different estimations of the trade equations suggest income elasticities are greater than one (see, for example, Felipe and Lanzafame, 2020). Still, it is frequently used in the literature and allows us to significantly simplify the algebraic steps.

Substituting (8) into Eq. (7), we can write the level of output as a function of its autonomous component:

$$Y = \frac{X}{1 - c - h + \theta m} \tag{9}$$

such that a depreciation of the exchange rate is clearly contractionary.

It is well recognise in the literature on international economics that countries cannot sustain, in the long-run, increasing and persistent current-account imbalances. Equilibrium in the current account requires:

$$\frac{\theta M}{X} = 1 \tag{10}$$

[3] In formal terms, $\frac{\partial \dot{\mu_S}/\mu_S}{\partial \rho} = \frac{\partial \dot{\mu_S}/\mu_S}{\partial \mu_S/\mu_N} = -\beta$ and $\frac{\partial \dot{\mu_N}/\mu_N}{\partial \rho} = \frac{\partial \dot{\mu_S}/\mu_S}{\partial \mu_S/\mu_N} = \beta$, which implies $\frac{\partial \dot{\mu_S}/\mu_S}{\partial \mu_S/\mu_N} = -\frac{\partial \dot{\mu_N}/\mu_N}{\partial \mu_S/\mu_N}$. It should be clear that they are symmetric one to the other. If the South becomes more non-price competitive with respect to the North, it is easier for the latter to catch up. On the other hand, if the North becomes more non-price competitive than the South, it is easier for the latter to close the gap and more difficult for the former to further enlarge it.

Log-differentiating Eq. (9) and making use of (10), the rate of growth of output is equal to the difference between the rate of growth of exports and variations in relative prices:

$$\frac{\dot{Y}}{Y} = \frac{\dot{X}}{X} - \frac{\dot{\theta}}{\theta} \tag{11}$$

The expression above not only indicates that increases in price competitiveness paradoxically have an immediate negative effect on growth, but is in line with the idea that currency depreciations are recessive in nature.

We need to specify the rate of growth of exports. The amount of goods and services that the South region sells to the rest of the world depends on price and non-price competitiveness. Regarding the former, the level of θ at a given point of time is a secondary issue. What matters is the stability of relative prices over a certain horizon that allows domestic firms to plan their incursion into foreign markets better. There is a time lag between the decision to export and the actual purchase from an international company. It depends, for a given quality, on the stability of prices. In what concerns the non-price characteristics of goods and services exported, they are fundamentally captured by ρ. Hence, suppose:

$$X = A \exp\left(\sigma \varrho\right) Z^{\rho} \tag{12}$$

where Z is the level of output in the North region, A is an arbitrary constant, and σ captures the response of exports to the cumulative price effect, ϱ. The latter is given by:

$$\varrho = \int_0^t \theta(\tau)\ d\tau \tag{13}$$

Altogether, these two last equations provide an alternative to more traditional exports functions (as in Fagerberg, 1988; see also Romero and McCombie, 2016), with the only difference that prices matter over a certain interval of time $(0, t)$. Price effects on exports correspond to the cumulative variations of the RER. The underlying simplifying assumption is that the sum of all price variations from the beginning of history matters for exports today. On the other hand, a temporary currency depreciation will have, *ceteris paribus*, a neglectful impact on the capacity of domestic firms to respond to foreign demand.

Substituting Eq. (13) into (12), log-differentiating the resulting expression and applying the first fundamental theorem of calculus, we have:

$$\frac{\dot{X}}{X} = \rho z + \sigma \theta \tag{14}$$

that is, the rate of growth of exports depend on the capacity of the domestic economy to respond to foreign demand, or non-price competitiveness, and the level of the exchange rate. Finally, substituting Eq. (14) into Eq. (11), we obtain the export-led rate of growth compatible with equilibrium in the balance-of-payments:

$$\frac{\dot{Y}}{Y} = \rho z + \sigma \theta - \dot{\theta}/\theta \tag{15}$$

such that a more depreciated RER is related to a higher rate of growth but exchange rate depreciations have a negative impact on economic performance. In this way, we are correctly capturing the effect of the so-called J-curve. A country's trade deficit will initially worsen after the depreciation of its currency with a negative impact on growth – mainly because in the near term, higher prices on imports will have a more significant impact on total nominal imports than the reduced volume of imports. A stable RER will allow firms to adjust exports to the new price conditions approximately a year after, leading to a higher output growth rate. Naturally, the same economic rationale applies to the opposite scenario. When a country experiences a currency appreciation, this would consequently result in an inverted J-curve. Notice that we do not need to impose the validity of the so-called Marshall-Lerner condition, and that our modelling choice allows us to differentiate between levels and growth rates effects in θ.

Of course, given that relative prices are an endogenous variable of the model, in equilibrium, they cannot rise or fall without limits, $\dot{\theta}/\theta = 0$. Hence, the long-run rate of growth is determined by the behaviour of exports:

$$y_{bp} = \rho z + \sigma\theta \tag{16}$$

Frequently referred to as the dynamic Harrod trade-multiplier, Krugman's 45-degree rule or Thirlwall's (1979) law, Eq. (16) shows that price competitiveness might affect long-run performance through export behaviour (for a recent review of the related literature, see Blecker, 2021). Such a channel results from the fact that exports respond positively to a less volatile RER. It is not specifically related to a process of structural change because non-price competitiveness among other structural conditions remain unchanged at this point of the analysis. The interplay between θ and ρ will be discussed later on in the model.

3.4 Supply conditions

Our narrative would remain incomplete without modelling the supply-side of this economy. Suppose the following Leontief production technology:[4]

$$Y = \min\left\{\frac{K}{\vartheta}; qeN\right\} \tag{17}$$

where K stands for the capital stock; ϑ is the capital-output ratio; $q = Y/L$ corresponds to labour productivity, with L as the amount of workers used in production; $e = L/N$ is the employment or participation rate, and N the size of the labour force. As a simplification hypothesis, we assume ϑ is constant and compatible with normal capacity utilisation, and that the population grows at an exogenous rate n. Of course, they are only simplification assumptions. The reader might argue that such stylised facts are inappropriate for several countries, specially within the developmentalist tradition. For instance, the structural transformation that characterises development processes in emerging economies is likely to change the technical coefficient of capital. As already acknowledged in the previous Sections, ours is an aggregate model. It will allow us to explore in more detail endogenous dynamics of structural change with the limitation of being unable to provide further insights on e.g. the coexistence between different productive activities or the composition between formal and informal sectors (see Araújo, 2013; Klein-Martins and Skott, 2021). Furthermore, demographic transition has increasingly been recognise to play an important role for long-run economic performance (Manfredi and Fanti, 2006; Allain, 2019). Here we limit ourselves to

[4]The Leontief production function is in a sense an accounting identity. From the static efficiency condition we have that $Y = K(Y/K) = (Y/L)(L/N)N$. Such an specification is usually adopted among demand-led growth theories to incorporate the supply side of the economy, and avoids the problematic Cobb-Douglas type of technology (for a recent critique, see Zambelli, 2018; Gechert et al., 2021). Labour and capital are not paid according to their marginal productivities. As we will show, income distribution depends on the degree of distributive conflict. The latter, in turn, is related to the bargain power of workers in the labour market and the price/productivity response of firms in the goods market.

acknowledge that empirical evidence in this regard is somehow controversial, indicating an interesting avenue of investigation. Further research on those issues is to be encouraged.

From the dynamic efficiency conditions, it follows that the rate of employment and capital accumulation adjust to the demand-led output growth rate:

$$\frac{\dot{e}}{e} = \frac{\dot{Y}}{Y} - \frac{\dot{q}}{q} - n$$
$$\frac{\dot{K}}{K} = \frac{\dot{Y}}{Y} \tag{18}$$

The first expression shows how the actual growth rate adjusts to the natural one through the labour market. An economy growing faster than the sum between the growth rate of labour productivity and the labour force will experience an increasing employment rate. This trajectory follows from the fact that firms are hiring faster than the reduction in the technical labour coefficient. Analogously, participation rates start to fall if the sum between $\dot{q}/q$ and n is higher than the pace at which production increases. On the other hand, the second expression in (18) indicates that firms adjust their capital stock following the demand-led determined growth rate.

Regarding the technical labour coefficient, we acknowledge two main mechanisms. First, following the considerable empirical evidence that gives support to the existence of dynamic economies of scale, e.g. Kaldor-Verdoorn's law (see McCombie and Spreafico, 2016; Romero and Britto, 2017), the rate of growth of labour productivity is supposed to respond to the long-run rate of growth of the economy, y_{bp}, as in Eq. (16). This fact means that RER depreciations or appreciations do not impact technique choice, which uniquely responds to structural conditions. Second, we allow for feedback effects from the labour market with a two-fold motivation (a review of the related literature can be found in Tavani and Zamparelli, 2017). On the one hand, as participation rates increase, labour shortages become more frequent, and firms respond by increasing their search for labour-saving production techniques. On the other hand, an increase in the employment rate is associated with a higher bargain power of workers. As a result, it becomes more likely that they will obtain real wage increases above productivity gains, increasing the wage-share (Goodwin, 1967; Velupillai, 2006). The following fall in profitability of investment leads firms, once more, to pursue production techniques that save labour, increasing $\dot{q}/q$ (for empirical evidence in open economies, see Dávila-Fernández, 2020).

From the discussion above, we adopt a parsimonious linear behavioural rule:

$$\frac{\dot{q}}{q} = -\kappa_0 + \kappa y_{bp} + \bar{\kappa} e, \; 0 < \kappa < 1, \; 0 < \bar{\kappa} < 1 \tag{19}$$

where $\kappa_0 > 0$ is a given parameter, $\kappa \in [0, 1]$ is the so-called coefficient of Kaldor-Verdoorn, and $\bar{\kappa} > 0$ captures the sensitivity of labour productivity to the dynamics of the labour market.[5] Notice that with no growth and zero employment, the South country experiences

[5] As demostrated by McCombie and Spreafico (2016), "the Verdoorn coefficient also *should not* be interpreted as a measure of increasing returns to scale per se" (p. 1131, emphasis added). Still, in line with the empirical evidence provided by Romero and Britto (2017), we acknowledge that it captures, at least partially, the presence of dynamic economies of scale and increases with technological intensity (complexity) of the goods produced. Hence, a higher κ is associated with a more complex productive structure. As indicated by one of the reviewers, an additional mechanism capturing long-run processes of structural change involves the endogeneity of the Kaldor-Verdoorn coefficient. It has been shown that such a route offers an alternative representation of path dependence (see, for example, Setterfield, 1997). Future research on these lines is to be encouraged.

a reduction in labour productivity. This is in accordance with the idea that under persistently high unemployment rates, there could be a deterioration in human capital and in the capacity for learning-by-doing, with negative implications in terms of productivity rates.

3.5 Distributive conditions

The final block of equations consists in the distribution of income between inputs. A long tradition in macroeconomics has discussed how a higher employment rate is related to an improvement in the fall-back position of workers, raising their bargaining power. In such a scenario, they are able to obtain higher increases in real wages relative to labour productivity gains, leading to a higher wage-share, ϖ. Formalising this mechanism in the lines of Goodwin (1967), and those who followed (e.g. Sordi and Vercelli, 2014), would require an additional differential equation. To avoid the complications of this route, we limit ourselves to assume a linear correspondence between ϖ and e that passes the origin:

$$\varpi = \phi e, \;\; \phi > 0 \tag{20}$$

such that, for a zero employment rate, there is no production and the income share of labour is also equal to zero.[6] Notice that labour shares and employment rates will only move together if the intensity of the distributive conflict, as captured by the parameter ϕ, remains constant. The latter shows workers' capacity to translate increases in employment into a higher income share. Of course, if there is a strong negative shock in ϕ, the wage-share will fall even if employment is increasing moderately. The negative trend in wage-shares documented in several countries is partially explained by the labour movement's disarticulation that has reduced workers' capacity to obtain wage increases in response to an improvement in labour market conditions.

Recognising the role of income distribution not only for technical change but also to price dynamics (as in Velupillai, 2006), a given ϖ is associated with a certain level of distributive conflict. For example, there is a struggle between firms and workers to increase, recover or preserve their income shares. We already discussed how a higher wage-share is related to a reduction in profitability and that firms might respond by increasing their search for labour-saving production techniques. Nonetheless, this is only one of the possible responses. Alternatively, firms have the option to increase prices:

$$\begin{aligned} \frac{\dot{p}_N}{p_N} &= 0 \\ \frac{\dot{p}_S}{p_S} &= -\gamma_0 + \gamma\varpi, \;\; 0 < \gamma < 1 \end{aligned} \tag{21}$$

[6]This reasoning is also compatible with the so-called dual economies in the sense of Lewis (1954). As long as the subsistence sector does not use capital and has decreasing marginal returns on labour, transferring workers to the modern sector will increase real wages in the former. The result is an upward-sloping labour supply curve in both sectors. Hence, rising participation rates are followed by a general improvement in workers' bargaining power (see Ros, 2013, pp. 127-150). As indicated by one of the reviewers, wage-share and labour productivity are intrinsically related from the very definition of the former, $\varpi = w/pq$, where w is the nominal wage. This fact means that the wage-share variation rate is equal to the rate of growth of nominal wages minus the rate of growth of prices and labour productivity. In the context of the model, the wage-share is assumed to be proportional to employment, as in Eq. (20). On the other hand, prices depend on the wage-share, as we will show in Eq. (21). Finally, labour productivity responds to employment, as in Eq. (19), and further feedback on participation rates through the dynamic Leontief efficiency condition (18). This means that nominal wages are the adjusting variable and, consequently, are only implicitly defined.

where $\gamma_0 > 0$ and $\gamma > 0$ are parameters in the behavioural relationship. For simplicity, we are keeping North prices constant. Adopting a similar behavioural rule for both regions will increase the algebraic steps without modifying our main story. Notice that deflation is a possible outcome of an extremely weak labour force. For a share of wages below γ_0/γ, prices will actually fall.

Finally, we are able to present the correspondence between price and non-price competitiveness. There is some evidence indicating that the level of the exchange rate influences resource allocation, compensating negative externalities, especially in developing countries (as in Rodrik, 2008). This channel works through structural change caused by factors such as employment shifts towards higher productivity and increasing return sectors, information-related market failures and other externalities (see Demir and Razmi, 2021). Implicitly, the idea is that a more depreciated currency increases profitability of tradables vis-a-vis non-tradables. Only the former is associated with increasing returns to scale, especially in developing countries. Thus, price competitiveness may foster non-price competitiveness. Recall from (5) that quality or product differentiation in each region were supposed to depend on the current conditions of the productive structure as well as on a variable capturing other elements exogenous to the model. We endogenise this last component:

$$\begin{aligned} \beta_{\mu_S} &= \zeta\theta, \; 0 < \zeta < 1 \\ \beta_{\mu_N} &= 0 \end{aligned} \tag{22}$$

where ζ is basically capturing the response of product differentiation to price conditions. For parsimonious reasons, we focus on the South economy, assuming that β_{μ_N} is equal to zero, so that non-price competitiveness in the North country only responds to ρ.[7]

3.6 The dynamic system

Substituting Eqs. (15) and (19) into the first expression in (18), and making use of Eq. (16), we obtain the dynamics of the employment rate. Adjustments in the labour market are a function of the level and the rate of change of price competitiveness, as well the level of non-price competitiveness. On the other hand, substituting (21) into Eq. (2), it is possible to see how adjustments in relative prices respond to the intensity of the distributive conflict, which in turn is conditional to the state of the labour market. Last but not least, substituting (22) into Eq. (6), non-price competitiveness responds to price conditions through the "structural change" channel. The resulting 3-dimensional dynamic system is given by:

$$\begin{aligned} \frac{\dot{e}}{e} &= (1-\kappa)\left(\rho z + \sigma\theta\right) - \dot{\theta}/\theta - \bar{\kappa}e + \kappa_0 - n = g_1\left(e,\rho,\theta\right) \\ \frac{\dot{\theta}}{\theta} &= \gamma_0 - \gamma\phi e = g_2\left(e,\rho,\theta\right) \\ \frac{\dot{\rho}}{\rho} &= -2\beta\rho + \zeta\theta = g_3\left(e,\rho,\theta\right) \end{aligned} \tag{23}$$

[7]Adopting a $\beta_{M_N} \neq 0$ and $\dot{p_N}/p_N \neq 0$ would only increase the number of parameters in the model without adding much in terms of economic content. If we manage to convince the reader of the importance of this framework, future research could tackle in more explicit terms the interaction between North and South countries. This would likely also increase the dimension of the system, making it more interesting from a dynamic point of view.

In steady-state, $\dot{e} = \dot{\theta} = \dot{\rho} = 0$. This gives us as equilibrium conditions:

$$\begin{aligned} 0 &= \left[(1-\kappa)\left(\rho z + \sigma\theta\right) - \bar{\kappa} e + \kappa_0 - n\right] e \\ 0 &= \left[\gamma_0 - \gamma\phi e\right]\theta \\ 0 &= \left[-2\beta\rho + \zeta\theta\right]\rho \end{aligned} \tag{24}$$

Ruling out the trivial case in which $e = \theta = \rho = 0$, the first expression in (24) indicates that, in equilibrium, the rate of growth of the economy will be equal to the so-called natural growth rate, i.e. sum between the rate of growth of labour productivity and the labour force. Both $\dot{Y}/Y$ and $\dot{q}/q$ are endogenous to the structural conditions of the economy, in particular, price and non-price competitiveness. Given that the RER cannot appreciate or depreciate without limits, the model is not compatible with the possibility of continuous currency depreciations. The second and third expressions show the requirements to balance the two dimensions of competitiveness in both South and North countries.

We, thus, can state and prove the following Proposition regarding the existence and uniqueness of an internal equilibrium solution:

Proposition 1 *The dynamic system (23) has a unique internal equilibrium solution, $P = (e^*, \theta^*, \rho^*)$, defined and given by:*

$$\begin{aligned} e^* &= \frac{\gamma_0}{\gamma\phi} \\ \theta^* &= \frac{\bar{\kappa} e^* - \kappa_0 + n}{(1-\kappa)\left(\frac{\zeta z}{2\beta} + \sigma\right)} \\ \rho^* &= \frac{\zeta\theta^*}{2\beta} \end{aligned}$$

Proof. See Mathematical Appendix A1. ■

It is interesting to notice the sign of some partial derivatives. For instance, $\partial\theta^*/\partial\kappa > 0$. This sign means that a higher Kaldor-Verdoorn coefficient is associated with greater price competitiveness, while a productive structure with low technological sophistication becomes prone to have an overvalued RER. Given the correspondence between θ and ρ, a currency appreciated results in lower quality and product differentiation. The effect of ζ on the two dimensions of competitiveness, on the other hand, is not the same. For a given equilibrium RER, it is easy to see that $\partial\rho^*/\partial\zeta > 0$, which is quite intuitive. As previously discussed, this parameter captures a channel of "structural change" through which prices influence the productive structure. In the limit, $\zeta = 0$ implies $\rho^* = 0$. Nonetheless, $\partial\theta^*/\partial\zeta < 0$. It follows from the fact that higher non-price competitiveness is associated with a rise in the rate of growth of exports. Firms respond by hiring more workers leading to an increase in their bargaining power. Eventually, they will increase prices, resulting, in equilibrium, in a more appreciated currency.

Such a result brings us to $\partial e^*/\partial\phi < 0$, i.e. stronger distributive conflict is related to a lower equilibrium employment rate. We want to highlight that this is not to say that strong labour unions lead to lower e. The parameter in question represents a set of institutional variables that can affect the bargaining power of workers and the way labour unions behave in the process of collective bargaining. Among them, we can list the share of workers that belong to a labour union, the level and coverage of unemployment benefits, and the centralisation of wage bargaining. This last variable is part of the so-called Calmfors-Driffill hypothesis. It states an inverted U-shape relationship between the degree of collective bargaining and the level of unemployment: As the size of trade unions increase, unemployment also increases up to the point unions begin to exercise monopoly power (see Calmfors and Driffill, 1988). The rationale is related to M. Olson's idea, in *The Rise and Decline of Nations*, that organised interests are most harmful when they do not internalise significant amounts of the costs they impose on society but become less harmful as their interest becomes encompassing enough to suffer the costs. Hence, our model implicitly represents an economy with decentralised wage bargaining.

The equilibrium rate of employment depends on the intensity of the distributive conflict. The stronger the opposition between workers and capitalists, the faster labour will translate participation rates into a higher wage-share. Firms, in turn, respond by increasing prices. The net result is an appreciation of the RER in levels that damages growth. A consequence of anaemic demand is firms hiring fewer workers to satisfy their sales prospects, thus, bringing employment rates down. When it comes to price and non-price competitiveness, they are both simultaneously determined. *Ceteris paribus*, fewer conflict societies are related to higher employment and greater price competitiveness. Notice that a similar result follows from a higher Kaldor-Verdoorn coefficient. It has been argued that κ is larger the higher the technological sophistication of the productive structure (for empirical support, see Romero and Britto, 2017). We show that more significant dynamic economies of scale allow firms in the South country to compete in price terms. Furthermore, because of the "structural change" mechanism, relative prices influence non-price competitiveness in equilibrium.

Next, we turn to the investigation of the local stability properties of P. Applying the existence part of the Hopf bifurcation theorem (Gandolfo, 2009, pp. 479-483), we can state and prove the following Proposition:

Proposition 2 *The coefficients of the characteristic equation are positive as long as:*

$$\bar{\kappa} > \gamma\phi \tag{25}$$

The unique internal equilibrium solution is locally asymptotically stable in the region of the parameter space defined as:

$$(\bar{\kappa} - \gamma\phi)\, e \left[(1-\kappa)\, \sigma e \gamma\phi\theta + (\bar{\kappa} - \gamma\phi)\, e 2\beta\rho + 4\beta^2\rho^2\right] > (1-\kappa)\, z\zeta\gamma\phi e\theta\rho \tag{26}$$

If a change in one of the parameters determines the violation of this last condition, the characteristic equation possesses a pair of complex conjugate eigenvalues that become purely imaginary, while no other eigenvalues with zero real part exist. In this case, a Hopf bifurcation might occur and the system admits a family of periodic solutions.

Proof. See Mathematical Appendix A2. ■

Altogether, Propositions 1 and 2 provide, respectively, a *static* and *dynamic* representation of cumulative causation. In the first case, we refer to the determination of equilibrium and how price and non-price terms are determined simultaneously, taking into account the behaviour of firms and workers in the goods and labour markets. In the second case, it is shown that endogenous long-run cycles of structural change might emerge. Of course, the existence part of the Hopf bifurcation theorem leaves us in the dark regarding the nature of the periodic attractor. It may be unstable, in which case we refer to a sub-critical Hopf bifurcation; or it may be stable, resulting in the super-critical case.[8] Furthermore, from

[8] It is possible to demonstrate the direction of the limit cycle bifurcation analytically by relying on the first Lyapunov coefficient, l_1 (see Kuznetsov, 2004, pp. 157-194). When $l_1 > 0$, the basin of attraction of the stable focus is surrounded by an unstable cycle, characterising a sub-critical bifurcation. On the other hand, in the super-critical case, $l_1 < 0$, the stable focus becomes unstable and is surrounded by an isolated, stable closed orbit. However, the algebraic steps involved in the respective proof are quite tedious, and their economic interpretation is not straightforward. Hence, we rely on numerical simulations to determine the nature of the bifurcation.

an economic point of view, the last condition in Proposition 2 is not very intuitive. Before proceeding, it is worth spending some time studying at least one particular case. Suppose the response of non-price competitiveness to the exchange rate is zero. This means we are blocking the "structural change" channel connecting price conditions to growth. We can state and prove the following Proposition:

Proposition 3 *When non-price competitiveness does not respond to the RER, i.e. $\zeta = 0$, the equilibrium solution $P = (e^*, \theta^*, \rho^*)$ is defined and given by:*

$$e^* = \frac{\gamma_0}{\gamma\phi}$$
$$\theta^* = \frac{\bar{\kappa}e^* - \kappa_0 + n}{(1-\kappa)\,\sigma}$$
$$\rho^* = 0$$

Furthermore, provided that condition (25) is satisfied, P is locally asymptotically stable.

Proof. See Mathematical Appendix A3. ■

We already anticipated that, in the model, $\zeta = 0$ implies $\rho^* = 0$. This result follows from the assumption that the autonomous component of μ_S only depends on RER, as in Eq. (22). We will come back to this point in the next Section when introducing the possibility of Schumpeterian innovation waves. Two additional findings are worth stressing. First, the internal equilibrium point is always locally stable. That is, blocking the "structural change" channel makes impossible the existence of long-run cycles of structural change. Such an outcome is important because shows that $\zeta > 0$ is a necessary condition for a dynamic representation of cumulative causation. Second, a strong response of exports to price conditions, σ, is related to a more appreciated equilibrium RER. Recall that, from Eq. (12), exports respond to stable prices over a certain time horizon. In equilibrium, a high σ indicates that the RER required to match the rate of growth of the economy with the natural growth rate is lower. In the next Section, we present a numerical exercise to show that long-run cycles are stable and are not merely a formal curiosity, being very much likely to emerge for a combination of parameters in line with empirical evidence in the field.

4 Robustness and interpretative power

As noted, our model builds on a North-South approach to uneven development that generates endogenous growth and long-run waves of structural change. Our purpose in this Section is to show that the system fits crucial stylised facts of the historical experiences of EA and LA. This step is similar to Cimoli et al. (2019), who interpreted different sets of policies in both regions as exogenous shocks and evaluated the respective convergence trajectories. Given that we understand growth as a fundamental disequilibrium phenomenon, we want to assess how likely are fluctuations emerge. We are also interested in testing whether the model is compatible with LA having:

1. A tendency for a more appreciated RER.
2. Lower non-price competitiveness.
3. Lower dynamic economies of scale.
4. Stronger distributive conflict.

5. Lower growth & greater volatility.

which are empirical stylised facts revisited in detail by Cimoli and co-authors. Hence, in what follows, we shall initially present our calibration strategy, leaving the discussion on "real-world" examples and the possibility of obtaining irregular fluctuations for the last two parts of the Section.

4.1 A closer look into the transmission channels

In order to choose plausible values for the 11 parameters in the model, we have considered the evidence is given in several empirical studies. The behavioural relationship governing the rate of growth of labour productivity has been extensively estimated in the literature. There is a certain consensus that the Kaldor-Verdoorn coefficient, κ, lies in between 0.25 and 0.75 (e.g. McCombie et al., 2002; Romero and Britto, 2017). The magnitude of $\bar{\kappa}$ was chosen following Hein and Tarassow (2010) and Dávila-Fernández (2020). For the price and income elasticity of exports, we follow the extensive literature on Thirlwall's law that estimates the respective trade equations (e.g. Fagerberg, 1988; Romero and McCombie, 2016; Felipe and Lanzafame, 2020). As in Dávila-Fernández and Sordi (2019), in a stagnant economy with zero employment, labour productivity is assumed to fall at a rate of 0.01. For the behavioural equations capturing aspects of distributive conflict, we rely on the empirical literature on the growth-cycle (see Graselli and Maheshwari, 2018). Variables such as the growth rate of the rest of the world or the labour force were chosen in line with well-known macroeconomic trends. We would like to emphasise that we are not actually calibrating a real economy, though implicitly we have a developing country in mind. The reported studies were used to have a baseline framework of the magnitudes involved, which are summarised in Table 1. Notice that (26) is satisfied, i.e. the unique internal equilibrium solution is stable. Such a calibration is compatible with the South country having an overvalued RER, $\theta^* < 1$.

Given the importance of labour productivity to Dixon and Thirlwall (1975) results, we are particularly interested in the role of dynamic economies of scale and the "structural change" channel to the possibility of obtaining long-run cycles of structural change. Hence, in Fig. 2, we report, in panels (a) and (b), the 2-dimension bifurcation diagrams on ϕ, κ, and ζ. The first parameter captures the impact that increases in the employment rate have on distributive conditions. The second stands for the Kaldor-Verdoorn coefficient. Finally, ζ captures how price conditions affect non-price competitiveness and, for that reason, is taken as a proxy of the "structural change" mechanism. We define the following intervals:

$$\phi \in [0.75; 1.25], \ \kappa \in [0.25; 0.75], \ \zeta \in [0; 0.25]$$

The region in orange corresponds to the parameter set that results in a stable attractor, while in yellow we have those leading to periodic fluctuations. A dotted black line marks the Hopf bifurcation.

As an initial significant result, we would like to highlight the likelihood of the periodic solution to occur. When distributive conflict is sufficiently low, the equilibrium point is stable, no matter the magnitude of the Kaldor-Verdoorn coefficient or the RER's impact on the quality and differentiation of domestic production. However, as ϕ increases, we obtain a family of periodic solutions. Panel (c) presents a sort of 3-dimension bifurcation diagram. The plotted plane corresponds to the case condition (26) is satisfied with equality. For a combination of parameters above the plane, we have the dynamic system admits a periodic attractor. On the other hand, a set of parameters below the plane results in simple asymptotically stability.

Table 1: Choice of parameters and an overview of how to interpret them

Parameter	Definition	Value	Description and possible policy implications
z	Output growth rate in the North	0.03	Exports in the South depend on foreign demand. An increase in z is associated with a higher long-run growth rate in the South conditional to current non-price competitiveness conditions.
σ	Exports' response to price effects in the South	0.00525	Exports in the South depend on price conditions over a certain time-horizon. A higher σ is related to a greater capacity of firms in the South to respond to a more depreciated RER, thus exporting to the North.
γ_0	Exogenous elements affecting price competitiveness in the South	0.01	Price competitiveness depends on a number of variables that we do not explicitly include into the model such as the existing market structure or the strength of absorptive capabilities. An improvement in those is related to a higher γ_0.
γ	Sensitivity of prices to the wage-share in the South	0.02	Firms' might respond to a higher real-wage to labour productivity ratio by increasing their prices. A high γ indicates companies are very sensitive to distributive conditions.
ϕ	Sensitivity of the wage-share to employment in the South	1	Increasing employment rates result in higher bargaining power of workers. Parameter ϕ captures the response of income distribution to labour market conditions.
n	Population growth rate in the South	0.02	Population in the South is assumed to grow at an exogenous rate. This implies that the "natural" and the demand-led output growth rates adjust through labour productivity.
β	Sensitivity of non-price conditions to non-price competitiveness in the North & South	0.02	As a region increases its non-price advantage over the other, it becomes more difficult to further increase the gap. Parameter β stands as the decreasing returns of product creation or differentiation.
ς	Sensitivity of non-price competitiveness to price-competitiveness in the South	0.04	From a policy perspective, this is the most important parameter in the model. It captures the effectiveness of the adopted industrial policy. An effective development strategy is reflected in a greater capacity to translate price conditions into non-price competitiveness, i.e. positive "structural change".
κ_0	Exogenous elements affecting labour productivity growth in the South	0.01	This parameter stands as the growth rate of labour productivity when there is zero growth and employment. Thus, it captures the degree of depreciation of human capital.
κ	Learning-by-doing effects	0.5	Learning-by-doing depends on the magnitude of dynamic economies of scale as in the so-called Kaldor-Verdoorn's law.
$\bar{\kappa}$	Induced technical change	0.03	Instead of raising prices, firms' might respond to increases in the real-wage to labour productivity ratio by increasing their search for labour saving production techniques. A high $\bar{\kappa}$ suggests companies strongly engage in induced technical change when labour costs increase. Such an effect is expected to be higher in the North relatively to the South.

To show that we are dealing with a super-critical Hopf bifurcation, Fig. 3 contrasts the case we have convergence to equilibrium, as in panel (a), to the emergence of a stable orbit around the equilibrium point in panel (b).[9] In the first of them, we adopted our baseline calibration set of parameters. As for the second, the only modifications consist in $\kappa = 0.4$ and $\phi = 1.1$. Initial conditions are given by:

$$(e_0, \theta_0, \rho_0) = (e^* \pm 0.1, \theta^* \pm 0.1, \rho^* \pm 0.1)$$

so that we represent a situation in which we start above and below the equilibrium point. Cycles are clock-wise oriented with decreasing amplitude in panel (a). On the other hand, panel (b) indicates that both initial conditions converge to a unique orbit.

Fig. 4 evaluates the robustness of the cycle to marginal changes in our parameters of interest. Panel (a) contrasts the cases in which $\kappa = 0.375$ and $\kappa = 0.4$, using our baseline parameter set up with the exception of $\phi = 1.1$. It is possible to appreciate that a reduction in the magnitude of the economies of scale is related to a more volatile system. This result suggests that countries with a small modern sector might become more prone to experience a sequence of high and low growth episodes with price and non-price competitiveness varying more over time. In panel (b), we plot the correspondent time-series of the rate of growth of output, calculated using Eq. (16). The dotted lines stand for the respective averages. We confirm that differences in terms of the equilibrium point are minor, though the same cannot be said about the magnitude of the oscillations. Variations in the long-run rate of growth of the economy, y_{bp}, are in line with the concept of cycles of structural change as well as recent empirical evidence on Thirlwall's law that applies time-varying parameters estimation techniques (see the seminal contribution by Felipe and Lanzafame, 2020).

We proceed by comparing $\phi = 1$ and $\phi = 1.1$, in panels (c)-(d), maintaining our standard calibration scenario, except $\kappa = 0.4$. As expected, a more intensive distributive conflict is related to greater oscillations, which is confirmed in terms of the rate of growth compatible with equilibrium in the balance-of-payments. Such an outcome follows basically because income distribution embeds firms response to the state of the labour market, both in terms of price and the search for labour-saving production techniques. The stronger this response is, the stronger variations in price and non-price competitiveness will be, impacting growth. Finally, panels (e)-(f) focus on the role of "structural change" as captured by ζ. Increasing the response of non-price to price factors does not seem to have a major impact on the orbit's size. Nonetheless, we observe important effects in the determination of the equilibrium point. A higher ζ means that a stable RER can induce more effectively increases in the quality of goods and services exported by the South economy. As a result, we report a Pareto-superior equilibrium solution in terms of growth rates through non-price competitiveness.

The structure above allows us to differentiate between two main forces. As for the first, it consists of a dynamic representation of cumulative causation. An increase in the rate of growth of exports leads firms to increase production to match what is, in the context of this model, the only source of autonomous non-capacity creating aggregate demand. Because of dynamic economies of scale, a higher rate of growth results in higher labour productivity. *Ceteris paribus*, however, firms are able to produce more with fewer workers, reducing the participation rate. At this point, the bargaining power of workers deteriorates as well as their fall-back position. Distributive conflict slows down, followed by a reduction in the

[9] An important difference between the Hopf bifurcation, in continuous time, and the Neimark-Saker bifurcation, in discrete time, is that whereas the invariant limit cycle originating from the former consists of a single orbit, in the latter, there exist many different orbits. Our model was conceive in continuous time and, thus, we find ourselves in the first case. For a comprehesive introduction to both types of bifurcations, see Medio and Lines (2001).

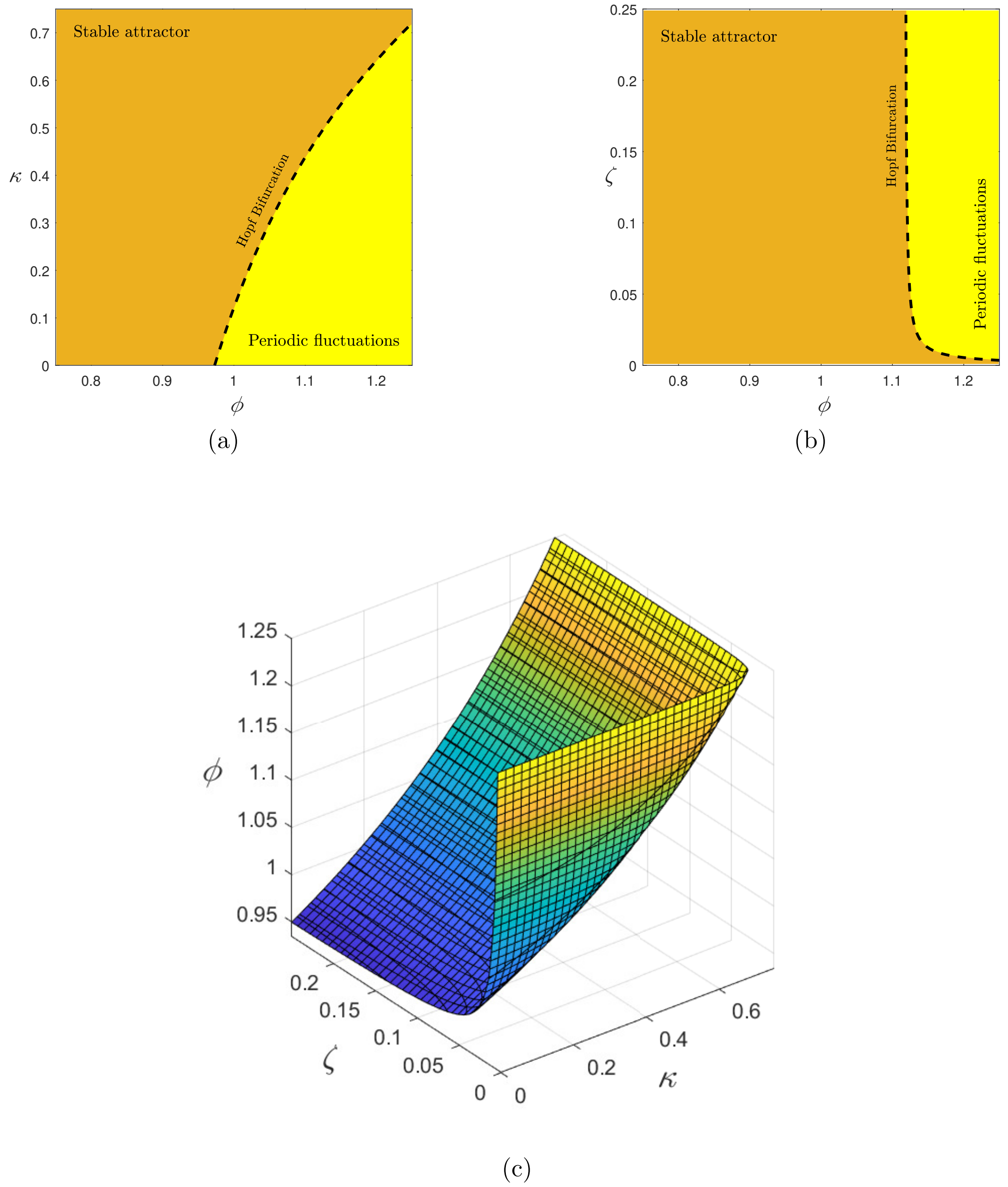


Figure 2: 2D and 3D bifurcation diagrams.

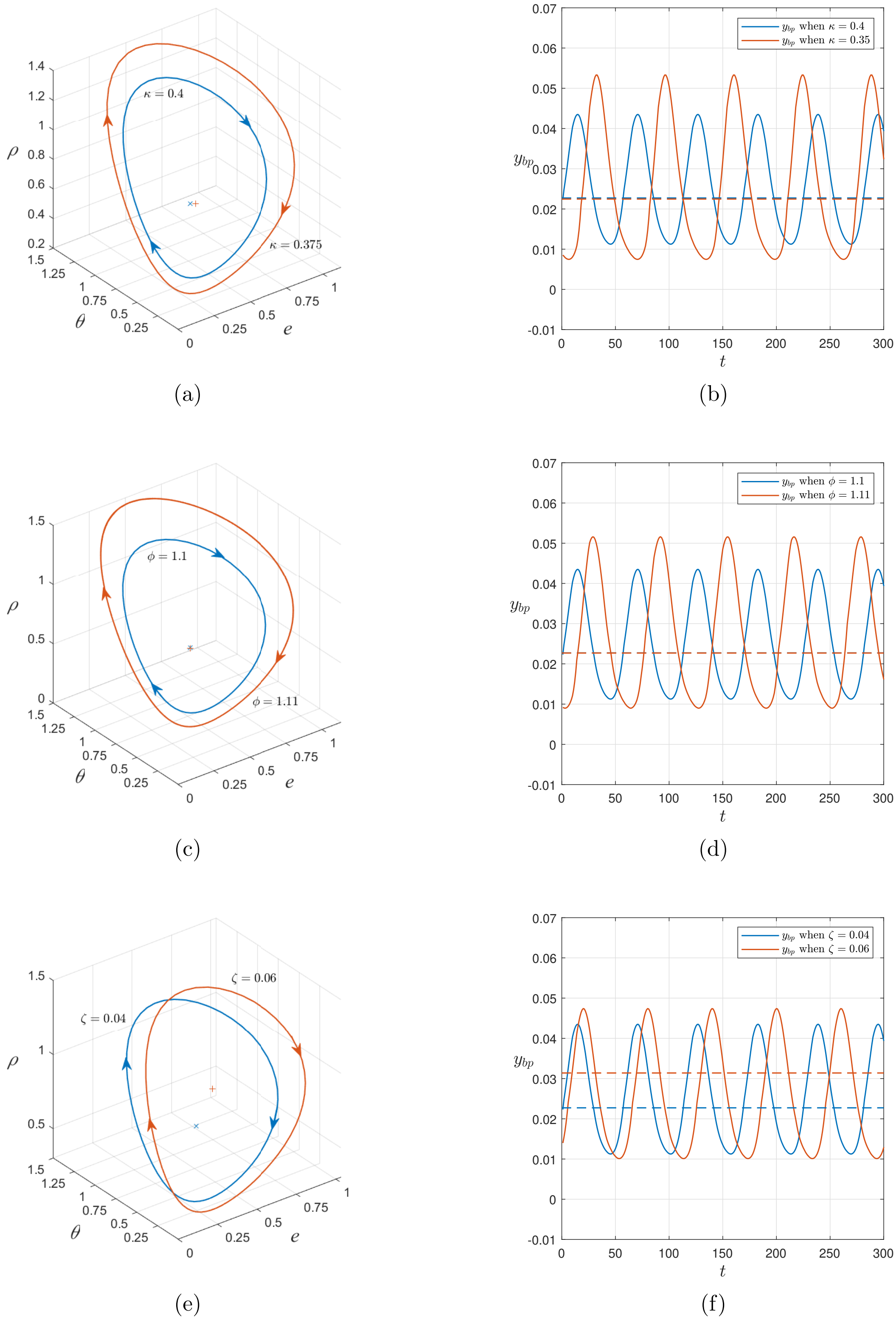


Figure 3: Robustness of the periodic attractor. Symbols $+$ and $*$ stand for the respective equilibrium points.

rate of inflation. The RER will depreciate, damaging growth through the direct aggregate demand channel. However, it impulses exports through two additional mechanisms: on the one hand, a more depreciated currency in levels for a sufficiently long time horizon allows firms to better plan their incursion into foreign markets; on the other hand, there is a process of "structural change" that allows domestic firms to gain non-price competitiveness. In both cases, exports are foster, characterising the explosive nature of cumulative causation:

$$\uparrow \frac{\dot{X}}{X} \Rightarrow \uparrow \frac{\dot{Y}}{Y} \Rightarrow \uparrow \frac{\dot{q}}{q} \Rightarrow \begin{cases} \uparrow \theta \Rightarrow \uparrow \dot{X}/X \\ \\ \uparrow \dot{\theta}/\theta \Rightarrow \downarrow \dot{Y}/Y \end{cases}$$

As a stabiliser of the system, the second force comes from the labour market. Let us think again in terms of an initial increase in the rate of growth of exports. The resulting output expansion is necessarily related to a higher employment rate because firms need to hire more workers to match expanding demand. As the labour market tightens, some sectors start to experience labour shortages, hand in hand with improved workers' bargaining power. Firms react in two different ways. If they increase their search for labour-saving production techniques, labour productivity improves, and we are back to the scenario described in the previous paragraph. However, to protect profit margins, they could increase prices. Higher inflation in the South economy will appreciate the RER. During the overvaluation process, economic performance will improve through the aggregate demand channel. Nonetheless, the reduction in price competitiveness in levels will negatively impact the export plan horizon of the firm and the "structural change" channel through non-price competitiveness. The following reduction in exports stabilises the initial impulse:

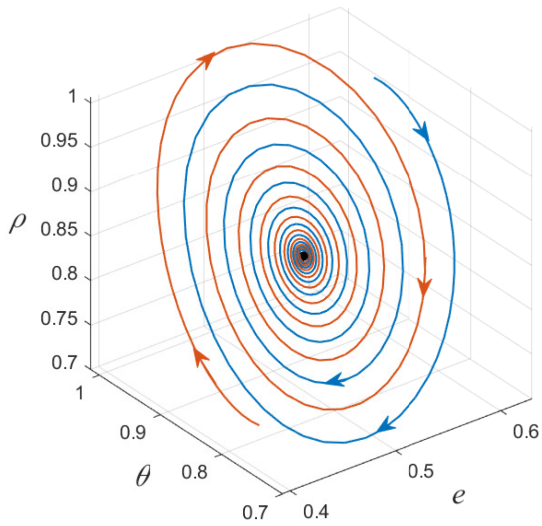
$$\uparrow \frac{\dot{X}}{X} \Rightarrow \uparrow \frac{\dot{Y}}{Y} \Rightarrow \uparrow e \Rightarrow \uparrow \varpi \Rightarrow \begin{cases} \downarrow \theta \Rightarrow \downarrow \dot{X}/X \\ \\ \downarrow \dot{\theta}/\theta \Rightarrow \uparrow \dot{Y}/Y \end{cases}$$

such that endogenous long-run cycles of structural change result from the interaction between these two mechanisms.

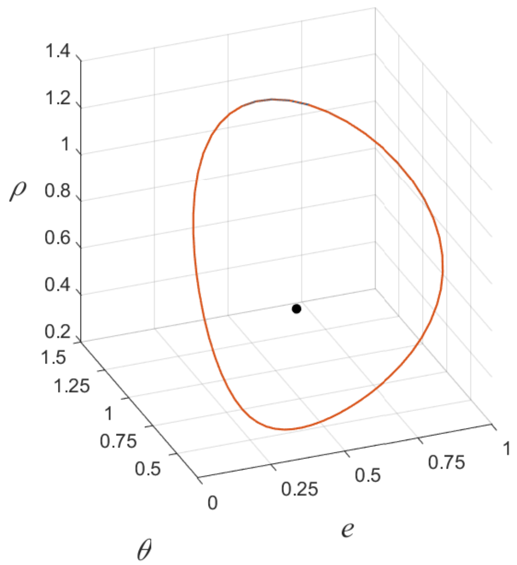
It is possible to compare the time-series of two different rates of growth. The first, in orange, is computed using Eq. (15), and corresponds to the out of equilibrium growth rate compatible with equilibrium in the balance-of-payments. The second, in blue, is its steady-state equivalent, which rules out the possibility of everlasting RER appreciations or depreciations. It was calculated as in Eq. (16). Even though the distinction might sound subtle, the mechanisms discussed throughout the paper rely on it. Fig. 5 depicts both and shows the former is more volatile than the latter, which intuitively makes sense. This difference results from the fact that distributive conflict depends on growth including variations of the exchange rate, while Kaldor-Verdoorn's law was supposed not to depend on such "transitional" dynamics. Overall, we consider the differentiation between RER in levels and variation rates is an important one, and that both should be incorporated altogether into demand-led growth models.

4.2 The historical experiences of Asia and Latin America

One of the most important features of economic development in the last 60 years is the catching-up and overtake of EA relative to LA economies. As shown in Table 2, data from the World Bank indicates that, in 1960, EA's GDP per capita was almost three times smaller than in LA. However, in the following decades, such income-gap was continuously reduced and was eventually reversed. Furthermore, in recent years, countries such as Argentina



(a)



(b)

Figure 4: Emergence of endogenous cycles of structural change. In panel (a) we have $\kappa = 0.5$ and $\phi = 1$ while, in panel (b), $\kappa = 0.4$ and $\phi = 1.1$.

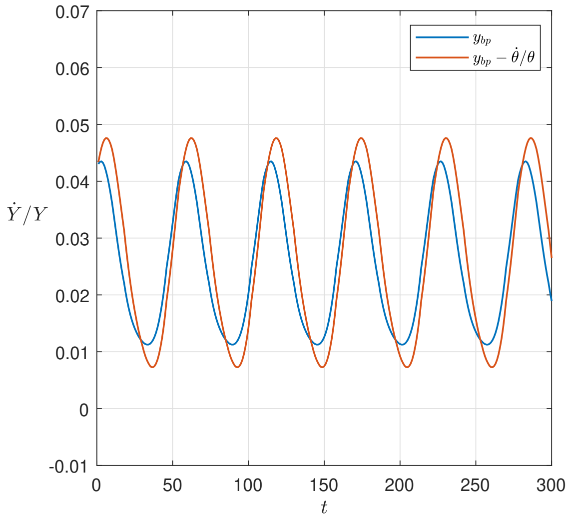


Figure 5: Comparing rates of growth with and without exchange rate variations.

Table 2: EA and LA per capita GDP, 1960-2020, constant 2015 US$

Region	1960	1980	2000	2020
East Asia	1111.74	2541.1	5006.54	11126.28
Latin America	3280.49	6162.79	6748.79	8003.12
Ratio	0.33	0.41	0.74	1.39

and Brazil have experienced a sharp process of deindustrialisation and negative structural change (see Palma, 2008; Rodrik, 2016). There is an ongoing discussion on how the rise of China in the international arena might have deepened this phenomenon (e.g. McMillan et al., 2014).

A generally accepted explanation for those trends lies in the differences between growth strategies in both regions. LA adopted an inward developing model based on industrialisation by import substitution. Meanwhile, EA countries preferred export-led industrialisation. These differences had profound consequences on the macroeconomic policy regime adopted by each region. In EA, a competitive real exchange rate was of fundamental importance for the success of their development strategy; for LAC countries, however, import tariffs and exchange rate controls were more critical for isolating the domestic market from external competition, allowing the substitution of imports for domestic production and promoting industrialisation. The liberalisation reforms of the 1990s were also different in nature, with Asia promoting competitiveness and LA more concerned with maintaining the status quo. The successful strategy of the former region has allowed the consolidation of a modern sector with higher dynamic economies of scale and smoother distributive conflict.[10]

Once an export-led industrialisation model is adopted, expanding the market-share in exports of manufacturing goods demands a competitive real exchange rate and increasing non-price competitiveness of exports, which means an increase in the quality or technological intensity of the manufacturing goods exported to the world markets. An increase in non-

[10]Kaldor (1967) argued that industrialisation by import substitution of final goods is just the first stage of industrial development. Due to economies of scale, sooner or later, the small size of domestic markets will make it impossible for domestic firms to increase production and labour productivity. This means that the continuation of industrialisation requires domestic firms to produce for foreign markets, in other words, adopting an export-led industrialisation strategy.

price competitiveness requires the adoption of industrial policies directed to developing the technological capabilities of domestic firms and massive investment in education to increase workers' cognitive and learning capabilities. An inward orientation of economic development does not promote the incentives for increasing non-price competitiveness, which explains the growing technological backwardness of domestic firms of LA. In sum, the success of EA relative to LA was due to a combination of price and non-price competitiveness in an export-led developing strategy.

Our findings could help to explain some of these patterns. Indeed, contrasting the two regions, LA presents a tendency for a more appreciated RER (θ), lower non-price competitiveness (ρ), lower dynamic economies of scale (κ), stronger distributive conflict (ϕ), resulting in a reduced long-run growth rate (y_{bp}) and greater volatility. Moreover, our results are robust to distinguishing between adverse currency devaluations and the positive implications of a more depreciated RER. While Fig. 2 indicates that long-run cycles are not a curiosity, rather being very much likely to emerge, Figs. 3-5 are in line with the historical experience of two non-negligible regions in the global South. The long-run growth rate is endogenous to price and non-price competitiveness that are simultaneously determined from the interaction between labour and goods markets.

4.3 Periodic or aperiodic fluctuations?

The oscillations presented so far are of periodic motion. This fact, of course, is at odds with empirical evidence, which indicates the existence of irregular fluctuations, even in terms of the long-run rate of growth. For example, Felipe and Lanzafame (2020) have recently estimated y_{bp} for China applying time-varying parameter estimation techniques. They showed that the export-led framework fits well the experience of that country and that the rate of growth compatible with equilibrium in the balance-of-payments depicts aperiodic cycles of 10-15 years. As a final step, we show that the model developed in the present paper is compatible with those findings. Following Goodwin's (1951) insight that Schumpeterian innovations require investment to occur periodically, we suppose these technological waves impact the autonomous component of non-price competitiveness:

$$\beta_{\mu_S} = \zeta\theta + \psi \cos(\bar{\psi} t) \tag{27}$$

where ψ and $\bar{\psi}$ determine the shape of the respective waves. A higher value of the former is related to more robust effects on β_{μ_S}, while a greater $\bar{\psi}$ is associated with innovation waves of shorter length.

The modification above changes the nature of the dynamic system that becomes non-autonomous. A "natural" oscillation frequency interacts with an external "force" and it may results in more complex dynamics (for a similar application, see Dávila-Fernández and Sordi, 2019). Given that this paper is concerned with long-run cycles of structural change, in our numerical simulations, Schumpeterian innovations are supposed to be very slow in motion with overall minor effects:

$$\psi = 0.01, \ \bar{\psi} = 0.04$$

which is in line with the magnitudes of the remaining calibration parameters.

The view that countries are influenced irreversibly by how they have changed is commonly referred to in economics as path dependence. An intuitive way to assess if the model is compatible with such a property consists in verifying whether it exhibits sensitivity to initial conditions. A dynamic system can be considered to present hysteretic behaviour when the trajectories of the endogenous variables exhibit some sort of path dependency (for a discussion, see Dosi et al., 2018). Fig. 6, panel (a), reports the emergence of a chaotic attractor in the 3-dimensional phase space when we use Eq. (27) instead of (22). Panel (b) shows how very similar initial conditions, in the beginning, move together but eventually result in entirely different growth trajectories, representing the statement "history matters". As in Setterfield (1997), our approach modifies Kaldor's basic model by suggesting that the process of cumulative causation occurs in the context of specific technological and institutional regimes. Still, we give one step forward and rigorously showed, analytically and numerically, that the economy might indeed never be in a state of rest, presenting persistent and irregular fluctuations similar to those observed in actual data.

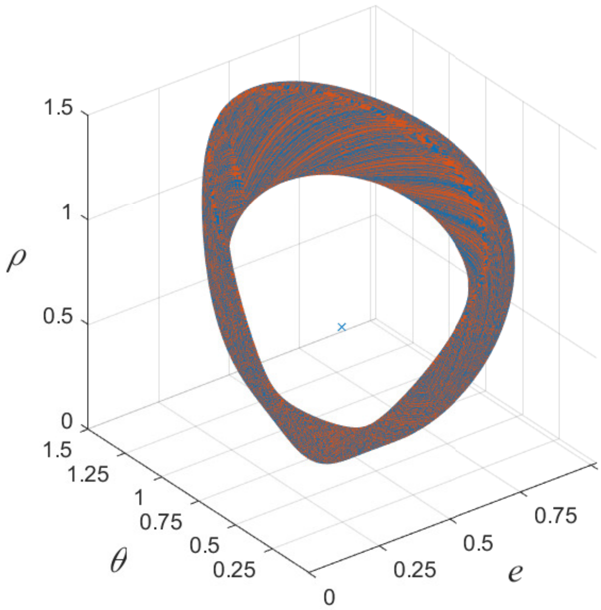
5 Final considerations

Development economists have been concerned for some time now about the role of the RER for economic growth. The existing empirical evidence suggests a positive relationship between price competitiveness in levels and economic performance. Currency devaluations, however, damage growth. While these two elements have been separately incorporated into demand-led growth theories, to the best of our knowledge, a comprehensive assessment of the interaction between them is still missing. This article filled a gap in the literature by presenting a stylised export-led growth model in which price and non-price competitiveness respond to the level and variation of the real exchange rate.

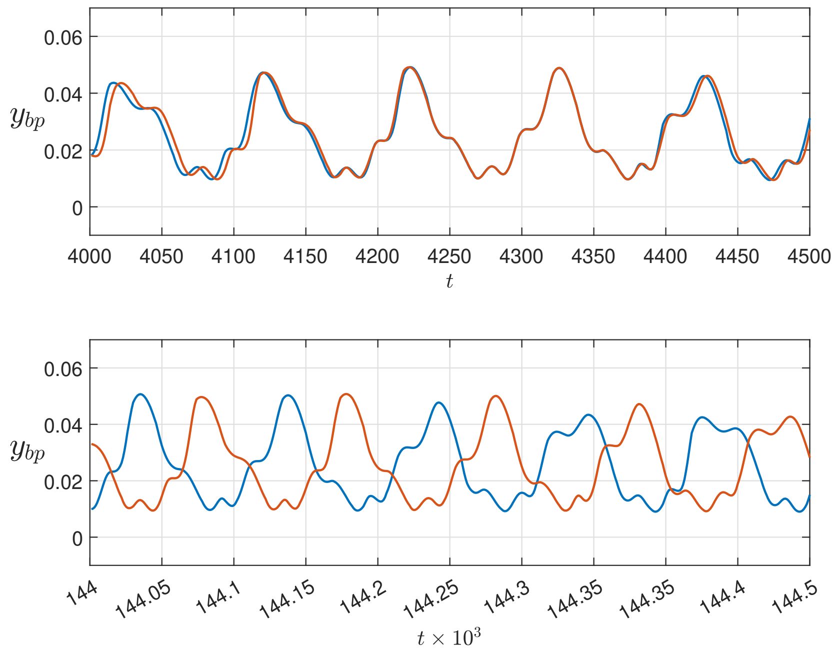
For more than forty years, the *static* cumulative causation model by Dixon and Thirlwall (1975) has offered a baseline framework for studying the RER-growth correspondence. We have, in turn, provided a novel *dynamic* representation, allowing for the interplay between the two dimensions of competitiveness with the labour and goods market. The world was divided into two regions, *North* and *South*, open to international trade, that produce goods and services which are imperfect substitutes. It was shown that, in equilibrium, the RER and the capacity of the productive structure to respond to changes in foreign demand are simultaneously determined. A more depreciated RER and higher non-price competitiveness are associated with higher growth through exports. Firms hire more workers to match demand, raising the steady-state employment rate.

Still, by applying the existence part of the Hopf bifurcation theorem, we showed that endogenous cycles of structural change are likely to arise. These long-run fluctuations mean that the economy is never in a state of rest. The level of distributive conflict is crucial for such slow motion waves to appear. A combination of a strong response of income distribution to the rate of employment with a low Kaldor-Verdoorn coefficient increases the system's volatility. Given that developing economies such as Argentina or Brazil, in which there is an ongoing deindustrialisation process, are likely to experience higher conflict over the distribution of income and reduced dynamic economies of scale, our findings could help to explain their fraught performance. In more general terms, contrasting Latin America and East Asia, the former region presents recurrently overvalued RER, lower non-price competitiveness, lower dynamic economies of scale, and stronger distributive conflict, resulting in less growth and greater volatility. The model developed in this paper is compatible with such broad stylised facts.

Finally, we provided a detailed description of the interplay between two different forces behind the emergence of the periodic attractor. On the one hand, the labour market works as a stabiliser, either through firms' increasing their search for labour-saving production techniques or raising domestic prices. On the other hand, the goods market embeds cumulative causation supported by structural change in which quality and product differentiation are non-neutral to relative prices. Thus, as the economy grows faster, labour productivity



(a)



(b)

Figure 6: Path dependence when $\beta_{\mu_S} = \zeta\theta + 0.01\cos(0.04t)$. Initial conditions (i) $(e_0, \theta_0, \rho_0) = (0.625; 0.95; 0.95)$, in blue, and (ii) $(e_0, \theta_0, \rho_0) = (0.6251; 0.95; 0.95)$, in orange.

increases through the Kaldor-Verdoorn effects, allowing for reduced prices that depreciate the RER. The depreciation in itself damages growth but, over a certain time horizon, a more depreciated exchange rate allows firms to plan their incursion in foreign markets better and fosters structural change. Introducing periodic Schumpeterian innovation waves generate irregular long-run fluctuations and sensitivity to initial conditions, providing a representation of the statement "history matters".

A Mathematical appendix

A.1 Proof of Proposition 1

To prove Proposition 1, recall the equilibrium conditions are given by:

$$
\begin{aligned}
0 &= \left[(1-\kappa)\left(\rho z + \sigma\theta\right) - \bar{\kappa} e + \kappa_0 - n\right] e \\
0 &= \left[\gamma_0 - \gamma\phi e\right]\theta \\
0 &= \left[-2\beta\rho + \zeta\theta\right]\rho
\end{aligned}
$$

Ruling out the trivial case in which $e = \theta = \rho = 0$, we have that:

$$
\begin{aligned}
\rho z + \sigma\theta &= -\kappa_0 + \kappa\left(\rho z + \sigma\theta\right) + \bar{\kappa} e + n && \text{(A.1)} \\
\gamma\phi e &= \gamma_0 && \text{(A.2)} \\
2\beta\rho &= \zeta\theta && \text{(A.3)}
\end{aligned}
$$

It immediately follows from Eq. (A.2):

$$e^* = \frac{\gamma_0}{\gamma\phi} \tag{A.4}$$

Furthermore, notice that, rearranging Eq. (A.3):

$$\rho = \frac{\zeta\theta}{2\beta} \tag{A.5}$$

Substituting Eqs. (A.4)-(A.5) into (A.1), and solving simultaneously to θ and ρ, we have:

$$
\begin{aligned}
\theta^* &= \frac{\bar{\kappa} e^* - \kappa_0 + n}{(1-\kappa)\left(\frac{\zeta z}{2\beta} + \sigma\right)} \\
\rho^* &= \frac{\zeta\theta^*}{2\beta}
\end{aligned}
$$

A.2 Proof of Proposition 2

To prove Proposition 2, we linearise the dynamic system around the internal equilibrium solution, P:

$$
\begin{bmatrix} \dot{e} \\ \dot{\theta} \\ \dot{\rho} \end{bmatrix} = \underbrace{\begin{bmatrix} J_{11} & J_{12} & J_{13} \\ J_{21} & 0 & 0 \\ 0 & J_{32} & J_{33} \end{bmatrix}}_{\text{J}} \begin{bmatrix} e - e^* \\ \theta - \theta^* \\ \rho - \rho^* \end{bmatrix}
$$

where

$$
\begin{aligned}
J_{11} &= \left.\frac{\partial g_1\left(e,\theta,\rho\right)}{\partial e}\right|_{e=e^E,\theta=\theta^E,\rho=\rho^E} = -\left(\bar{\kappa} - \gamma\phi\right) e \gtreqless 0 \\
J_{12} &= \left.\frac{\partial g_1\left(e,\theta,\rho\right)}{\partial \theta}\right|_{e=e^E,\theta=\theta^E,\rho=\rho^E} = \left(1-\kappa\right)\sigma e > 0 \\
J_{13} &= \left.\frac{\partial g_1\left(e,\theta,\rho\right)}{\partial \rho}\right|_{e=e^E,\theta=\theta^E,\rho=\rho^E} = \left(1-\kappa\right) z e > 0
\end{aligned}
$$

$$J_{21} = \left.\frac{\partial g_2(e,\theta,\rho)}{\partial e}\right|_{e=e^E,\theta=\theta^E,\rho=\rho^E} = -\gamma\phi\theta < 0$$
$$J_{22} = \left.\frac{\partial g_2(e,\theta,\rho)}{\partial \theta}\right|_{e=e^E,\theta=\theta^E,\rho=\rho^E} = 0$$
$$J_{23} = \left.\frac{\partial g_2(e,\theta,\rho)}{\partial \rho}\right|_{e=e^E,\theta=\theta^E,\rho=\rho^E} = 0$$

$$J_{31} = \left.\frac{\partial g_3(e,\theta,\rho)}{\partial e}\right|_{e=e^E,\theta=\theta^E,\rho=\rho^E} = 0$$
$$J_{32} = \left.\frac{\partial g_3(e,\theta,\rho)}{\partial \theta}\right|_{e=e^E,\theta=\theta^E,\rho=\rho^E} = \zeta\rho > 0$$
$$J_{33} = \left.\frac{\partial g_3(e,\theta,\rho)}{\partial \rho}\right|_{e=e^E,\theta=\theta^E,\rho=\rho^E} = -2\beta\rho < 0$$

are the elements of the Jacobian matrix, J.

The characteristic equation is:

$$\lambda^3 + b_1\lambda^2 + b_2\lambda + b_3 = 0$$

where its coefficients are define and given by

$$\begin{aligned} b_1 &= -\mathrm{tr}J \\ &= -J_{11} - J_{33} \\ &= (\bar{\kappa} - \gamma\phi)\, e + 2\beta\rho \end{aligned} \tag{A.6}$$

$$\begin{aligned} b_2 &= \begin{vmatrix} J_{11} & J_{12} \\ J_{21} & 0 \end{vmatrix} + \begin{vmatrix} J_{11} & J_{13} \\ 0 & J_{33} \end{vmatrix} + \begin{vmatrix} 0 & 0 \\ J_{32} & J_{33} \end{vmatrix} \\ &= J_{11}J_{22} - J_{12}J_{21} + J_{11}J_{33} + J_{22}J_{33} \\ &= (1-\kappa)\,\sigma e\gamma\phi\theta + (\bar{\kappa} - \gamma\phi)\, e2\beta\rho \end{aligned} \tag{A.7}$$

$$\begin{aligned} b_3 &= -\det J \\ &= -\begin{vmatrix} J_{11} & J_{12} & J_{13} \\ J_{21} & 0 & 0 \\ 0 & J_{32} & J_{33} \end{vmatrix} \\ &= -J_{13}J_{21}J_{32} + J_{12}J_{21}J_{33} \\ &= (1-\kappa)\, ze\gamma\phi\theta\zeta\rho + 2\,(1-\kappa)\,\sigma e\gamma\phi\theta\beta\rho \\ &= (1-\kappa)\,(z\zeta + 2\sigma\beta)\,\gamma\phi e\theta\rho \end{aligned} \tag{A.8}$$

It immediately follows that the coefficients of the characteristic equation are positive as long as:

$$\bar{\kappa} > \gamma\phi$$

such that b_1, b_2, and $b_3 > 0$.

The sufficient condition for the local stability of (e^*, θ^*, ρ^*) is that all roots of the characteristic equation have negative real parts, which, from Routh-Hurwitz criteria, further requires:

$$b_1 b_2 - b_3 > 0 \tag{A.9}$$

Substituting Eqs. (A.6)-(A.7) into (A.9), we find that the unique internal equilibrium solution is stable as long as:

$$b_1 b_2 > b_3$$
$$(\bar{\kappa} - \gamma\phi)\, e \left[(1-\kappa)\, \sigma e \gamma \phi \theta + (\bar{\kappa} - \gamma\phi)\, e 2\beta\rho + 4\beta^2\rho^2\right] > (1-\kappa)\, z\zeta\gamma\phi e\theta\rho$$

If a change in one of the parameters determines the violation of (A.9) such that $b_1 b_2 - b_3 = 0$, the characteristic equation possesses a pair of complex conjugate eigenvalues that become purely imaginary at the critical value of the parameter, while no other eigenvalues with zero real part exist. In this case, a Hopf bifurcation might occur. To complete the proof, we need to verify whether the derivative of the real part of the complex eigenvalues with respect to the bifurcation parameter is different from zero at the critical value, i.e. the so-called transversality condition. Given that in the paper we are interested in three crucial parameters, this makes the algebraic steps of the last part of the proof very long and with little economic content (they are still available under request). Therefore, we rely instead on numerical simulations to show that a super-critical Hopf bifurcation occurs and is robust to variations in the bifurcation parameters.

A.3 Proof of Proposition 3

To prove Proposition 3, we proceed in two steps. First, recall that, from Proposition 1, P is defined and given by:

$$e^* = \frac{\gamma_0}{\gamma\phi}$$
$$\theta^* = \frac{\bar{\kappa} e^* - \kappa_0 + n}{(1-\kappa)\left(\frac{\zeta z}{2\beta} + \sigma\right)}$$
$$\rho^* = \frac{\zeta\theta^*}{2\beta}$$

Substituting $\zeta = 0$, it immediately follows that:

$$e^* = \frac{\gamma_0}{\gamma\phi}$$
$$\theta^* = \frac{\bar{\kappa} e^* - \kappa_0 + n}{(1-\kappa)\,\sigma}$$
$$\rho^* = 0$$

Finally, notice that ζ only appears on the right side of condition (26). This implies that the latter is always satisfied. Thus, a Hopf bifurcation cannot occur.

References

[1] Allain, O. (2019). Demographic growth, Harrodian (in)stability and the supermultiplier. *Cambridge Journal of Economics* 43, 85-106.

[2] Andreoni, A., Chang, H. (2019). The political economy of industrial policy: Structural interdependencies, policy alignment and conflict management. *Structural Change and Economic Dynamics* 48, 136-150.

[3] Araújo, R. (2013). Cumulative causation in a structural economic dynamic approach to economic growth and uneven development. *Structural Change and Economic Dynamics* 24, 130-140.

[4] Beckerman, W. (1962). Projecting Europe's growth. *Economic Journal* 72, 912-25.

[5] Blecker, R. (2013). Long-run growth in open economies: Export-led cumulative causation or a balance-of-payments constraint? In Harcourt, G. and Krielser, P. (eds.) *The Oxford Handbook of Post-Keynesian Economics* 1, 390-414. Oxford University Press, Oxford.

[6] Blecker, R. (2021). New advances and controversies in the framework of balance-of-payments-constrained growth. *Journal of Economic Surveys*. Online first. DOI: 10.1111/joes.12463.

[7] Blecker, R., Setterfield, M. (2019). *Heterodox Macroeconomics: Models of Demand, Distribution and Growth*. Edward Elgar, Cheltenham.

[8] Boggio, L. (2003). A model of take-off and fast growth in open economies. *Metroeconomica* 54(2), 301-325.

[9] Boggio, L., Barbieri, L. (2017). International competitiveness in post-Keynesian growth theory: Controversies and empirical evidence. *Cambridge Journal of Economics* 41, 25-47.

[10] Botta, A. (2009). A structuralist North–South model on structural change, economic growth and catching-up. *Structural Change and Economic Dynamics* 20(1), 61-73.

[11] Calmfors, L., Driffill, J. (1988). Bargaining structure, corporatism and macroeconomic performance. *Economic Policy* 3(6): 13-61.

[12] Cimoli, M., Porcile, G. (2014). Technology, structural change and BOP-constrained growth: A structuralist toolbox. *Cambridge Journal of Economics* 38, 215-237.

[13] Cimoli, M., Pereima, J., Porcile, G. (2019). A technology gap interpretation of growth paths in Asia and Latin America. *Research Policy* 48(1), 125-136.

[14] Dávila-Fernández, M. (2020). Alternative approaches to technological change in a small open economy *Journal of Evolutionary Economics* 30, 279-317.

[15] Dávila-Fernández, M., Sordi, S. (2019). Path dependence, distributive cycles and export capacity in a BoPC growth model. *Structural Change and Economic Dynamics* 50, 258-272.

[16] Demir, F., Razmi, A. (2021). The real exchange rate and development theory, evidence, issues and challenges. *Journal of Economic Surveys*. Online first. DOI: 10.1111/joes.12418.

[17] Dixon, R., Thirlwall, A. (1975). A model of regional growth-rate differences on Kaldorian lines. *Oxford Economic Papers* 27(2), 201-214.

[18] Dosi, G., Pereira, M., Roventini, A., Virgillito, M. (2018). Causes and consequences of hysteresis: Aggregate demand, productivity, and employment. *Industrial and Corporate Change* 27(6), 1015-1044.

[19] Fagerberg, J. (1988). International competitiveness. *Economic Journal* 98, 355-374.

[20] Felipe, J., Lanzafame, M. (2020). The PRC's long-run growth through the lens of the export-led growth model. *Journal of Comparative Economics* 48, 163-181.

[21] Gandolfo, G. (2009). *Economic Dynamics*. Springer-Verlag, Heildelberg. 4th Edition.

[22] Gechert, S., Havranek, T., Irsova, Z. (2021). Measuring capital-labour substitution: The importance of method choices and publication bias. *Review of Economic Dynamics*. Online first. DOI: 10.1016j.red.2021.05.003.

[23] Goodwin, R. (1951). The nonlinear accelerator and the persistence of business cycles. *Econometrica* 19(1), 1-17.

[24] Goodwin, R. (1967). A growth cycle. In: Feinstein, C.H. (ed.) *Socialism, Capitalism and Economic Growth*, 54-58. Cambridge University Press, Cambridge.

[25] Graselli, M., Maheshwari, A. (2018). Testing a Goodwin model with general capital accumulation rate. *Metroeconomica* 69(3), 619-643.

[26] Hannan, M., Pólos, L., Carroll, G. (2004). The evolution of inertia. *Industrial and Corporate Change* 13(1): 213-242.

[27] Hein, E., Tarassow, A. (2010). Distribution, aggregate demand and productivity growth: Theory and empirical results for six OECD countries based on a post-Kaleckian model. *Cambridge Journal of Economics* 34(4), 727-754.

[28] Kaldor, N. (1967). *Strategic Factors in Economic Development*. Cornell University Press, Ithaca.

[29] Kaldor, N. (1971). Conflicts in national economic objectives. *Economic Journal* 81, 1-16.

[30] Klein-Martins G., Skott, P. (2021). Sources of inflation and the effects of balanced budgets and inflation targeting in developing countries. *Industrial and Corporate Change*. Online first. DOI: 10.1093/icc/dtab006.

[31] Kuznetsov, Y. (2004). *Elements of Applied Bifurcation Theory*. Springer-Verlag, Heildelberg. 3rd Edition.

[32] Lewis, A. (1954). Economic development with unlimited supplies of labour. *The Manchester School* 22(2), 139-191.

[33] Magacho, G., McCombie, J. (2020). Structural change and cumulative causation: A Kaldorian approach. *Metroeconomica* 71(3), 633-660.

[34] Manfredi, P., Fanti, L. (2006). Demography in macroeconomic models: When labour supply matters for economic cycles. *Metroeconomica* 57(4), 536-563.

[35] McCombie, J., Pugno, M., Soro, B. (eds.) (2002). *Productivity Growth and Economic Performance: Essays on Verdoorn's Law*. Palgrave, London.

[36] McCombie, J., Spreafico, M. (2016). Kaldor's 'technical progress function' and Verdoorn's law revisited . *Cambridge Journal of Economics* 10(4), 1117-1136.

[37] McMillan, M., Rodrik, D., Verduzco-Gallo, I. (2014). Globalization, structural change, and productivity growth, with an update on Africa. *World Development* 63, 11-32.

[38] Medio, A., Lines, M. (2001). *Nonlinear Dynamics: A Primer*. Cambridge University Press, Cambridge.

[39] Missio, F., Araújo, R., Jayme Jr, F. (2017). Endogenous elasticities and the impact of the real exchange rate on structural economic dynamics. *Structural Change and Economic Dynamics* 42, 67-75.

[40] Nishi, H. (2019). Balance-of-payments-constrained cyclical growth with distributive class conflicts and productivity dynamics. *Metroeconomica* 70, 620-640.

[41] Palma, G. (2008). Deindustrialisation, premature deindustrialisation, and the Dutch disease. In Blume, L., Durlauf, S. (eds.) *The New Palgrave: A Dictionary of Economics*, 401-410. Palgrave Macmillan, Basingstoke. 2nd Edition

[42] Pagano, U. (2014). The crisis of intellectual monopoly capitalism. *Cambridge Journal of Economics* 38, 1409–1429.

[43] Perez, C. (2010). Technological revolutions and techno-economic paradigms. *Cambridge Journal of Economics* 34(1), 185-202.

[44] Porcile, G., Spinola, D., Yajima, G. (2021). Patterns of growth in structuralist models: The role of political economy. *Centre for Applied Finance and Economisc WP Series* 12.

[45] Pugno, M. (1996). A Kaldorian model of economic growth with labour shortage and major technical changes. *Structural Change and Economic Dynamics* 7(4), 429-449.

[46] Punzo, L. (2006). Towards a disequilibrium theory of structural dynamics: Goodwin's contribution. *Structural Change and Economic Dynamics* 17(4), 382-399.

[47] Rapetti, M. (2020). The real exchange rate and economic growth: A survey. *Journal of Globalization and Development* 11(2), 20190024.

[48] Ribeiro, R., McCombie, J., Lima, G. (2016). Exchange rate, income distribution and technical change in a balance-of-payments constrained growth model. *Review of Political Economy* 28(4), 545-565.

[49] Ribeiro, R., McCombie, J., Lima, G. (2017). A reconciliation proposal of demand-driven growth models in open economies. *Journal of Economic Studies* 44(2), 226-244.

[50] Rodrik, D. (2008). The real exchange rate and economic growth. *Brookings Papers on Economic Activity* 39(2), 365-439.

[51] Rodrik, D. (2016). Premature deindustrialization. *Journal of Economic Growth* 21, 1-33.

[52] Romero, J. (2019). A Kaldor–Schumpeter model of cumulative growth. *Cambridge Journal of Economics* 43, 1597-1621.

[53] Romero, J., Britto, G. (2017). Increasing returns to scale, technological catch-up and research intensity: Endogenising the Verdoorn coefficient. *Cambridge Journal of Economics* 41(2), 391-412.

[54] Romero, J., McCombie, J. (2016). The multi-sectoral Thirlwall's law: Evidence from 14 developed European countries using product level data. *International Review of Applied Economics* 30(3), 301-325.

[55] Ros, J. (2013). *Rethinking Economic Development, Growth, and Institutions.* Oxford University Press, Oxford.

[56] Sasaki, H. (2021). Thirlwall's law, uneven development, and income distribution. *Metroeconomica* 72, 592-611.

[57] Sordi, S., Vercelli, A. (2014). Unemployment, income distribution and debt-financed investment in a growth cycle model. *Journal of Economic Dynamics & Control* 48, 325-348.

[58] Setterfield, M. (1997). 'History versus equilibrium' and the theory of economic growth. *Cambridge Journal of Economics* 21, 365-378.

[59] Setterfield, M. (2011). The remarkable durability of Thirlwall's Law. *PSL Quarterly Review* 64, 393-427.

[60] Tavani, D., Zamparelli, L. (2017). Endogenous technical change in alternative theories of growth and distribution *Journal of Economic Surveys* 31(5), 1272-1303.

[61] Thirlwall, A. (1979). The balance of payments constraint as an explanation of international growth rate differences. *BNL Quarterly Review* 32, 45-53.

[62] Thirlwall, A. (2002). *The Nature of Economic Growth.* Edward Elgar, Aldershot.

[63] Velupillai, V. (2006). A disequilibrium macrodynamic model of fluctuations. *Journal of Macroeconomics* 28, 752-767.

[64] Zambelli, S. (2018). The aggregate production function is NOT neoclassical. *Cambridge Journal of Economics* 42(2), 383-426.