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The La Marca Model Revisited: Structuralist Goodwin Cycles with Evolutionary Supply Side and Balance of Payments Constraints

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Abstract

High economic volatility and large amplitude economic cycles are problems that persist in middle-income countries, especially Latin America, reinforcing the presence of development traps. This research is aimed at investigating the causes of this volatility. The existence of growth cycles has been broadly discussed in the literature since the times of Kondratiev and Schumpeter. However, the literature modeling endogenous deterministic mechanisms that generate these cycles is scarce. This article contributes to fill this gap by merging the macroeconomic demand-side perspective à la Goodwin-Kaldor with the evolutionary supply-side Neo-Schumpeterian theory - creating endogenous cycles. This article expands the open-economy Structuralist Goodwin model of La Marca (2010), in which economic activity, income distribution and accumulation of foreign assets dynamically interact generating dampened cycles. The expansion consists in adding to the model (1) an evolutionary supply-side in which innovation is at the center of the economic dynamic affecting the productivity through technology transfer and the Kaldor-Verdoorn effect. (2) An external sector dynamics that changes the exchange rate regime, following Dornbusch (1992)'s Latin Triangle theory. Nominal exchange rate behaves following the Balance of Payments Dominance theory (Ocampo, 2011), adjusting its value to avoid external sector deficits. Results point to (I) a productivity dynamics leading to the emergence of endogenous stable cycles. The economy does not converge to a steady state, and instability becomes a deterministic inherent characteristic of middle-income economies. (II) A change in the currency regime reduces volatility by turning a stable cycle trajectory into a monotonic convergence at the cost of lower economic activity and wage share (in total output).

Keywords: Economic Cycles, Evolutionary theory, Structuralism, Macroeconomic Dynamics.

JEL: E32; F44; O11; O30

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Introduction

The recurrence of a boom and bust dynamic in some key economic variables, such as GDP growth, is a persistent problem in the economic system, especially for developing countries. This volatility has strong impacts in the economic structures, raising uncertainty, fostering productive specialization, and increasing the fragility of the economic system. Stylized facts show that economic volatility has an important regular component, in which the literature explains using (I) concept of growth episodes and (II) cycle theories (Cliometrics). The latter is the main focus of this research.

The study of Cliometrics is a classical discussion in the economic theory. Despite its long tradition, the existence and determinants of cycles in many economic variables are still an open topic in the academic debate. Econometric evidence is substantial and points to the existence of these cycles in key macroeconomic variables (Korotayev & Tsirel, 2010). The debate surrounding growth cycles is especially important in the group of countries in which volatility is in overall higher. This includes most part of low- and medium- income countries. In these, we observe the persistent repetition of short periods of growth succeeded by strong crisis and followed by adjustment periods that weaken the structure of the economy (Foster-McGregor, Kaba, & Szirmai, 2015).

There are many schools of economic thought focused on discussing, modeling and explaining economic cycles. Business cycle theory has always been a hot topic in economics. Schumpeter (1939) with the Technology Business Cycle, and Goodwin (1967), with the growth-distribution Lotka-Volterra model, proposed to give an answer to these questions. Since the 1980's, real business cycle theorists have also been leading the discussion about cycles in a neoclassical perspective (Hodrick & Prescott, 1997).

In the Structuralist theory, the role of economic structures is the main underlying aspect that defines the behavior of the economic system (Prebisch, 1950). Product, and labor markets, and external sector structures and institutions define the real economic and development possibilities of a country (Cimoli & Porcile, 2014). The presence of weak economic structures is a central topic in the Latin American Structuralist theory (Taylor, 1983). It results in the emergence of high amplitude short-growth cycles and inherent instability. Latin America is a continent in which macroeconomic volatility has been a constant issue, and there is still a gap to model

the emergence of an endogenous[2] cyclical dynamics for Latin America in a center-periphery framework.

Initially, this paper follows the growth model tradition started by Harrod and Goodwin. Goodwin (1967) designed a model in which the structure behind the economy defines a pattern in which growth and distribution runs in a cyclical predator-prey dynamics. This pattern was later developed in a Structuralist version by Barbosa-Filho & Taylor (2006). Finally, La Marca (2010) gave a further contribution to the model, combining the Structuralist Goodwin model with a stock-flow framework by Foley & Taylor (2004). The La Marca model consists in a three dimensional dynamic system in which external sector dynamics is added to the growth and distributional interaction through accumulation of foreign assets/liabilities. This specification is able to produce dampened cycles in the trajectory of the selected variables during their adjustment to the steady state. It is important to mention that the La Marca (2010) model is a one thought to address fast-growing export-led economies such as the ones in East Asia, not Latin American economies, which needs some adjustments and expansions.

In this paper I propose to extend the La Marca model to analyze the growth-cyclical pattern of countries who find themselves in the middle income trap (Lavopa & Szirmai, 2014). The main focus is on Latin America. Economic actors interact in an open market economy. The dynamic behavior and interaction between capacity utilization, distribution (wages/profits), external sector (current account), productivity and nominal exchange rate defines the trajectory and the equilibrium of the system. Under specific conditions, the model generates closed orbits, reproducing a Lotka-Volterra cyclical mechanism. The proposed model consists in a Structuralist Goodwin model with an evolutionary supply side and endogenous nominal exchange rate with Balance of Payments constraint.

This research observes the need to make some assumptions about the behavior of the economic actors to expand the (La Marca, 2010) model in the directions stated above. The expansion will go into the following direction:

I) <u>Model a Supply Side structure</u>
   1) Define a *productivity dynamics* by removing the assumption of constant technology. The Kaldor-Verdoorn effect plays a central role on one hand. On the other hand, other central aspect is to define a North-South technology gap dynamics. A Center-periphery framework in which the

[2] The idea behind deterministic endogenous cycles is that the trajectory of the dynamic system oscillates indefinitely, neither converging to the steady state nor having an explosive trajectory. Cycles emerge as a central characteristic of the economic structure, and not by the presence of exogenous shocks (such as in the Real Business Cycle theory).

North is dynamics technologically and the south is lagged behind. So firms with external assets have more learning opportunities, reducing the technology gap.

2) Define two sectors based on Krugman & Venables (1995): a Tradeable and a non-tradeable sector. These sectors have a different productivity dynamics that interact between them and the other macroeconomic variables. This discussion is linked to the idea of the resource curse (Dutch Disease). (Section to be further developed)

II) Model the exchange rate dynamics and the Balance of Payments Constraints

3) Define a nominal exchange rate dynamics. The concept behind it is based on the Dornbusch Latin Triangle (Dornbusch, 1992). In which the fixed exchange regime attracts foreign capital, but in the non-tradeable sector, which traps countries into specializing themselves in commodity exports. What if there is flexible exchange rate? There is then the need to model an endogenous nominal exchange rate – balancing the capital account (floating exchange rates) using the Balance of Payments Constraints theories to define the nominal exchange rate dynamics in the short-run and long-run.

The model proposes to observe the interaction between exchange rate, wage share, output growth, capacity accumulation, net foreign asset accumulation, productivity, balance of payments constrains, and technology transfer.

A main research gap concerns how cycles emerge from an endogenous pattern of productivity and exchange rate dynamics. The main gap is the absence of models that reproduce endogenous cycles (deterministic) for Latin American economies. This is a topic frequently discussed in the theory, and a matter of many econometric studies (Erten & Ocampo, 2013). However, the literature does not offer well formalized models to address this specific topic. In this sense **this paper aims at contributing to the Structuralist theory by proposing expanding a formal framework to observe the emergence of deterministic cycles** (persistent cycles, with neutral stability).

1. Literature Review:

1.1. Demand side cycles: Lotka Volterra Cycles

Lotka Volterra (LV) is a specific type of dynamic model in which its peculiar specification results in the formation of closed orbit solutions. In two dimensions this model creates a Predator-Prey dynamics, very much used in Biology and Ecological

studies. It follows a specification in which one variable is the predator and the other the prey that interact generating a cyclical dynamic. The LV model can be generalized to more than two dimensions (Kolgomorov model). In this case it is possible to have deterministic cycles that fluctuate around the long-run equilibria (steady state).

The use of the Lotka-Volterra system to economics can be traced back to the work of Goodwin (1967), who established a model in which economic activity and income distribution interact dynamically. The Goodwin model creates endogenous cycle in the relationship between wage share (predator) and employment (prey), reproducing a predator-prey dynamics in a closed saving-determined growing economy. This framework gave origin to a large amount of models in which economic activity (effective demand) and distribution interact. The original model, thought for the US economy, finds profit squeeze cycles slightly damped and repetitive.

The Structuralist tradition, which accounts for the role of structural elements underlying the economic organization which determine its outcomes have made efforts to expand the Goodwin model. This tradition developed itself with the efforts from Raul Prebisch, Celso Furtado and the whole Latin American tradition of thinkers that put structural condition in a Center-Periphery tradition in the center of the analysis. Since the 1980's, Lance Taylor has formalized many of the concepts in the Structuralist theory (Taylor, 1983). In an attempt to expand the Goodwin Model with structuralist features, Barbosa-Filho & Taylor (2006) developed a dynamic system relationship between wage share and capacity utilization in a demand-driven economy. This model is based on the classical works of Kalecki (1971) and Steindl (1952) and puts the matter of a distributive conflict in the center of the analysis. The Structuralist Goodwin was also computed to the US economy, describing its *profit led*[3] characteristics.

More recently, La Marca (2010) develops a model that merges the Structuralist Goodwin system with the Foley & Taylor (2004) model. The latter suggests that heterodox models should use social account matrices in order to derive its causal relations, being stock-flow consistent. Foley & Taylor (2004) also works for an open economy and also adds a financial elements (equities) to the model. La Marca (2010) used then the framework developed by Foley & Taylor (2004) to developed an open economy version of the Goodwin model. Economic growth and fluctuations in output, capacity utilization, distribution and real exchange rate interact in an open economy generating damped cycles. La Marca (2010) extends the Structuralist Goodwin to an open economy, which results in a more complex structure to the Goodwin model, expanded it to three dimensions.

[3] A pro-profit distribution has net positive effects on investment and growth.

The dynamic aspects of the La Marca (2010) model are further explained in section 3. The next subsections consist in the theory behind the proposed expansions of the model.

1.2. Supply-side cycles: productivity, Schumpeterian cycles, structural change and catching up.

In this section we discuss the supply-side theory used to expand the La Marca (2010) model. Productivity and technological change are important aspects usually neglected in the Goodwin tradition. The Goodwin (1967) model traces back the relationship between income distribution and economic activity, but there is a passive role of the supply-side. It assumes a Phillips curve to define the relationship between employment and real wages, and a Leontief production function, with fixed coefficients. Demand determines through the effects of income distribution the adjustments on employment and economic activity. The role of the supply side is ignored. Nonetheless, there are many supply side theories that address economic cycles. Some are presented here in this section, being part of the theoretical foundations of the La Marca (2010) model expansion.

The motivation behind comparing and merging the demand- and supply-side theories of economic cycles goes hand in hand with the recent efforts to reconcile the demand-led Keynesian macroeconomic framework with the Schumpeterian evolutionary microeconomic supply-side theory. This research follows in this sense the “Keynes meets Schumpeter” tradition (Dosi, Fagiolo, & Roventini, 2010).

In the mainstream growth theories, there is a central role for productivity (Total Factor Productivity) in the economic system (Supply side). Discussed in the endogenous growth theory, the Total Factor Productivity is a black box that is usually associated to technological change. This is the idea behind real business cycles that considers technological shocks as exogenous, in which the system itself reacts readjusting itself towards the equilibrium point. Business cycles here are created by stochastic shocks that converge monotonically (or with damped cycles) to a long run equilibrium trajectory. There are no endogenous deterministic persistent cycles in the model. The system dynamics gets a cyclical behavior only from these stochastic shocks.

The evolutionary tradition, on the other hand, is a supply-side tradition that sees as central the presence of deterministic endogenous cycles. Schumpeter and its Business Cycle book (Schumpeter, 1939) gave an explanation to the existence of endogenous business cycles in the economic structure. The central argument is focused on the role of technology. It changes the industrial paradigm through an endogenous innovative mechanism inherent of the capitalist system. This leads to a constant need of the

economic structures to adjust to its new conditions because of its own competitive characteristics (Nelson & Winter, 1977). The constant flow of innovation (some that are successful and others not) gives rise to a cyclical behavior (Silverberg & Verspagen, 1995). This competitive process constantly changes the whole characteristics of the economic system, resulting in big productivity change. The Neo-Schumpeterian models usually deal with individual or sectoral innovations and are currently using tools such as the Agent-Based models – eg. Ciarli et al (2010), Gaffeo et al (2008). The cyclical aggregate behavior in this framework results from the interaction of individual heterogeneous agent's behavior – it considers a complex dynamic with many nonlinearities. This is an interesting way to deal with cycles, but the complexity involved in such simulation models turn these models into overly sensitive to the parameters, being not the scope of this research.

Structural Change also plays a central role in terms of the supply side cyclical behavior. Krugman & Venables (1995) show that multi-sector models in open economies defines the specialization patterns and fragility of an economic structure. Each sector has a different productivity level and the reallocation of resources plays a central role in defining the productivity and competitiveness of an economy. In terms of the evolutionary theory developed post-Schumpeter, the discussion about the emergence of new sectors and reallocation between sectors is a relevant source of volatility (Silverberg & Verspagen, 1995). The Structuralist Theory has some of the main contributions in this regard. Cimoli & Porcile (2014) develop a toolbox to link a North-South framework, Structural Change, Balance of Payments Constraints and Technological Gap. The Kaldor-Verdoorn effect (Kaldor, 1975) is a central concept in this discussion, linking economic activity and productivity. The economy is externally constrained and has its fragility patter related to how it absorbs external shocks from terms of trade.

The Cimoli & Porcile (2014) model has the theoretical basis to understand the supply side constrains to Latin America. But it is not able to generate cycles, which is one main aspect to be addressed in this research. Finally, the international technology transfer leading a catching up process (Verspagen, 1991) needs to be discussed. Countries lagged technologically have in principle more potential to catch up to the technology frontier. Nevertheless the learning process is not natural. Lagged countries need to build a certain level of domestic capabilities that allow them to learn from abroad.

There are many reconciliation challenges to the academic research in defining endogenous model for middle income countries. In this paper we address the following topics:

I. Integrate a productivity dynamics to the Goodwin model through (a) adding a Kaldor-Verdoorn effect, and (b) Modeling international technology transfers.
II. Expand the open Structuralist Goodwin Model in a two-sector model following Krugman & Venables (1995) (to be done later).

These models focus on the role of the supply-side in generating the cyclical dynamics in an open economy in which growth and income distribution dynamically interact.

2.3. External sector: Dornbusch triangle, exchange rate and the Thirlwall model.

Another important source of volatility is related to the role of the external sector in the economic system. In this sense the nominal exchange rate plays a central role.

In Latin America the exchange rate regime is an important aspect that defines how individual countries adjust to their external sector. The Latin Triangle theory developed by Dornbusch (1992) discusses the fixed nominal exchange rate role in the context of external adjustments. The fixed exchange rate anchor policy used in Latin America during 1990's as an inflation control mechanism ended up generating unwanted consequences to these countries' balance of payments. A domestic currency over-appreciation led to pressures for internal adjustments. This appreciation had strong effects in the productive sector, in which investments started crowding out from the tradable sector to the non-tradable. The latter being the sectors with less productivity. This resulted in a structural change burden (Szirmai, 2012) in which the change to less productive sectors reduce the overall productivity of the economy. The solution to the issue was to adopt a flexible exchange rate regime. In the La Marca (2010) model, the nominal exchange rate is fixed, the real exchange rate only moving through domestic price change (directly related to costs, mainly wages). This assumption is going to be removed in order to observe the current situation in Latin America, considering the relevance of the Latin Triangle's flexible exchange rate argument.

The Balance of Payments Constrains model (BoPC), which is also known as the Thirlwall model, offer a possible conciliation between the supply-side and the demand-side. The Thirlwall (1979) model is a demand-led one as it ultimately depends on the current account to define the long-run growth possibilities (Thirlwall's law). On the other hand, as the dynamic behavior of the current account depends on income and price elasticities of imports and exports and these are directly related to the condition of the productive structure and technology, supply-side plays a role. The elasticities have been endogenized by Cimoli (1988), Cimoli & Porcile (2014), and Verspagen (1991). There is also an extreme version of the BoPC called the Balance of Payments Dominance theory (Ocampo, 2011). In this version Latin American countries need to

adjust the external sector even in the short-run. The nominal exchange rate adjusts to the level that turns net exports equal to zero (so growth of exports and imports can be the same after that). This article will consider the Ocampo (2011) version of the BoPC when modeling the endogenous nominal exchange rate.

Financial flows and terms of trade are important exogenous elements that create volatility. A possible reconciliation to the La Marca model to these elements is by using a flexible nominal exchange rate that adjusts itself in order to guarantee that the growth of imports and exports grows at the same rate. In this way the real exchange rate would have a constant moving equation. This aspect is further explained when discussing the expansions of the model.

3. The original model

The La Marca (2010) is a model derived by a Social Accounting matrix with a stock-flow consistent set of accounts. The model implicitly starts from a Goodwin production function (Leontief). It is a demand-led model in which aggregate demand and income distribution plays a central role. The La Marca (2010) model has the following assumptions:

1) There are four sectors: households, firms, government and external sector (ROW). Firms consist of a productive sector including industrial enterprises and the domestic financial sector. Firms can invest abroad with portfolio investments, loans, FDI or liquid assets (deposits and any kind of foreign currency reserves). Their net liabilities are denominated in foreign currency. These firms finance new investments through retained earnings and issuing new equities. They can pay back loans and equities. The central point is the transaction with the foreign sector, in which misalignments between national expenditure and income generate and increase or reduction in net foreign assets.
2) Government debt is negligible. The model abstracts from monetary policies.
3) There are three types of assets: productive capital, equities and net foreign assets (net foreign liabilities).
4) There are specific characteristics of the labor- and product- market equilibrium, the determinants of savings, investment and current account.
5) Labor discipline defines the real wage setting (Bowles & Boyer, 1988).
6) There is a Keynesian Investment function that is autonomous from savings.
7) External sector is fundamental to define investment and demand expansion. There is a low substitutability between foreign and domestic investment.

8) There is a non-linear dynamics between real exchange rate and capacity utilization, and between distribution and net asset position.
9) Emerging economies have assets and liabilities denominated in foreign currency.
10) Consumers and investors do not seem to borrow against future income and retained earnings are a crucial source of finance for firms.
11) This is a pure Demand-led model.
12) Distribution: interaction between workers, firms and government with trait of confliction. Conflictive natures lead to emergency of cycles. Kaleckian and Kaldorian tradition in Wage/Profit led economies (Bhaduri & Marglin, 1990). Real exchange rate here becomes a distributive variable.
13) Cycles: non-clearing labor market, distributional conflict, non-marginal productivity pricing.

The basic blocks of the model are described in the original La Marca (2010) paper. The next subsections present the dynamic aspects of the model, which consists in a relationship between a distribution wage share motion equation ($\dot{\psi}$), an economic activity capacity utilization motion equation ($\dot{u}$), and an external sector adjustment external asset accumulation equation ($\dot{b}$). The mathematics behind the model can be found in the original paper and also in the appendix of this paper (to be finished).

a. Wage Share distributive equation

Output (X) in this model is divided in its profit share π, its wage share ψ, and the share of imported intermediate inputs (a) in domestic currency – conversion done using the real exchange rate (ξ). In this sense, the sum of the shares is equal to one. $\psi + \pi + \xi a = 1$.

The motion equation of the Wage Share ($\dot{\psi}$) has the following specification:

$$\dot{\psi} = \tau(\psi^* - \psi) \tag{1}$$

In eq. (1) τ represents the speed of adjustment between the equilibrium value of the wage share (ψ^*) and the effective wage share (ψ). The model assumes a linear adjustment process to the equilibrium point. The equilibrium value of the wage share is defined by a labor discipline real wage (Bowles & Boyer, 1988) the motion equation of the wage share result as:

$$\dot{\psi} = \tau[l \exp(1 + ulk) - \psi] \tag{2}$$

In which $l = L/X$, being l the fixed amount of effective labor (L) per unit of product (X). $u = X/K$, u is the output (X) to capital (K) ratio, used as an index of capacity utilization. $k = K/N$ being k a constant for the relationship between capital (K) and employable working population (N).

The equilibrium value of the wage share follows a Phillips curve, in which employment rate h has a positive relationship to wages. $h = \frac{ulk}{\varepsilon}$ in which ε is the degree of effort exerted by workers. As mentioned, the equilibrium value comes from a labor discipline real wage Phillips curve theory. It links the employment and the capacity utilization rate consistent with a labor market equilibrium wage share. The profit share and the share of intermediate inputs adjust to the wage share in the following way: $\xi = \frac{1-\psi}{a\left(1+\frac{1}{\eta}\right)}$ and $\pi = \frac{1-\psi}{\eta\left(1+\frac{1}{\eta}\right)}$ in which η is the price elasticity of domestic output in world market.

3.1 Capacity utilization equation

The capacity utilization moving equation adjusts the goods market through the identity between domestic investment (g), domestic savings (σ) and net foreign investments (z).

$$\dot{u} = \lambda(g + z - \sigma) \tag{3}$$

In this eq. (3) λ is the speed of adjustment. g is the domestic investment. It follows a Keynesian investment function in which $g = \alpha\pi u + \gamma$. α is the sensitivity of investment to profitability and γ in the exogenous investment component that represent the "animal spirit" of the capitalists. The variable z is the sum of all the components of the current account that depend on the exchange rate and σ is the total national savings. The values of z and σ are the exchange rate sensitive elements of the external sector and the total savings, respectively[4]. A substitution of the variables that define the values of g, z and s in eq. (3), as originally in La Marca (2010) results in the following equation:

$$\dot{u} = \lambda\left[\left(\alpha - s_p\right)\pi - s_h\psi - \xi a\right]u + \gamma + \xi^{\eta}x + \left(1 - s_p\right)j\xi b \tag{4}$$

In this equation s_h is the propensity to save of households and s_p is the aggregated propensity to save. x is the export-capital ratio, j is the interest rate and $b = B/K$ is the real value of foreign assets (B) per unit of capital (K). Capacity utilization evolves

[4] We have $\sigma = s_h[(1 - s_b)(\pi u + j\xi b) + \psi u] - \upsilon(\pi u + j\xi b) + s_b(\pi u + j\xi b)$ and $z = \xi^{\eta}x + j\xi b - \xi a u$. In which υ is the propensity to consume out of capital gains.

consistently with the level of savings, investment, interest payments and net exports. Capacity utilization then adjusts itself to the value that balances the product market.

b. External asset equation

The third dynamic equation relates to the movements in the net external position (b). It relates the internal and external changes in net asset accumulation. It comes from the relationship between current account surplus and an increase of claims on the foreign sector. The relationship can be described as follows:

$$\dot{b} = \frac{1}{\xi}(\sigma - g) - gb \tag{5}$$

In this sense the growth (reduction) of net assets depends positively on internal savings but negatively on the internal and external investments. When substituting σ and g we end up with:

$$\dot{b} = \frac{(s_p - \alpha)\pi u + s_h \psi u - \gamma}{\xi} - (g - s_p j)b \tag{6}$$

The three motion equations (2), (4) and (6) form a system of dynamic equations. The trajectory and stability conditions of the system depend then on the assumptions regarding the parameter values. That is possible to observe through an analysis of the Jacobian of the system in its steady state.

$$J = \begin{bmatrix} \partial\dot{u}/\partial u & \partial\dot{u}/\partial\psi & \partial\dot{u}/\partial b \\ \partial\dot{\psi}/\partial u & \partial\dot{\psi}/\partial\psi & 0 \\ \partial\dot{b}/\partial u & \partial\dot{b}/\partial\psi & \partial\dot{b}/\partial b \end{bmatrix} \tag{7}$$

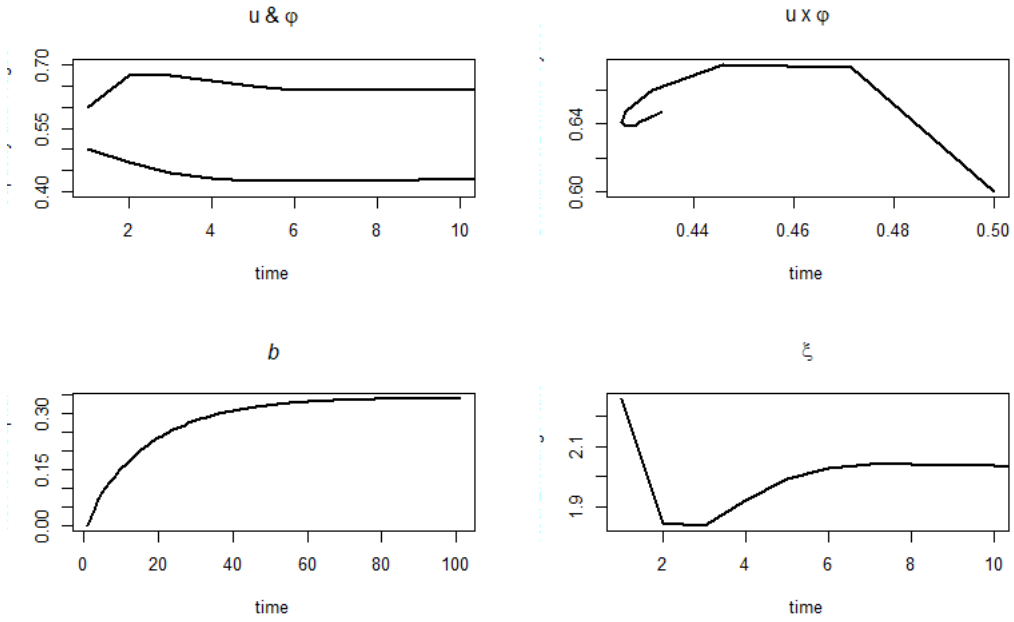
The motion equation of the wage share does not depend of the net external assets, so $\partial\dot{\psi}/\partial b$. A stable system must negative eigenvalues in their real part.

c. Calibrations of the La Marca model

In this sub-section we can see two distinct simulations for the original La Marca model. The first one shows the original results of the paper, in which the author calibrates the model using values considered reasonable. In this way, La Marca found the presence of dampened cycles in the model. The second simulation, with a different less realistic

calibration, shows an interesting patter in which the variables oscillates many times before going to its equilibrium value.

Figure 1. Reproduction of the La Marca (2010) results.



$\tau = 1, \lambda = 1, k = 20, l = 0.1, \gamma = 0.05, \alpha = 0.5, \eta = 1.3, a = 0.1, x = 0.05, j = 0.03, s_b = 0.5, s_h = 0.3$. Initial conditions: $\psi_0 = 0.6, u_0 = 0.5, b_0 = 0$. Steady state: $\psi = 0.65, u = 0.43, b = 0.34$. Eigenvalues: $\lambda_1 = -0.71 + 0.59i, \lambda_2 = -0.7 - 0.59i, \lambda_3 = -0.06$.

Figure 1 reproduces the Figure 5 results of the La Marca (2010) paper, The upper left figure shows the evolution of capacity utilization (top curve) and wage share (bottom curve) on time. The top right graph shows the cyclical relation between growth and distribution. The bottom left figure shows the evolution of the net external assets on time. Finally the bottom right figure shows the evolution of the real exchange rate on time.

The original model results in a small oscillation dampened cycle configuration. The Jacobian of the dynamic model under these assumptions results with a negative trace and positive determinant – which results in a stable dynamics. Moreover, the eigenvalues of the Jacobian consists in a pair of conjugate of complex numbers. This results in the generation of cycles. The final result of the model is the emergence of a dampened cycle trajectory with a small number of oscillations.

The adjustment process can be understand in the following terms (La Marca, 2010):

Stagflationary phase: An initial shock displays the variables from its equilibrium value (eg. fiscal contraction). There is an excess supply which results in "forced exports". Output and capacity utilization fall to balance supply and demand (domestic plus foreign) at the current real exchange rate. Wage share grows, squeezing profits and appreciating the real exchange rate. The economy slows down and domestic prices increases relative to foreign. Competitive exports and net assets revenue reduces which makes demand reduce more the supply. Employment reduces more than its equilibrium value – starting a reversal of the wage dynamics.

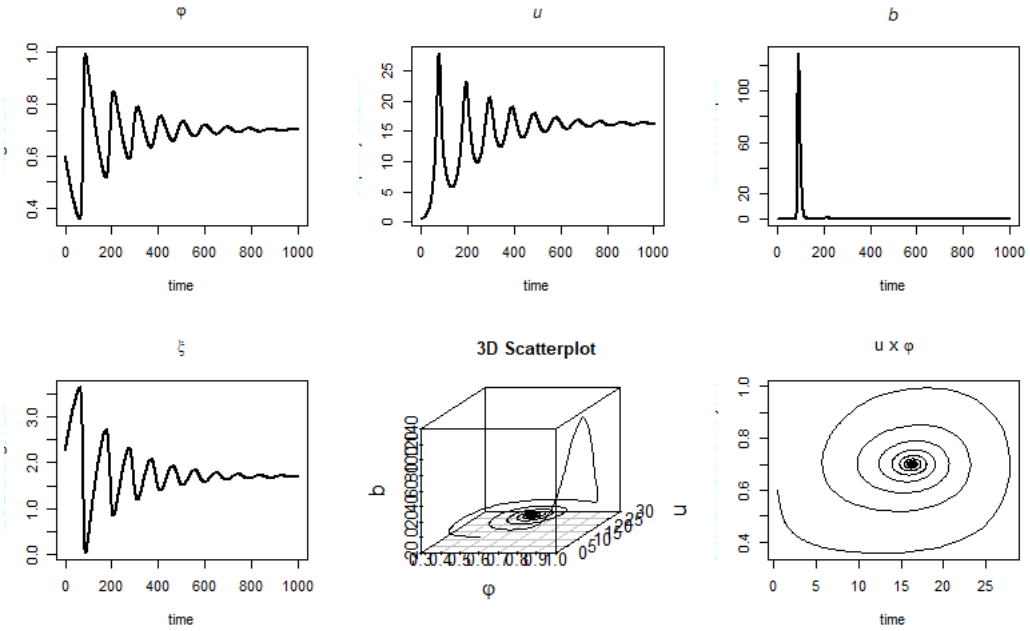
Stagnationary phase: Prices then slow down, the real exchange rate depreciates and profits and competitive exports start recovering. Output and wage contraction balances production and demand. Further wage reduction brings the economy to a recovery phase.

Recovery Phase: There is output and capacity utilization growth. There is "forced imports" which fill the gap between fast-growth demand and lagged supply. There is an inflationary boom (costs raising wages and prices) that leads to a reduction in profits. The role of the net asset-capital ratio (b), as a response to the output-distribution dynamic, feed back into the aggregate demand equilibrium.

This cyclical dynamics arise from the complex social relationship in the model. The growth-distribution dynamics feeds into the evolution of the real exchange rate, international competitiveness and factor payments that combine to generate oscillations in the current account and trade balance.

Using the same model, it is possible to test different parameters to observe how that would affect the evolution of the distinct variables. An interesting pattern emerges in the following calibration:

Figure 2. Alternative calibration of the La Marca model



$\tau = 0.1, \lambda = 1, k = 20, l = 0.01, \gamma = 0.05, \alpha = 5, \eta = 1.3, a = 0.1, x = 0.01, j = 0.1, s_b = 0.5, s_h = 0.6$. Initial conditions: $\psi_0 = 0.6, u_0 = 0.5, b_0 = 0$. Steady state: $\psi = 0.70, u = 16.2, b = -0.15$. Eigenvalues: $\lambda_1 = -0.05 + 0.67i, \lambda_2 = -0.05 - 0.67i, \lambda_3 = -10.57$

In Figure 2 we have on top right the behavior of the wage share on time. Top center is the capacity utilization rate on time, while top right is the net external assets on time. Bottom left is the dynamic behavior of the exchange rate on time. In the bottom center we see the tri-dimensional graph of the relationship between wage share, capacity utilization, and net external assets. Finally in the bottom right is the bi-dimensional relationship between capacity utilization and wage share.

The results show a strong oscillation with dampened cycles in wage share and capacity utilization. The net assets show a peak in the first cycle but then smooth its steady state. The real exchange rate follows the opposite of the wage share, with an interesting cyclical behavior. Considering the current specification of the model it is possible to define a dynamic pattern with dampened cycles. In section 4 the model is expanded by adding a supply-side dynamics and balance of payments constrains. With the four dimensional models we see that other trajectories emerge as possible outcomes.

The rationality behind this case is similar to the previous case in but the adjustment mechanism happens in many rounds, being every round weaker than the previous one.

The economy under these conditions suffers more volatility and has less capacity to adjust itself from shocks (e.g. external price changes).

4. Model expansions:

The scope of this model is to focus on the behavior of economies trapped in the middle income. The middle income trap is a concept that highlights how countries could not advance economically above certain level as its competitiveness in manufactured export goods is reduced by rising wages. The cyclical aspect is fundamental as it reproduces a dynamic that does not monotonically converge to the steady state, but keeps fluctuating. The cycles with neutral stability ($RE(\lambda) = 0$) are only possible when we see that competitiveness in terms of productivity is also affected by the distribution/output behavior. Another expansion consists on endogenizing the nominal exchange rate, considering a flexible exchange rate regime. The nominal exchange rate operates following the Balance of Payments Dominance concept of avoiding balance of payment deficits even in the short-run (Ocampo, 2011). In this way, the nominal exchange rate will adjust to the value in which the growth of exports is equal to the growth of imports.

a. Productivity dynamics

Following the theoretical debate in section 2, in this section we expand the model by adding a productivity dynamics that incorporates the role of the supply side also as a relevant determinant of the model. The initial attempt to implement it is through the Kaldor-Verdoorn effect. This effect incorporates learning by doing, which allows the occurrence of increasing returns to scale. An increase in demand, either by a growth in output (X) or investment (g), results in a rise in productivity.

In the model productivity is given as ε/l. The work effort (ε) will be kept considered stable, but the effective labor per unit of product (l) will be endogenized. The Kaldor-Verdoorn effect then shows and effect, in which $l = f(g)$, $dl/dg < 0$. In this sense, investment growth leads to a reduction of the effective labor per product (L/X) and increases productivity.

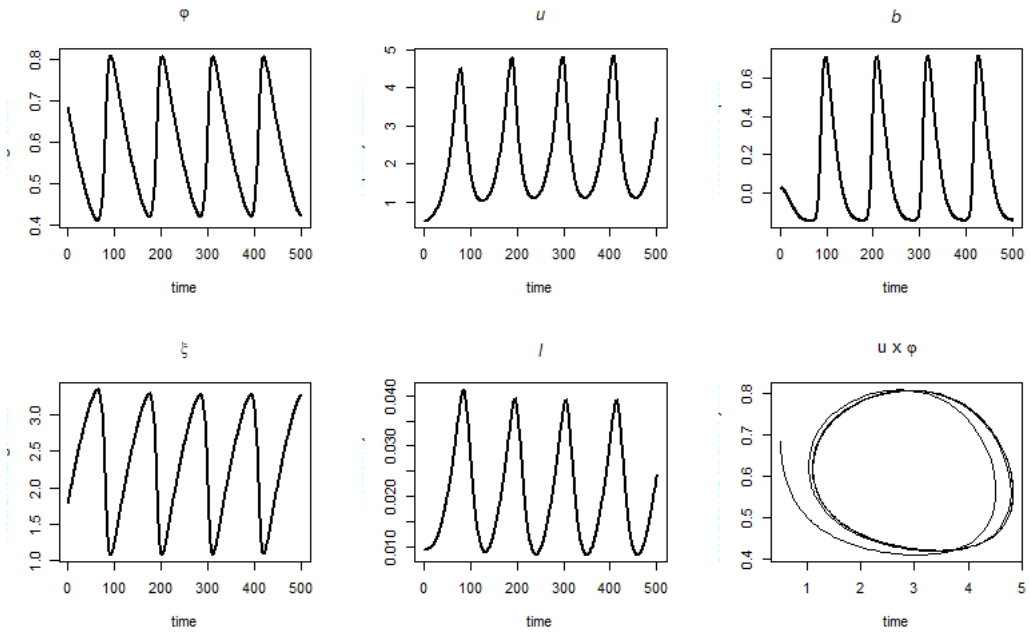
In addition to that, the accumulation of external assets can generate positive technological spillovers in terms of productivity to the internal firms. The technology transfer is a fundamental aspect to understand the relationship between North-South, marked by the presence of a technology gap (Verspagen, 1991). The domestic firms become more competitive as they learn with the activities of their subsidiaries located abroad. Technology transfer to the domestic economy has the positive effect on

domestic firms' productivity. This raises the average productivity in the country. The effects of technology transfer in productivity (θ) is given by:

$$\dot{l} = \rho g + \theta b \tag{8}$$

In the productivity dynamics ρ is the learning-by-doing Kaldor-Verdoorn effect and θ captures the technological transfer from foreign firms to domestic firms. Because l is seen as inverse of productivity, $\rho = d\dot{l}/dg < 0$ and $\theta = d\dot{l}/db < 0$. The option for a linear equation to define the causes that leads to the inverse of productivity is a matter of simplification.

Figure 3. Modified La Marca results with productivity dynamics



Parameter values: $\tau = 0.1$, $\lambda = 1$, $k = 20$, $l = 0.01$, $\gamma = 0.05$, $\alpha = 5$, $\eta = 1.3$, $a = 0.1$, $x = 0.05$, $j = 0.3$, $s_b = 0.4$, $s_h = 1$. $\rho = 0.01$, $\theta = 0.01888$. Initial conditions: $\psi_0 = 0.6$, $u_0 = 0.5$, $b_0 = 0$, $l = 0.01$. Steady state: $\psi = 0.68$, $u = 0.51$, $b = 0.21$, $l = 0.09$ Eigenvalues: $\lambda_1 = -0.15 + 0.44i$, $\lambda_2 = -0.15 - 0.44i$, $\lambda_3 = -0.42$, $\lambda_4 = -0.06$.

The first five figures from top to bottom, and left to right represents the evolution of the wage share, capacity utilization, net external asset/capital, real exchange rate and

effective labor per unit of product in time. The last figure shows how growth and distribution evolve between themselves.

This specification generates a very interesting pattern. The initial value converges to a limit cycle. This limit cycle does not maintain itself indefinitely though. When observing the value of the eigenvalues, we see that the model is still stable, but it generates a chaotic behavior in which it keeps oscillating for a big number of runs and then stabilizes itself. The same pattern was observed under other initial values. It is important to highlight that the variable $\theta = 0.01888$ was calibrated as the hopf bifurcation (Lorenz, 1989). Any small change in the system will result in either an explosive behavior or a regular cyclical stability. The hopf bifurcation parameter must then be adjusted to a different calibration.

What these results tell us is that the economy under these conditions may enter in a cyclical pattern in which it will never reach a stable equilibrium. The convergence pattern though will always pull the economy to a volatility pattern, even with the absence of external shocks. In these sense, an endogenous pattern of volatility emerges in the economy that pushes to a trap zone.

b. Nominal exchange rate dynamics

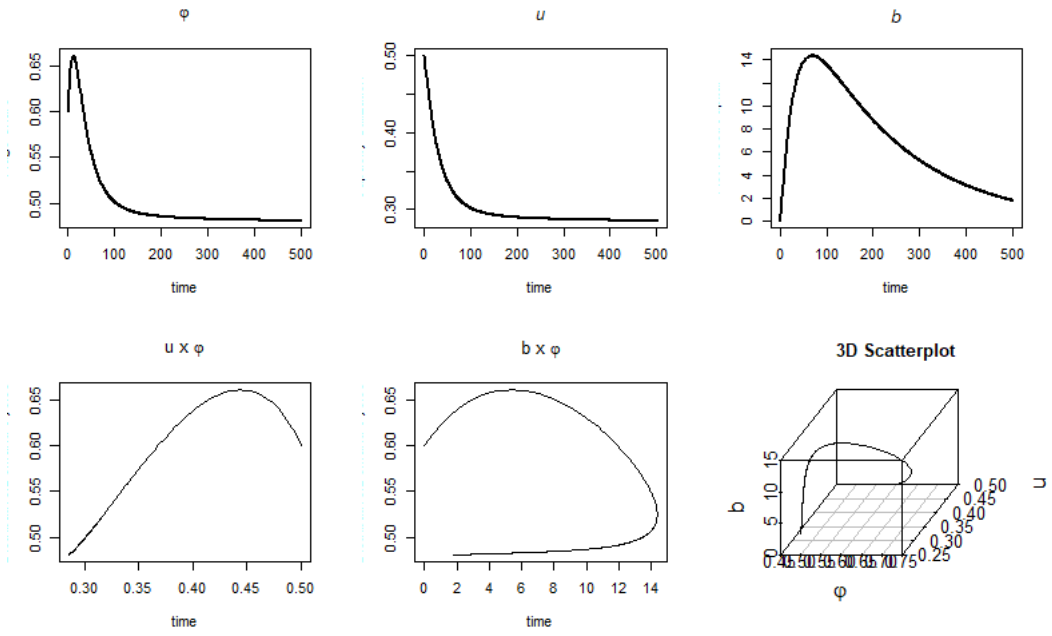
Another relevant aspect to discuss Latin American economies is the Dornbusch Triangle. The exchange rate regime plays a central role (Dornbusch, 1992). The La Marca (2010) model ignores the discussion and assumes a constant nominal exchange rate (fixed). There is a possibility in the model that in the long run the economy operates with chronic external deficit. For the case of Latin America the external restrictions always played a central role. The Balance of Payments constraints, modeled by (Thirlwall, 1979) highlights that in the long run no economy can growth above their rate of growth compatible with the balance of payments (given in its simpler version by the ratio between income elasticities of exports and imports)

In the original model, the real exchange rate is defined as $\xi = \frac{e\bar{P}}{P}$. P is the domestic good price, $\bar{P}$ the foreign good price and e the nominal exchange rate, which is considered a constant. Considering the BoPC model, the long-run exchange rate dynamics adjusts itself to stabilize the external sector. In the Balance of Payments dominance this is also valid for the short-run. In this way, the real exchange rate is constant, and the nominal operates in order to create a trajectory in which the net external assets (B) tends to an equilibrium steady state in which the growth of exports is equal to the growth of imports. In order to do so, we assume a constant real exchange rate

$$\xi = w \tag{9}$$

Being w a given constant. Considering the Balance of Payments Dominance of Ocampo (2011), in the case of middle income trapped countries, even in the short-run, the balance of payments needs to be balanced. In order to do so, the nominal exchange rate must adjust itself to move towards this goal. In this case the real exchange rate should have zero growth, being always in its steady state. This implies that $\dot{\xi} = 0$. When adding this element, we reach a 4-dimensional system in which growth, distribution and net foreign assets variates with a constant foreign real exchange rate. Considering the initial La Marca (2010) parametrization we have:

Figure 4. Modified La Marca results with exchange rate dynamics, Figure 1 parametrization



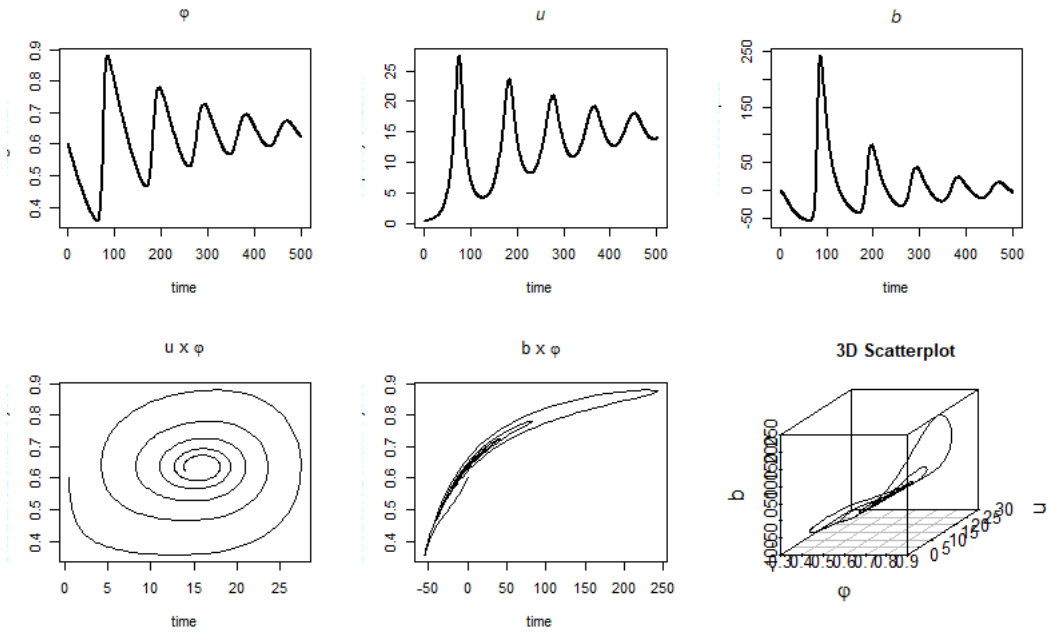
Parameter values: $\tau = 1$, $\lambda = 1$, $k = 20$, $l = 0.1$, $\gamma = 0.05$, $\alpha = 0.5$, $\eta = 1.3$, $a = 0.1$, $x = 0.05$, $j = 0.03$, $s_b = 0.5$, $s_h = 0.3$. Initial conditions: $\psi_0 = 0.6$, $u_0 = 0.5$, $b_0 = 0$, $\xi_0 = 0.01$. Steady state: $\psi = 0.47$, $u = 0.28$, $b = -0.30$, $\xi = 0.01$. Eigenvalues: $\lambda_1 = -0.91$, $\lambda_2 = -0.28$, $\lambda_3 = -0.04$, , $\lambda_4 = 0$.

In this figure, the three top figures represent the evolution of wage share, capacity utilization and net exports/capital respectively (left to right) on time. The bottom left

figure shows the relationship between capacity utilization and wage share. In the bottom middle we see the relationship between net foreign assets/capital and wage share. Finally the bottom right figure shows the tri-dimensional relationship between net foreign assets/capita, wage share and capacity utilization.

This case followed the same calibration values of Figure 1. The system converges but it does not generate cycles. As we can observe there is no complex eigenvalues. They follow a Monotonic Convergence to a stable equilibrium point. Variables such as the wage share and the net asset initially increase and then start to converge to the steady state. The capacity utilization converges monotonically to the steady state. The real exchange rate keeps itself in its same initial value.

Figure 5. Modified La Marca results with productivity dynamics. Same parametrization as Figure 2



$\tau = 0.1$, $\lambda = 1$, $k = 20$, $l = 0.01$, $\gamma = 0.05$, $\alpha = 5$, $\eta = 1.3$, $a = 0.1$, $x = 0.05$, $j = 0.3$, $s_b = 0.4$, $s_h = 1$. $\rho = 0.01$, $\theta = 0.01888$. Initial conditions: $\psi_0 = 0.6$, $u_0 = 0.5$, $b_0 = 0$, $\xi_0 = 0.01$. Steady state: $\psi = 0.64$, $u = 15.76$, $b = -0.12$, $\xi = 0.01$. Eigenvalues: $\lambda_1 = -12.48$, $\lambda_2 = 0$, $\lambda_3 = -0.05 + 0.74i$, , $\lambda_4 = -0.05 - 0.74i$.

The variables represented in the figures are the same as Figure 4.

This case has the same calibration values as in the case of Figure 2. This case results in an oscillatory convergence to the steady state. Eigenvalues have negative real parts

(steady model) and a pair of conjugate complex numbers (cycles). The net foreign assets/capital have a an interesting behavior in which the oscillations that lead to the accumulation of assets is much bigger than the reductions, which is in line with the idea that strong deficits in the external sector demand a response from the economic structure.

In the following section the results are interpreted following the literature review on economic cycles discussed in Section 2.

5. Discussion of the results.

a. Productivity dynamics

In Figure 3, the inclusion of a productivity dynamics is able to generate deterministic stable cycles. The result shows that even in the presence of no shocks, the system in inherently unstable. Productivity then interacts with the distribution and economic activity generating cycles.

The calibration is aimed to reproduce a Latin American middle-income economy. One in which the behavior of the real exchange rate is endogenously unstable. The endogeneity of productivity is central to explain this behavior. An increase in the wage share has negative effects on productivity itself, but in a wage-led economy it boosts growth, which through an increase in the capacity utilization affects investment. The rise in productivity occurs through the Kaldor-Verdoorn effect. This compensatory dynamics gives rise to the cycles.

The central contribution is the fact that the economic cycles are explained as a pure endogenous mechanism in these economies. It is not a pure result of exogenous shocks, such as the policy shocks of the Real Business Cycle, technological shocks of the Schumpeterian theory or the Terms of Trade shocks as in the traditional Structuralist perspective. These results could raise the argument that this cyclicality is a pattern that is in the DNA of these economies.

b. Nominal exchange rate dynamics

Figure 4 shows that when we change the exchange rate regime to a flexible nominal exchange rate that focuses on balancing the external sector, the dynamic properties of the model alter completely. The trajectory to the steady state changes from dampened cycles to a monotonic trajectory. This implies that, despite the still considering the presence of external shocks that lead to volatility, when we change the exchange rate regime of the economy simulated in the original La Marca (2010) model, they system is not volatile by itself anymore. An external sector policy aimed at avoiding external debt reduces the endogenous pattern of volatility. This result is very much in line with the BoPC and the Balance of Payment Dominance theories. In which a middle-income economy, that cannot hold foreign debt in its own currency, has its growth directed constrained by the behavior of its external sector. A direct adjustment to the external sector then solves the volatility. The cost is high though in terms of economic activity and distribution. As it can be seen in the model, a change in the currency regime reduces the economic activity and the part of income that go to wages when compared to the fixed exchange rate regime.

This is very similar to what happened to many Latin American countries in the 1990's. Taking the case of Brazil as an example, the transition to the fixed nominal exchange rate regime in 1994 resulted in increases in real wages, the wage share and in the utilization capacity. The country started suffering from pressures in its Balance of Payments with the fixed rate. After the crisis of 1998 and return to the flexible exchange rate, economic activity was strongly reduced as well as real wages (rise in internal prices and a major nominal exchange rate devaluation).

6. Conclusion

This paper proposed two expansions to the La Marca (2010) model, a productivity dynamics and an exchange rate dynamics. This work does not close in itself. It offers a small contribution, a jigsaw, to a puzzle that is still open in the Structuralist literature: what is behind the "chicken flights" growth pattern, the big challenge of the low- and middle- income countries to sustain growth? In other terms: how to endogenize deterministic cycles that are characteristic of middle-income countries in a North-South dynamics?

The perspective embedded in this paper clearly states that the answers to the above questions are directly related to the supply-side of the economy. Schumpeter and the evolutionary school offer some central contributions to understand the complex dynamic that emerges in a world in which technological change is at the fundamental. The paper offer a simple solution to the inclusion of productivity in the model, taking into account a learning by doing Kaldor-Verdoorn element and a technology transfer/learning from domestic firms that have assets abroad (increasing the average

productivity of the economy). The results indicate that the inclusion of a productivity dynamics is able to generate deterministic stable cycles. This is of fundamental importance, because it shows that even in the presence of no shocks, the system in inherently not stable and cyclical. Productivity then interacts with the distribution and economic activity generating cycles.

The currency regime à la Dornbusch (1992)'s Latin Triangle is also a central aspect to be observed. A flexible nominal exchange rate focused on balancing the external sector changes the dynamic properties of the model. The convergence trajectory to the steady state does not generate cycles anymore. This is an important finding. The Thirlwall model and the Balance of Payments Dominance of Ocampo (2011) state the relevance of the external constrains the long- and short-run respectively. An exchange rate mechanism that is able to adjust the external sector automatically (no debt accumulation) results in La Marca (2010) in a pattern that reduces the endogenous instability in the adjustment mechanism. Despite the flexibility that the nominal exchange rate offers, when it keeps the real exchange rate constant, it reduces the volatility. But there are costs in terms of the steady state. It reduces the equilibrium values of the wage share and the capacity utilization. Achieving smaller volatility involves a trade-off, a reduction in the economic activity and income concentration on profits.

Finally, this paper offers an invitation to expand new contributions in the Structuralist Prebisch-Kaldor-Thirlwall of La Marca (2010) exploring even further the Schumpeterian aspects of the economic cycles. The cyclicality aspect of middle income trapped economies could be further analyzed with other model expansions: adding a multi-sector model, exploring further the technological dynamic, increasing the heterogeneity of agents. The Structuralist literature on cycles is still scarce on modeling techniques and the additions of new theoretical approaches and new models to observe specific aspects related to low- and middle- income countries offers an open space for a whole new road of research opportunities.

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