Real exchange rate and distribution effects on growth and macro fluctuations in open economies*

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Abstract

The paper investigates the emergence of various forms of growth and distributional patterns as the outcome of institutional and socioeconomic interactions between broadly defined actors in an open economy macromodel. The focus is on both the long-run configuration and short-run dynamics of employment, functional distribution, growth rates, capacity utilization, foreign net asset accumulation, terms of trade, and wealth in a stock-flow consistent framework. We first allow for the generation of growth and distributive fluctuations by extending the Structuralist-Goodwin results to the open economy. We specify a labor extraction process that shape the distributional conflict, including a short-run price-competitiveness effect on trade and social relations, and integrate the capital and foreign asset accumulation process with the endogenous distributive dynamics in a stock-flow consistent framework. We then consider alternative specifications of the labor market and the financial market and observe their effects on the equilibrium and the transitional dynamics. The complex nonlinear dynamics of growth, capacity utilization, distribution and foreign net asset position provides an analytical basis for testing how alternative policy and institutional reforms that can affect both longer run pattern of growth and distribution as well as macroeconomic stability.

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1 Introduction: Identities, causality and fluctuations

How can cyclical fluctuations in capacity utilization, distribution and current account be generated in a growing economy? What is the role of foreign net assets and interest flows on the current account and aggregate demand dynamics? Are social relations relevant in the determination of the distribution, capital and net foreign asset accumulation and the whole economic outcome? How does the macroeconomic structure, shaped by a background institutional setting, affect the social interaction and gives rise to alternative outcomes? The paper aims at providing a framework to answer those and closely related

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questions emphasizing the role of macroeconomic structure on the decision of economic actors grouped into few broadly defined sectors.

Various theories and approaches of open economy macroeconomics in their attempt to explain how the internal and external balance are obtained, necessarily have to come to grips with *(i)* defining the characteristics of the labor- and product-market equilibrium, *(ii)* identifying the ultimate determinants of national aggregate savings σ, of foreign savings or the current account z, and of domestic investment g, *(iii)* defining the causal direction for obtaining the macro equilibrium condition $\sigma - z - g = 0$, and *(iv)* define the role of the real exchange rate in the adjustment process. Current account, output, and real exchange rate fluctuations have been explained by a variety of adjustment mechanisms underlining alternative points of views on the issues *(i)* to *(iv)*.

Many supply-driven models of international macroeconomics and trade explain output and growth fluctuations as the optimal response of domestic saving and foreign borrowing to productivity and external shocks in the world interest rate and other international prices. The "intertemporal approach to the current account," for instance, extends the general-equilibrium/comparative advantage principle to the time dimension and the open economy macroeconomics, assuming full-employment resource-determined output and marginal productivity-pricing for income distribution. In the intertemporal approach, the marginal productivity of capital determines investment and its fluctuations, while the law of one price for traded goods nullify the effect of the real exchange rate on expenditure and production (at least in the baseline model without non-tradable goods). The current account is obtained passively by the intertemporal optimal determination of national savings σ and investment g. If the income generated with the use of scarce resources is profitably used either as current expenditure or exchanged for "future expenditure" to foreign borrowers, current account imbalances are the intentional device of the individualistic rationally-behaving country for allocating and smoothing consumption over time, that is, the means of allowing income and spending "desired misalignments".[1] External balance cycles are therefore explained as the outcome of intentional expenditure reallocations across countries as a device for buffering exogenous technological and wealth shocks.

Institutional and socioeconomic interactions within the country are notably ruled out, as well as the role of the exchange rate and the resulting short to medium run competitiveness effect of similar goods in shaping the direction of trade.[2]

[1]The prevailing MIRA paradigm (methodological individualism, rational action) restricts individuals' fundamental economic goal and activity to choosing an optimal consumption path by arranging efficient production and exchange plans, avoiding misallocation and waste of resources and exploiting any possible comparative advantages across economies. The resulting *full employment of resources* and absence of *unexploited arbitrage opportunities* hypotheses imply price equalization of homogeneous goods and therefore exclude any macro adjustment role for the real exchange rate (unless defined as a traded/nontraded price ratio) typical of traditional Keynesian models. In the neoclassical general-equilibrium paradigm, therefore, international trade is the means of exploiting endowments and/or technology differences or some internal economies of scale, or allowing income and expenditure differences and allocate consumption and investment intertemporally.

[2]The empirical applicability of the intertemporal approach proved to be problematic as well: the law of one price unambiguously does not hold in the short to medium run (Rogoff, 1996) and therefore there is no effective arbitrage mechanism ruling out price effect on competitiveness and trade. Moreover, the consumption smoothing hypothesis seems to strongly underestimate current account fluctuations (a survey of some tests of the stochastic current account model in Obstfeld and Rogoff, 1995 and 1996).

The discussion on the role of real exchange fluctuations, "expenditure change" and "expenditure switching" due to price differences in traded goods and internal relative prices are however still reasonable concerns for policy makers and topical issues in policy debates. Wage determination and overall profitability are seen as critical factors for a country competitiveness, incentive to investment and capacity building.

These issues can been sensibly addressed by including in the theoretical framework the complex interactions of economic groups such as workers, firms and shareholders, as shaped by the ruling institutional set up.[3]

Profitability and distribution have a fundamental role on macroeconomic performances by affecting investment decisions, the determination of demand composition via differentiated saving behavior of households and firms a' la Kaldor, by affecting intermediate-input cost and foreign net assets revenues via real exchange rate determination, and by affecting the labor market and labor productivity. Distribution is a fundamental determinant of economic outcomes and has a characteristic trait of confliction: wages can be a device for labor extraction given the level of economic activity and employment (as in the neo-Marxian class conflict view of wage setting of Bowles and Boyer, 1988), a production cost affecting prices and international competitiveness (as in the structuralist tradition, Taylor, 1991 and 2004, for some examples), a source of direct and indirect aggregate demand through consumption, investment and net export (as in Bhaduri and Marglin, 1990) leading to the profit-led (exhilarations) and wage-led (consumptionist) regimes. Its multiple role and conflictive nature can lead to the emergence of cycles in the closed as well as in the open economy.

The emphasis on the role of institutions in determining the various alternative pricing mechanisms and equilibrium determination in the product, labor and asset market does not imply an univocal way to deal with points (i)-(iv). In particular, distributive, growth and current account cycles arising from non-market clearing in the labor market, distributional conflict, non-marginal productivity pricing and effects on growth of distribution, may be generated under different causal relations between the macro equilibrium components, g, σ and z, that can depend on prevailing specific features of the economy under consideration.

In his seminal paper Goodwin (1967) explained endogenous cycles in distribution and economic activity as a wage share/employment rate symbiotic predator-prey dynamics in a closed saving-determined growing economy. Adapting this relation to a Keynesian-structuralist framework, Barbosa-Filho and Taylor (2005) and Taylor(2004) find that an analogous dynamics between wage share and the capacity utilization can emerge from some specific structures of the economy. At the core of the Goodwin cycles there are a "economic activity curve," and a "distributional curve", which become an effective demand/distributional relation in the Keynesian adaptation.

In the present work we allow for the generation of current account growth cycles by extending the Structuralist-Goodwin results to the open economy, specifying a labor

[3]Dropping the assumption of the representative agent's MIRA behavior allows us to take into consideration the complexity of economic systems as the outcome of the composition of different - at times contrasting - forces, which do not lead to full exploitation of economic opportunities due to lack of structured information and foresight and persistence of conventional behavior. The failure of market participants to coordinate and clear markets in a Walrasian fashion brings to the fore the role of the aggregate demand and the independence of savings and investment decisions. The centrality of profitability in investment and the imperfection of good markets give prominence to the Keynesian-Kaldor-Kaleckian tradition of independent investment function and markup pricing.

extraction process that shape the distributional conflict, including a short-run price-competitiveness effect on trade and social relations, and integrating the capital and foreign asset accumulation process with the endogenous distributive dynamics in a stock-flow consistent framework a' la Foley and Taylor (2004). Recognizing that countries are systems of interacting actors gives rise to a complex macroeconomic scenario, where existing institutions, though allowed to recede on the background, are the source of alternative macroeconomic structures and the consequent alternative dynamics in distribution, trade and output leading to different economic pattern.

Section 2 describes our main modeling components: a labor discipline real wage setting adapted from Bowles and Boyer (1988, 1989); a mark-up pricing and distributional trade-off between wages, profits and the real exchange rate that characterizes the structuralist tradition; a Keynesian investment function, the emergence of wage- and profit-led regimes, and a stock-flow consistent sets of accounts. These Structuralist-Goodwin cycles are sustained by capacity utilization and distributional dynamics and can be generated under alternative closures between g, σ and z, such as a residually determined current account or a passively determined savings. Under the first closure the current account fluctuates around a long-run trend that depends on more structural net exports and foreign assets revenues. This implies that in the short run the saving-investment gap induced by distribution and output cycles dominates the current account determination, while competitiveness and net exports coefficients determine both its short-run composition and its longer-run determination.

In Section 3 the model is modified by assuming that households wealth is made by real money balances only, that passively adjust to the level of economic activity. The adjusting mechanism relies on the forced savings of households that absorb the money balance change consistent with the capacity utilization fluctuations. Distributional conflict and output cyclical variation, directly reflected on the net foreign revenues and net exports, determine the current account both in the short and long run.

The complex nonlinear dynamics of growth, capacity utilization, distribution and foreign net asset position is explored in the two cases showing how the distribution and aggregate demand predator-prey dynamics determine trade and current account cycles.

Section 4 draws some conclusions.

2 A Current Account Adjustment Model

Aggregate production X requires capital K, labor L, and imported intermediate inputs as a fraction a of total output, aX. Technology is given and coefficients are fixed, therefore the output/capital ratio $u \equiv X/K$ can be taken as an index of capacity utilization.[4]

There are three institutional sectors: households, firms, and the foreign sector (or ROW); and three assets: productive capital, equities, and foreign net assets (foreign debt, if negative). The balance sheets of the three sectors are reported in table 1, while table 2 is the social accounting matrix, SAM, in real terms. Most of our model relations

[4] We use the output capital ratio u as proxy of the capacity utilization, X/Q. The latter is the ratio of *effective*, X, to *potential* output, Q, allowed by the existing capital for a fixed technologically given capacity-capital ratio Q/K. Since the effective to potential output ratio, X/Q, is the product of the output capital ratio, u, and the fixed coefficient, Q/K, the determination of the degree of capacity utilization can be simply described by the determination of u.

are consistently derived from this accounting framework and will be explained in the present and following sections.

TABLE 1
BALANCE SHEETS

Households (HH)		Firms		Foreign (ROW)	
$p_E E$	Ω_h	K	$p_E E$	$-\xi B$	Ω_f
		ξB	Ω_b		

TABLE 2
SOCIAL ACCOUNTING MATRIX (SAM)

	Output Cost(1)	HH. (2)	Firms (3)	ROW (4)	Cap. (5)	Equit. (6)	Bonds (7)	Tot. (8)
(A) Output		C_h		χK	gK			X
Incomes								
(B) HH.	ψX		D_b					Y_h
(C) Firms	πX			$j\xi B$				Y_b
(D) ROW	$\xi a X$							Y_f
Flows of Funds								
(E) HH.		S_h				$-p_E\dot{E}$		0
(F) Firms			S_b		$-gK$	$p_E\dot{E}$	$-\xi\dot{B}$	0
(G) ROW				(S_f)			$\xi\dot{B}$	0
(H) Tot.	X	Y_h	Y_b	Y_f	0	0	0	

Households own firms through equities E (see table 1) whose unit price, p_E, is determined as the present value of firms net profits. They consume C_h and save S_h (column 2, table 2). The latter is a fraction s_h of total income, Y_h, which comprises wages ψX, where ψ is the wage share, and dividends D_b (row B, table 2). Savings are used to buy new equities $p_E\dot{E}$ (row E, table 2). A productive sector called "Firms"includes industrial enterprises and the domestic financial sector. They can invest abroad in the form of portfolio investment, loans, FDIs or liquid assets such as deposits or any kind of foreign currency reserve or receive foreign loans in "dollarized" or exchange rate-indexed debt certificates. The economy is a net "foreign creditor"or a "foreign debtor"when B is positive or negative, respectively (see table 1). Firms can finance new real investment and new foreign investments $\xi\dot{B}$ through retained earnings S_b and by issuing new equities $p_E\dot{E}$, where ξ is the real exchange rate. They can pay back loans and equities (negative $\xi\dot{B}$ and $p_E\dot{E}$) or issue new debt if profits fall short of debt interests payments (a negative S_b) (row F, table 2). Therefore, net transactions with the "Foreign"or "ROW"sector reflect misalignments between national expenditure and income and correspond to an increase in domestic debt when the economy is running a current account deficit and a debt reduction or increase in foreign assets B acquired by domestic firms when the economy is running a surplus, respectively. The real exchange rate ξ affects domestic firms' competitiveness and the debt value and consequently plays a large role in aggregate demand, capacity utilization and employment rate determination.

2.1 Labor discipline and distribution

The available technology requires a fixed amount of effective labor per unit of product $l \equiv L/X$. The employment rate $h = H/N$ is the ratio of total amount of worked hours (the total hour/workers hired) H and the "potential employment" N. The effectiveness of each work hour varies with the degree of "effort" ε exerted by workers, with $L \equiv \varepsilon H$. Labor productivity, $\varepsilon/l = X/H$, is therefore endogenous and varies with work effort.

We further assume, for simplicity sake, that potentially employable working population grows with capital accumulation, so that $K/N = k$ is constant. This can be due to the strong correlation between physical and human capital growth: capital accumulation is accompanied by the growth of the education and production-specific knowledge that restricts the employable population to N which can diverge from actual work-age population. The employment rate is therefore a function of labor productivity and capacity utilization

$$h = \frac{H}{L}\frac{X}{K}\frac{L}{X}\frac{K}{N} = \frac{ulk}{\varepsilon}; \tag{1}$$

our simplifications allow us to restrict the sources of variation between the two standard measures of economic activity, the employment rate and the capacity utilization, to the endogenous variation of work effort.

2.1.1 Product market and distribution

Let us define w as the wage rate, e as the nominal exchange rate, $\bar{P}$ as the foreign good price, a as the coefficient of the imported intermediates per unit of output, the wage share out of total output and the real exchange rate as $\psi \equiv wl/P\varepsilon$, and $\xi \equiv e\bar{P}/P$, respectively.[5]

Firms set prices charging a fixed mark-up m over variable costs which include wages as well as imported intermediate inputs

$$P = (1+m)\left(\frac{wl}{\varepsilon} + e\bar{P}a\right), \tag{2}$$

which gives our distributional relation in real terms

$$1 = (1+m)(\psi + \xi a). \tag{3}$$

Firms' profits are the residual of sales net of variable costs. Profit rate over capital value is simply

$$r = \frac{PX - \left(\frac{wl}{\varepsilon} + e\bar{P}a\right)X}{PK}$$

(capital is homogeneous and prices of capital and consumption goods are uniform), that is

[5]Given our assumption of a single (composite) consumption/investment domestic good and of a single (composite) foreign good, the natural definition for the real exchange rate is the price of the foreign output per domestic output units: a devaluation consists of a rise of foreign good prices in terms of the domestic ones.

$$r = \pi u, \tag{4}$$

where $\pi \equiv m/(1+m) = m(\psi + \xi a)$ is the profit share and $rK = \pi X$ are total profits. We assume that firms are able and willing to maintain a fixed mark-up (and therefore a given profit share) in face of exchange and wage rate variations by adjusting prices in the product market.

From (3), (4), and the definition of π we obtain

$$\pi + \psi + \xi a = 1 : \tag{5}$$

output value is distributed in shares between profits, wages, and intermediate inputs ($\pi X + \psi X + \xi a X = X$, column 1 of table 2). For any constant profit share or mark-up, there is a trade-off between the real exchange rate and wage share: in fact $\psi + \xi a = 1 - \pi$, with $\partial \xi / \partial \psi = -1/a$. Therefore, real exchange rate is an actual "distributive variable" operating on the factor cost side.

2.1.2 Labor market and productivity

A real-wage Phillips *distributive* curve

$$\psi^* = lc \exp\left(\frac{1}{1-h}\right) = lc \exp\left(1 + ulk\right), \tag{6}$$

(where c is a measure of the minimum real wage) associates any level of employment or capacity utilization to the wage share consistent with the equilibrium in the labor market.

There is no dearth of possible explanation for a upward sloping real-wage Phillips curve such as (6). For instance, larger capacity utilization and employment levels may generate a pressure on real wages by increasing the bargaining power of workers and/or by increasing the search costs for the needed labor force, and/or by changing the opportunity cost of working or losing a job. We therefore simply assume that labor market institutions are such that profit/wage ratio tends to be squeezed when employment and capacity utilization are rising. In the appendix we provide a possible explanation based on an labor extraction argument *à la* Bowles and Boyer (1988, 1989) in which firms set wages attempting to control work effort and labor productivity taking the employment and other labor market conditions as given. The exponential form of the curve is a convenient analytical device that allows for increasingly larger variation in the proximity of full employment and therefore stronger distributional effects of output variation at high level of economic activity and growth as showed by differentiating (6)

$$\frac{d\psi}{du} = l^2 kc \exp\left(1 + ulk\right).$$

Defining τ as an adjustment speed constant, we can assume a linear adjustment

$$\dot{\psi} = \tau\left(\psi^* - \psi\right), \tag{7}$$

that yields to a nonlinear differential equation as the law of motion of the wage share in the labor market

$$\dot{\psi} = \tau\left(lc \exp\left(1 + ulk\right) - \psi\right). \tag{8}$$

Deviations from the equilibrium wage share set off competitive wage changes that can restore equilibrium.

2.2 Effective Demand

2.2.1 Investment under uncertainty

Firms earn gross profits at a rate r and revenues from foreign investments, $j\xi b$, where $b \equiv B/K$ is the real value of foreign assets per unit of capital in the foreign-good index. Its domestic real value changes with the terms of trade: a relative price increase in foreign goods (depreciation of ξ) raises foreign assets' value or the burden of foreign debt repayment. Firms' asset valuation depends on both the flows of profits and interests discounted by the risk free international interest rate. This capitalized value of net profits gives the asset value of invested capital. Assuming static expectations we obtain[6]

$$q \equiv \frac{r + j\xi b}{j}. \tag{9}$$

Investment decisions are made by looking at their expected future profitability. We assume for simplicity that firms build up capital and domestic production capacity considering only domestic profitability and that the investment function takes the form

$$g = \alpha\pi u + \gamma \tag{10}$$

where $g \equiv \dot{K}/K$, α captures is the sensitivity of investment to profitability and γ is an exogenous investment component depending on "entrepreneurs' spirits". Investment demand responds to net profitability of productive capital and therefore to capacity utilization.

As mentioned in the previous section, line F of the SAM shows that domestic, gK, and foreign investments, $\xi\dot{B}$, are financed by new equities, $p_E\dot{E}$, and by retained earnings, S_b, the latter equal to a fraction s_b of net profits, $rK + j\xi B$. Column 3 shows how firms' total earnings, Y_b, are either reinvested, S_b, or used to pay dividends, D_b, with the latter necessarily equal to the remaining fraction $1 - s_b$ of net profits $rK + j\xi B$.

2.2.2 Product market adjustment and equilibrium

The trade account is made up of three elements: a technologically fixed component of intermediate imported inputs, ξaX; a component of competitive exports, ξxK, that depends on productive and export capacity and the exchange rate; and a component of net imports, Λ, that responds elastically to excess supply. While the former element is reported as a cost component in cell (D1) of the SAM, the latter two elements are reported as net exports in cell (A4) with $\chi K = \xi xK - \Lambda$. The excess demand function generated

[6] Reducing the capacity of agents to predict the future to a workable hypothesis of static expectation is a somehow strong assumption, but given that any model of expectation within the range of perfect foresight and static one can be labeled as "ad hoc" and given the implausibility of the former we opt for the latter.

Static expectations are a simplifying assumption as far as interest rate dynamics is concerned (present rates are good proxies of future rates under uncertainty). However, since Meese and Rogoff (1983) showed that a random walk outpredicts any fundamental based model in forecasting the exchange rate, static expectation may be regarded as an extremely rational response to nominal exchange rate unpredictability.

by the difference between consumption, investment, and competitive net exports demand, $C_h + \xi xK + gK$, on the one hand, and total supply, $\psi X + \pi X + \xi aX$, on the other, is elastically covered by Λ. The latter can be interpreted as an exchange-rate-insensitive increase in net imports due to insufficient domestic supply or a reduction of net exports due to a redirection of sales from exports to the domestic market induced by a rise in the domestic demand.

Equilibrium between total aggregate demand and total supply (equality between line A and column 1 of the SAM) is obtained when $C_h + \chi K + gK = \psi X + \pi X + \xi aX$, or

$$\Lambda = gK - (\psi X + D_b - C_h) - (\pi X + j\xi B - D_b) + \xi(xK + jB - aX). \tag{11}$$

Households receive both wage income and profit income through distributed net profits (line B, SAM) and save a given fraction of their income. Assuming that their consumption demand depends also on a fraction c of their wealth $p_E E$ and recalling that $p_E E = qK$, we can include a wealth effect in households' consumption equal to cqK. We define $\upsilon \equiv c/j$. Household and firms total savings in per capital units are, respectively

$$\sigma^h \equiv (\psi X + D_b - C_h)/K = s_h\left((1 - s_b)(r + j\xi b) + \psi u\right) - \upsilon(r + j\xi b),$$

and

$$\sigma^b \equiv (\pi X + j\xi B - D_b)/K = s_b(r + j\xi b),$$

with $0 < s_b \leq 1$, $0 \leq s_h \leq 1$ and $\upsilon \neq 0$.

Total national saving, the sum of households' and firms' savings, is therefore

$$\sigma \equiv \sigma^h + \sigma^b = s_h\left((1 - s_b)(r + j\xi b) + \psi u\right) - \upsilon(r + j\xi b) + s_b(r + j\xi b),$$

which, defining $s_p = s_b + s_h - s_b s_h - \upsilon$, becomes

$$\sigma = s_p(r + j\xi b) + s_h\psi u. \tag{12}$$

We sum up with z those components of the current account that respond to the real exchange rate,

$$z \equiv \xi x + j\xi b - \xi au. \tag{13}$$

We can further assume that, while in the short run demand pressures are satisfied by elastic imports, in the longer run they induce firms to adjust capacity utilization to a level consistent with the desired level of savings and investment and a more structural level of net exports and interest payments. If production is adjusted by a fraction λ of the excess demand currently filled by imports, with $\lambda\Lambda = \dot{u}K$, using (12) and (13), then the saving-investment equilibrium condition (11) becomes the law of motion of the capacity utilization change in the longer run:

$$\dot{u} = \lambda(g + z - \sigma), \tag{14}$$

or

$$\dot{u} = \lambda\left((\alpha - s_p)\pi - s_h\psi - \xi a)u + \gamma + \xi x + (1 - s_p)j\xi b\right). \tag{15}$$

Differentiation of (14), at the equilibrium gives

$$\left(\frac{\partial g}{\partial u} + \frac{\partial z}{\partial u} - \frac{\partial \sigma}{\partial u}\right)du + \left(\frac{\partial z}{\partial \psi} - \frac{\partial \sigma}{\partial \psi}\right)d\psi + \left(\frac{\partial z}{\partial b} - \frac{\partial \sigma}{\partial b}\right)db = 0, \tag{16}$$

with

$$\frac{\partial g}{\partial u} + \frac{\partial z}{\partial u} - \frac{\partial \sigma}{\partial u} = -((s_p - \alpha)\pi + s_h\psi + \xi a),$$
$$\frac{\partial z}{\partial \psi} - \frac{\partial \sigma}{\partial \psi} = -\frac{1}{a}(x - au) - \frac{1}{a}(1 - s_p)jb - s_h u,$$

and

$$\frac{\partial z}{\partial b} - \frac{\partial \sigma}{\partial b} = (1 - s_p)j\xi.$$

For reasonable values of s_p and α, output expansion induces an increase of savings out of profit and wages and of demand of intermediate imports larger than the increase in investment. The net effect on excess demand is negative and therefore the output adjustment is self-stabilizing.

The effect of foreign net assets on output depends on net asset interest payment and their effect on national savings, $\partial z/\partial b - \partial\sigma/\partial b$. The injection of larger net interest flows on the current account, $j\xi$, are stronger than the leakages generated by increased savings, $s_p j\xi$ and larger net assets augments capacity utilization for any given level of exchange rate and wage share, $du/db > 0$. Since reverse considerations apply if the economy is a net debtor, this economy is said to be *debt-burdened*.

The most interesting feature of this economy is however the join effect of net foreign asset and capacity utilization in the determination of the aggregate demand response to wage share increase/exchange rate appreciations. The system is said to be wage-led when $du/d\psi > 0$ (and $du/d\xi < 0$), or profit-led when $du/d\psi < 0$ (and $du/d\xi > 0$), for any given b. Since the sum $(\partial g/\partial u - \partial\sigma/\partial u + \partial z/\partial u)$ is negative, we need to assess whether a redistribution toward wages (corresponding to a real appreciation) drive up aggregate demand; that is whether $\partial z/\partial\psi - \partial\sigma/\partial\psi > 0$. This latter partial derivative can be broken down into three component: a trade account component $-(x - au)/a$, a component depending on foreign assets $-(1 - s_p)jb/a$, and one depending on households savings $-s_h u$, where $-1/a = \partial\xi/\partial\psi$. A wage increase/real appreciation has a negative effect on the trade account if the latter is positive (the opposite if negative), it has a negative effect on the total injections generated by interest flows from foreign net assets if $b > 0$ (the opposite if $b < 0$) and it has a negative effect on aggregate demand through higher savings out of wages. The system tends to be profit led if the economy is running a trade surplus and/or enjoys large net assets.

Figure 1, left panel, plots a family of *effective demand curves*, $\dot{u} = 0$ solutions in the (u, ψ) plane, at different foreign asset/capita levels: the effective demand curve tends to be wage-led at low levels of net assets.

For increasing values of b, the whole demand schedule shifts to the right. A country with a large share of intermediate import over export, small profit share and large sensitiveness of investment to profits it is less sensitive to wage share changes, while a country with a favorable import export ratio, large profit share and small sensitiveness of investment to profits is more affected by distributional shifts.

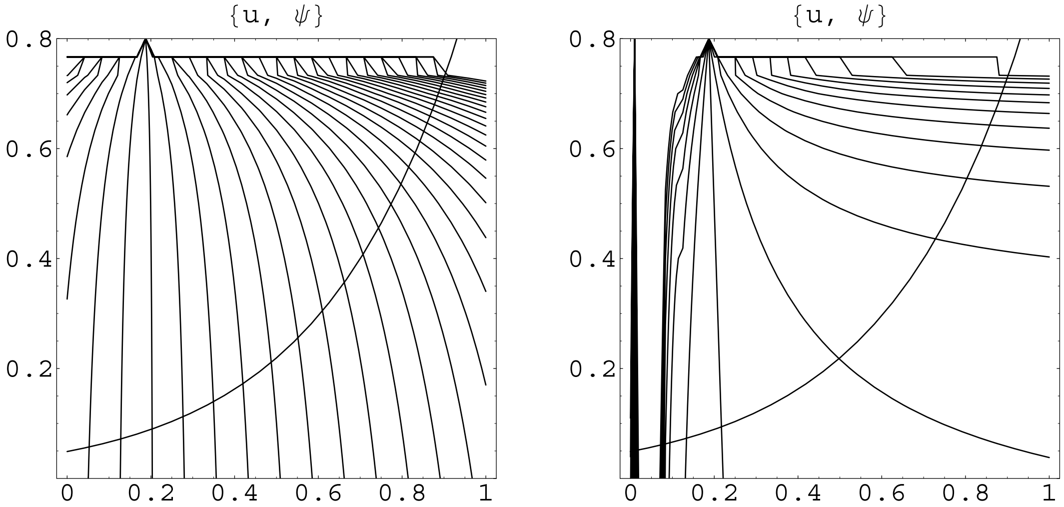

Figure 1: **Effective demand, distributive, and net assets equilibrium**. Left panel: Distributive and aggregate demand curves in the (u, ψ) plane; each curve represents a $\dot{u} = 0$ equilibrium at a given level of b. Right panel: Distributive and net assets equilibrium curves in the (u, ψ) plane; each curve represents a $\dot{b} = 0$ equilibrium at a given level of b. In both panels, curves on the right correspond to higher levels of net assets. (*k = 50; l = .06; c=.3; α= .4; π= .2; a = .4; x = .5; j = .08, s_p=.4, s_h=.2; γ=.03.*)

2.3 Foreign balances

The current account surpluses (negative foreign savings, line D and column 4 of the SAM) add up in the form of claims on the foreign sector, $-S_f = \xi\dot{B}$ (row G of the SAM).

$$S_f = \xi\dot{B} = (\xi x + j\xi b - \xi a u)K - \Lambda \tag{17}$$

From (17) we obtain the dynamic equation of the share of foreign currency denominated debt as a function of capacity utilization and growth rate

$$\dot{b} = x - au - \dot{u}(\xi\lambda)^{-1} + (j - g)b$$

or, using (14),

$$\dot{b} = \frac{\sigma - g}{\xi} - gb,$$

which restates the identity between the current account and the saving-investment gap. Further substitutions lead to

$$\dot{b} = \frac{(s_p - \alpha)\pi u + s_h\psi u - \gamma}{\xi} - (g - s_p j)b. \tag{18}$$

Asset equilibrium is obtained at

$$b = \frac{s[\psi]u - g}{\xi(g - s_p j)}, \tag{19}$$

where $s[\psi]$ is the average propensity to save of the domestic private sector: $s[\psi] = s_p\pi + s_h\psi$. Figure 1, right panel, shows the net asset equilibrium $\dot{b} = 0$ with b defining different equilibria in the (u, ψ) space. For u and ψ such that $g > s_p j$ and $\xi > 0$, increasing values of b are associated to larger levels of u and ψ. We observe that $g > s_p j$ is also the condition for self-stability and therefore we restrict our analysis to possible equilibria in this region of the (u, ψ) space.

Assuming that a component of the trade balance adjusts to obtain the short-run macroequilibrium implies that the current account adjusts passively to the excess supply, in the short run, while the composition of the current account depends on a structural components of z. In the longer run, however, output adjustment make the structural current account z prevail. Similarly, if the asset adjustment to the steady state is sufficiently slower than u and ψ in equilibrium, the current account in unit of capital becomes

$$\dot{b} = x - au^*[b] + (j - g^*[b])b,$$

that is

$$\dot{b} = z^*[b] - g^*[b]b,$$

where $u^*[b]$, $g^*[b]$ and $z^*[b]$ are obtained for $\dot{u} = \dot{\psi} = 0$.

The steady state equilibrium is, in any case,

$$b^* = \frac{x - au^*}{\xi^*(g^* - j)}. \tag{20}$$

2.4 Equilibrium and stability

Equations (8), (14) and (18) constitute our dynamic system of distribution, capacity utilization and current account leading to $\dot{u} = 0$, $\dot{\psi} = 0$, and $\dot{b} = 0$, the equilibrium in the labor and good markets and to a steady state balanced growth. Equation (10), together with (5), allow us to obtain our remaining endogenous flow variables g, and ξ.[7]

We can analyze stability through the Jacobian evaluated at an equilibrium point, u^*, ψ^*, and b^*.

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

[7]The extended system embracing all the entries of the SAM would include the determination of stock variations, $\dot{E}$ and $\dot{B}$ for instance, valuation p_E and wealth. The latter two are however direct functions of net profitability and we leave them implicit to concentrate on the main flow dynamics in the short run and the long run stock ratio dynamics.

Note that the use of *per output* shares π and ψ in our analysis may seem to hide the real and more interesting dynamics of the profit $\pi/(1-\xi a)$ and wage share $\psi/(1-\xi a)$ in *GDP units*, respectively. Expressing distribution in GDP shares in equilibrium,

$$\frac{\pi}{(1-\xi^* a)} + \frac{\psi^*}{(1-\xi^* a)} = 1,$$

we observe that a fall in capacity utilization and in the output wage share is associated with a real exchange rate depreciation and net output $(1-\xi a)$ contraction and therefore a larger profit rate in GDP units; signs are preserved shifting from one to the other normalization while the profit share in GDP units shows the usual trade-off with the wage share. Moreover, the wage share and net output correlation – wage recipients get less of a smaller pie - reduce the relative fall of the wage share to GDP.

where

$$\frac{\partial \dot{u}}{\partial u} = \lambda\left(\frac{\partial g}{\partial u} + \frac{\partial z}{\partial u} - \frac{\partial \sigma}{\partial u}\right) = -\lambda\left(s[\psi^*] - \alpha\pi + \xi^* a\right),$$

$$\frac{\partial \dot{u}}{\partial \psi} = \lambda\left(\frac{\partial z}{\partial \psi} - \frac{\partial \sigma}{\partial \psi}\right) = \lambda\left((1-s_h)u^* + \frac{(1-s_p)jb^*}{a} - \frac{x}{a}\right),$$

$$\frac{\partial \dot{u}}{\partial b} = \lambda\left(\frac{\partial z}{\partial b} - \frac{\partial \sigma}{\partial b}\right) = \lambda(1-s_p)j\xi^*,$$

$$\frac{\partial \dot{\psi}}{\partial u} = \tau l^2 k \psi^*,$$

$$\frac{\partial \dot{\psi}}{\partial \psi} = -\tau,$$

$$\frac{\partial \dot{b}}{\partial u} = \frac{1}{\xi^*}\left(\frac{\partial \sigma}{\partial u} - \frac{\partial g}{\partial u}(1+\xi^* b^*)\right) = \frac{1}{\xi^*}\left(s[\psi^*] - \alpha\pi(1+\xi^* b^*)\right),$$

$$\frac{\partial \dot{b}}{\partial \psi} = \frac{1}{\xi^*}\left(\frac{\sigma^* - g^*}{a\xi^*} + \frac{\partial \sigma}{\partial \psi}\right) = \frac{1}{\xi^*}\left(\frac{s[\psi^*]u^* - g^*}{a\xi^*} + s_h u^*\right),$$

and

$$\frac{\partial \dot{b}}{\partial b} = -(g^* - s_p j).$$

Proposition 1 *If an equilibrium exists at sufficiently high levels of u, ψ, b, g, and consequently low levels of ξ, this is stable and can generate damped cycles between u and ψ, and current account oscillations.*

A more formal proof of the proposition is given in the appendix. We can observe now that the signs of $\partial\dot{u}/\partial u$ and $\partial\dot{\psi}/\partial\psi$ are negative, while $\partial\dot{u}/\partial b$ and $\partial\dot{\psi}/\partial\psi$ are positive. A large u is associated with a large ψ via the distributive curve, to a large b via the aggregate demand function, to a large g through the investment and to a small ξ due to the distributive trade-off between real exchange rate and the wage share. For a reasonable configuration of parameters, the system is profit-led - $\partial\dot{u}/\partial\psi$ is negative - in an equilibrium with large u, ψ, b, and g. With $g > s_p j$, as it well may be the case if foreign investments include reserves and liquid low-interest-bearing assets, b is self-stabilizing. Sufficiently large values of b and ψ may lead to $\partial\dot{b}/\partial u < 0$ and $\partial\dot{b}/\partial\psi > 0$

The Jacobian signs can be summarized as follows:

$$J = \begin{bmatrix} - & - & + \\ + & - & 0 \\ - & + & - \end{bmatrix}.$$

In order to easily grasp the main aspects of the adjustment process and the emergence of distributive business cycles we can temporarily assume a "classical" saving pattern such as $s_b = 1$, $s_h = \upsilon = 0$, that is firms save all their income while households do not save. The aggregate demand injections generated by foreign assets revenues are perfectly offset by a correspondent amount of saving leakages. With $s_p = s_b = 1$ then $\partial\dot{u}/\partial b = 0$; foreign assets variations affect neither the aggregate demand nor the distributive equilibrium and the output-distribution adjustment can be treated separately from the asset adjustment.

Focusing on the (u, ψ) subset satisfying $g > s_p j$ and $\xi > 0$, then $\partial\dot{b}/\partial b < 0$ and foreign asset/capital ratio will converge to a steady state equilibrium.

The Jacobian of the reduced system has the following signs

$$J_{\bar{b}} = \begin{bmatrix} - & - \\ + & - \end{bmatrix}:$$

With $x/a \leq u$ (in equilibrium positive net foreign assets with low interest rate tend to be associated with a trade surplus), then the system is profit led: the consumption effect of a larger wage share does not offset the reduction of net exports coming from a redistribution/appreciation.

While the signs of $J_{\bar{b}}$ satisfy the conditions for stability with a negative trace and positive determinant, the relative magnitude of the own and cross effects of the variables can lead to damped cycles. For relatively close values of $\partial\dot{u}/\partial u$ and $\partial\dot{\psi}/\partial\psi$ and large absolute values of $\partial\dot{u}/\partial\psi$ and $\partial\dot{\psi}/\partial u$, such as in the case of a flat demand and steep distributive curve in the (u, ψ) plane, $(\partial\dot{u}/\partial u - \partial\dot{\psi}/\partial\psi)^2 < -4(\partial\dot{u}/\partial\psi)(\partial\dot{\psi}/\partial u)$ and the roots of $J_{\bar{b}}$ become complex. That implies a cyclical counterclockwise adjustment of u and ψ to the "medium run" equilibrium (see figure 2 below). These considerations hold a fortiori for $s_p < 1$ which implies a smaller $|d\psi/du|$ than in the case of $s_p = 1$, that is a flatter aggregate demand equilibrium in the (u, ψ) space.[8]

These counterclockwise cycles reproduce the *Lotka-Volterra* predator-prey symbiosis between wage share and employment/capacity utilization described first by Goodwin (1967) in his seminal paper adapted in a structural framework in Barbosa-Filho and Taylor (2005) and Taylor (2004).

If supply falls short of aggregate demand and the employment rate is below the equilibrium level, then the wage share falls. Excess demand is temporary satisfied by imports, but production and employment pick up, while capacity utilization and the growth rate rise. The ensuing depreciation increases net foreign assets revenues and the exchange-rate-sensitive net exports, while output expansion generates larger savings and slows down net export growth. When the employment rate is sufficiently large to push up wages, the exchange rate begins to appreciate, the exchange-rate-sensitive net exports and the net asset revenues contract, but together with a large growth rate generate enough demand to make production and employment still growing. Output expansion pushes up the wage share vigorously and increases savings, while the redistribution/appreciation reduces net exports. Eventually, output expansion and growth slows down. The fall in net exports and interest revenues induced by larger wages and the growth in savings generate an excess supply. Despite the appreciation unsold product is redirected abroad through *forced* exports. Employment and growth are contracting, until the wage increase-real appreciation will come to an end and then reversed with employment falling below its equilibrium level. The depreciation and the increased competitiveness will eventually restore capacity, employment and growth expansion leading toward another cycle. Assets variation play a side role in the simplified system, adjusting to the output-distribution variations. Output and employment growth generate larger capital growth then net savings to be directed abroad and reduce the net asset-capital ratio, while wage increases and appreciation generate larger net savings than growth and increase the relative size of foreign assets.

[8]The wage-led regime however does not allow for distributional cycles (u, ψ) for $\partial\dot{u}/\partial\psi > 0$ exclude the possibility of complex roots (Figure 2 shows the phase diagram under the two regimes).

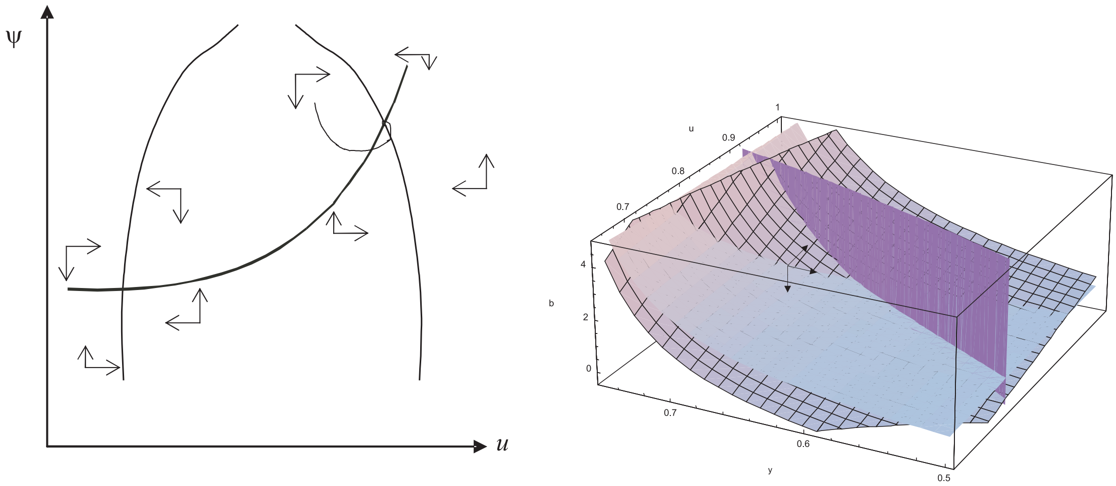

Figure 2: **Effective demand, distributive, and net assets stability**. Left panel: distributive/aggregate demand cycles can be generated in profit-led economies. Right panel: $\dot{u} = 0$ (check board surface), $\dot{\psi} = 0$ (vertical surface), and $\dot{b} = 0$ (light colored plane) in the (u, ψ, b) space; a stable equilibrium may exists.

For the complete system with $s_p < 1$, the considerations are similar. The oscillations of the net assets-capital ratio due to changes output and distribution feed back into the aggregate demand equilibrium. With b preserving its sign, cycles persist until $\dot{u} = \dot{\psi} = 0$ while further output and distributional changes can arise from a slow stock adjustment toward steady state. The current account oscillations are therefore the outcome of the dynamic interaction of a large number of variables and arises as a complex composition of market and social forces. The fairly straightforward cyclical predator-prey dynamics of output and distribution feeds into the dynamics of exchange exchange rate, international competitiveness and factor payments that combine to generate oscillations in the current account-output ratio.

The law of motion of the current account in unit of output is obtained using the equation foreign debt accumulation (17), the real exchange rate and the capacity utilization functions. The current account surplus in unit of domestic output $\kappa[t] = -\xi \dot{B}/X$ is,

$$\kappa = \frac{\sigma - g}{u}. \tag{21}$$

Figure 4 shows the current account dynamics corresponding to our predator-prey distributional cycles and net assets dynamics of figure 3. Since the current account is passively generated by excess supply, its fluctuations tend to be smoothed by the comovement of saving and investment via capacity utilization. On the other hand, real wage/exchange rate changes have opposite effects on savings out of wages and out of net foreign revenues: their interaction becomes the relevant source of the current account variability. Foreign revenues fluctuations in unit of output (dashed dotted line) tend to be the reversed mirror image of wage fluctuations because of the predominant effect of asset revaluation. Similarly, the trade account (in output units) is strongly correlated with the wage dynamics because of the effect on net foreign revenues revaluation and

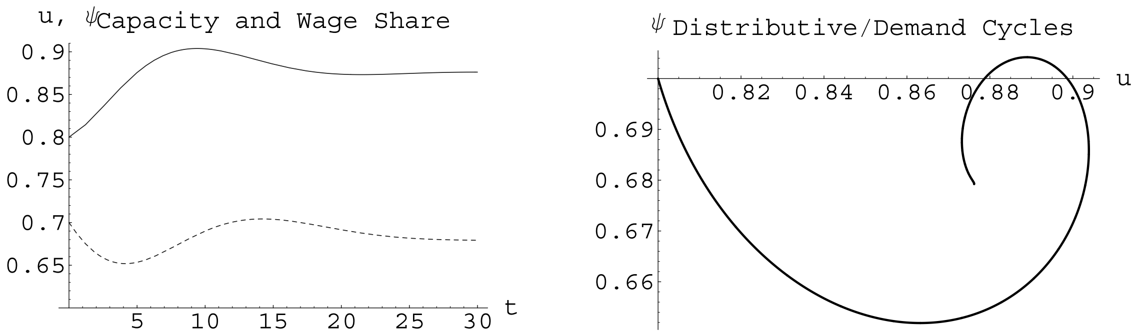

Figure 3: **Capacity utilization and wage share oscillations**. Left panel: Capacity (solid) and distributive (dashed line) oscillations. Right panel: Capacity and distributive predator-prey damped cycles. (*k = 50; l = .06; c=.3; α= .4; π= .2; a = .4; x = .5; j = .08, s_p=.4, s_h=.2; γ=.03.*))

of wages on savings. In spite of the traditional elasticity effect of a depreciation on net exports, a wage reduction accompanied by output growth but increasing excess demand generates larger *forced imports* and an increasing trade deficit. When wages are rising and the excess demand gap closing, *forced imports* fall more than the exchange-rate-sensitive net exports and the trade account tends be balanced. Then, a further wage increase/real appreciation accompanied by rising excess supply and *forced exports* lead to further improvements in the trade surplus, until a real depreciation, accompanied by falling excess demand and falling forced exports, reduces the trade balance again. In other words, the trade balance may well respond to the real exchange rate via standard trade elasticities, but is more sensitive to its distributional effect via excess demand dynamics.

3 A pure credit economy/forced saving adjustment model

We modify our previous model by assuming that the domestic economy includes two main sectors, households and a business/bank sector comprising firms, commercial and the central bank. The latter issue money to finance current transactions, while former save only to absorb money generated in the system. *Real balances* are indicated by M. Table 3 and 4 respectively show the new balance sheets and new SAM of the model.

TABLE 3

BALANCE SHEETS

Households		Firms/Banks		Foreign	
M	Ω_h	K	M	$-\xi B$	Ω_f
		ξB	Ω_b		

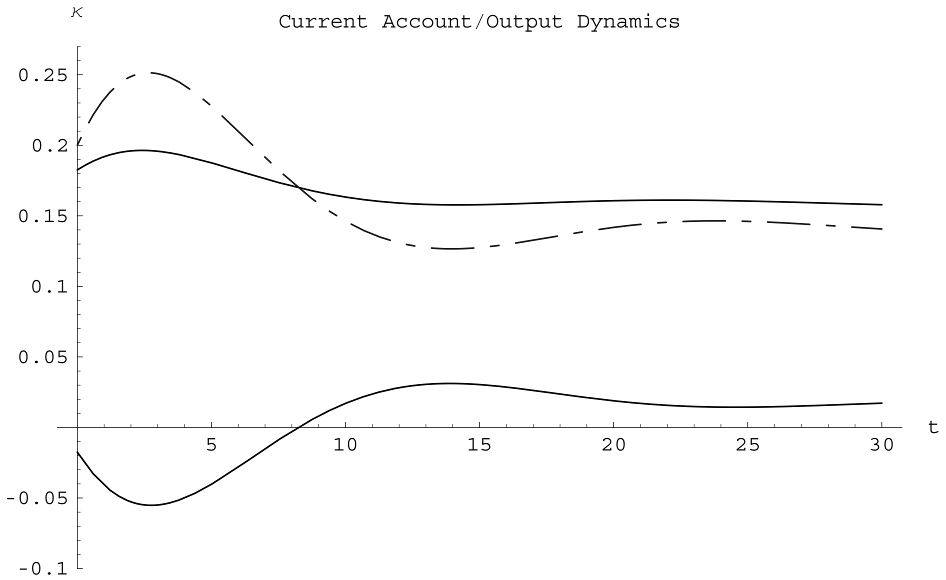

Figure 4: **Current account oscillations**. External balance Dynamics: Trade Balance (lower solid line) foreign revenues (dashed-dotted line) and current account dynamics (upper solid line) in output units

TABLE 4

Social Accounting Matrix (SAM)

	Output Cost(1)	HH. (2)	F./ B.(3)	ROW (4)	Capit. (5)	Money (6)	Bonds (7)	Tot. (8)
(A)Output		c_h		ξx	g			u
Incomes								
(B)HH.	ψu							y_h
(C)F./B.	πu			$j\xi b$				y_b
(D)ROW	ξau							y_f
Flow of Funds								
(E)HH.		σ_h				$-\dot{M}/K$		0
(F)F./B.			σ_b		$-g$	$\dot{M}/K$	$-\xi\dot{B}/K$	0
(G)ROW				(σ_f)			$\xi\dot{B}/K$	0
(H)Tot.	u	y_h	y_b	y_f	0	0	0	

We assume for simplicity that money are passively generated by economic activity according to an equation of exchange $X = vM$, where v is a constant velocity term. Dividing the equation by K we obtain $u = vm$, where $m = M/K$ is now the relative value of real balances over capital. Using the equation of exchange we obtain $\dot{M}/K = \dot{u}/v + gu/v$. Assuming that households save to accommodate money supply, $\sigma_h = \dot{u}/v + gu/v$, and that the business/bank sector has a given propensity to save s_p and save $\sigma_b = s_p(\pi u + j\xi b)$ we obtain national savings

$$\sigma = \dot{u}/v + gu/v + s_p(\pi u + j\xi b).$$

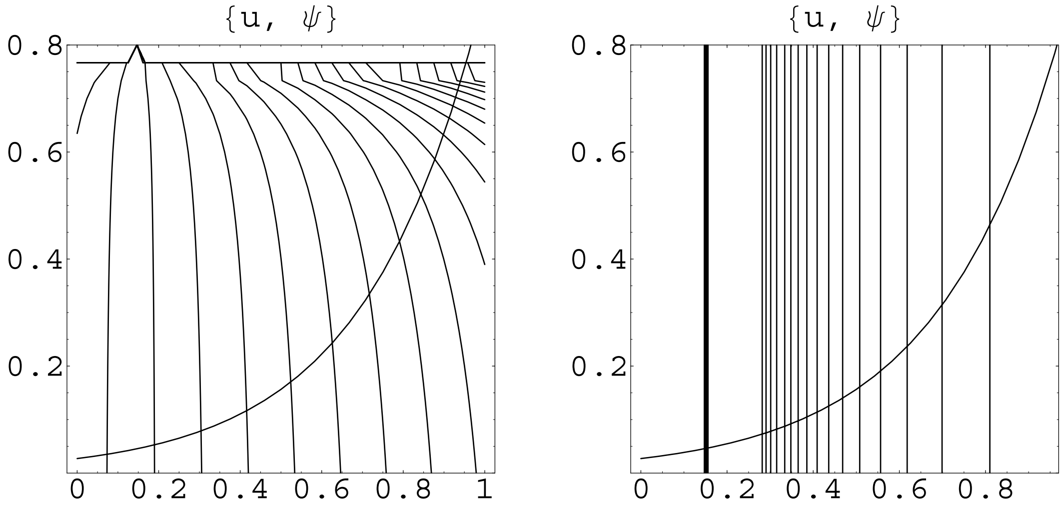

Figure 5: **Effective demand, distributive, and net assets equilibrium**. Left panel: Distributive and aggregate demand curves in the (u, ψ) plane; each curve represents a $\dot{u} = 0$ equilibrium at a given level of b. Right panel: Distributive and net assets equilibrium curves in the (u, ψ) plane; each curve represents a $\dot{b} = 0$ equilibrium at a given level of b. In both panels, curves on the right correspond to higher levels of net assets. (*k = 50; l = .06; c=.3; α= .4; π= .2; a = .4; x = .5; j = .08, s_p=.4, s_h=.2; γ=.03.*)

Our equilibrium condition $\sigma - z - g = 0$ is now

$$\frac{\dot{u} + gu}{v} + s_p(\pi u + j\xi b) + \xi(au - x - jb) - \alpha\pi u - \gamma = 0$$

that, rearranging, becomes

$$\dot{u} = v\left(\left(1 - \frac{u}{v}\right)(\alpha\pi u + \gamma) - s_p\pi u + (1 - s_p)\xi jb + \xi(x - au)\right). \tag{22}$$

Recalling the laws of motion of the wage share and net assets

$$\dot{\psi} = \tau\left(\psi^* - \psi\right)$$

and

$$\dot{b} = x - au + (j - g)\,b$$

, respectively, we observe the Jacobian of the new system

$$J = \begin{bmatrix} -\left(v(s_p - \alpha)\pi + \gamma + 2\alpha\pi u^* + v\xi^* a\right) & -\frac{v}{a}\left((1 - s_p)jb^* + x - au^*\right) & (1 - s_p)j\xi^* \\ \tau l^2 k\psi^* & -\tau & 0 \\ -(a + \alpha\pi b^*) & 0 & -(g^* - j) \end{bmatrix}$$

Figure 5 shows a parametric representation of the $\dot{u} = 0$ and $\dot{b} = 0$ curves at various levels of b, plotted against the distributive curve, $\dot{\psi} = 0$.

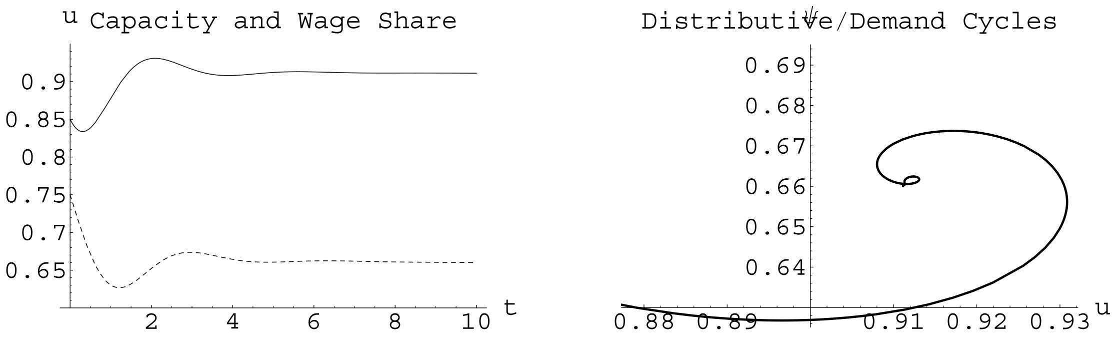

Figure 6: **Capacity utilization and wage share oscillations**. Left panel: Capacity (solid) and distributive (dashed line) oscillations. Right panel: Capacity and distributive predator-prey damped cycles. ((k = *50;* l = *.06;* c=*.3;* α= *.4;* π= *.2;* a = *.4;* x = *.5;* j = *.08,* s_p=*.4,* s_h=*.2;* γ=*.03.*)

At high level of economic activity, for a sufficient net assets ratio and/or trade surplus the system is profit-led. Moreover if the average rate of interest on net assets include low-yielding reserves and j is sufficiently small, the net asset law of motion is self-stabilizing. The Jacobian takes the signs

$$J = \begin{bmatrix} - & - & + \\ + & - & 0 \\ - & 0 & - \end{bmatrix}.$$

Analogous considerations to the former model show that the stability conditions are fulfilled and a pair of conjugate complex roots can characterize the system, mostly because of the large absolute values of the cross responses, $\partial\dot{u}/\partial\psi$ and $\partial\dot{\psi}/\partial u$.

Figure 6 and 7 show an example of cyclical pattern for capacity and distribution affecting the trade, the domestic value of foreign revenues and the current account. Figure 7 shows that, if the adjustment burden is shifted on national savings, then the trade balance can respond to wage reductions/depreciations via traditional trade elasticities. With net exports and net foreign revenues responding to exchange rate fluctuations with the same sign and similar magnitudes, the current account (in output units) is initially improved by the exchange rate depreciation and then worsened by the output expansion.

The *predator-prey* cyclical behavior is perfectly replicated in the open economy with the capacity utilization as the *predator* and the current account the *prey*.

4 Conclusions

The model describes the generation of distributional-demand cycles leading to endogenous current account cyclical dynamics. The eclectic set up, which merges the Goodwin predator-prey idea of distributional conflict cycles in its structuralist extension, which includes the Keynes-Kaldor-Kalecki role of distribution in the demand and relative price

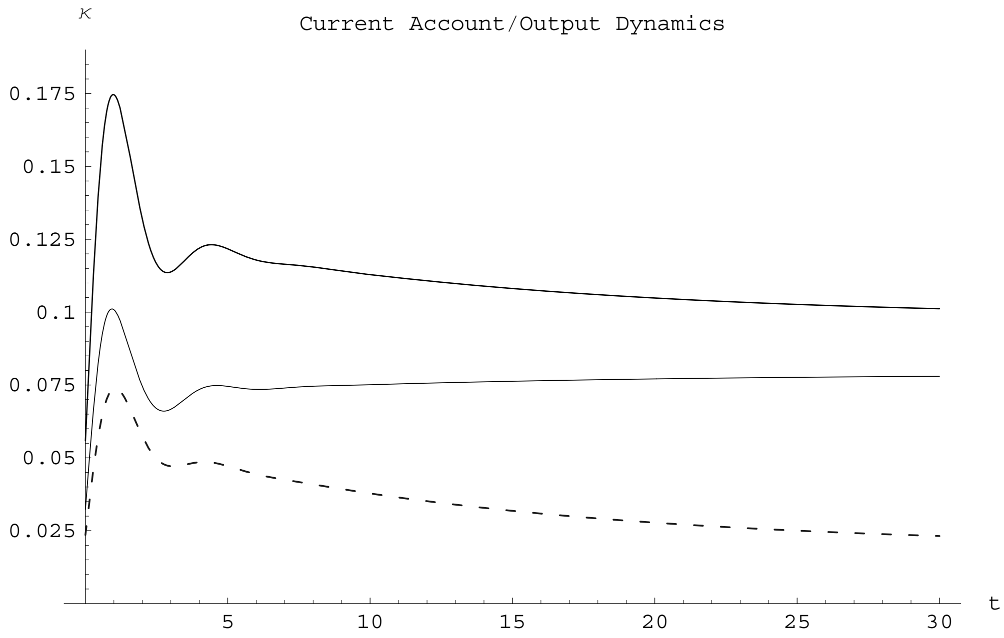

Figure 7: **Current account oscillations**. External balance Dynamics: Trade Balance (lower solid line) foreign revenues (dashed line) and current account dynamics (upper solid line) in output units (*k = 50; l = .06; c=.3;* α*= .4;* π*= .2; a = .4; x = .5; j = .08,* s_p*=.4,* s_h*=.2;* γ*=.03.*)

determination, and the specification of the distributive conflict as a labor extraction process a' la Bowles and Boyer, all rigorously contained in a stock-flow consistent set of accounts, allowed us to gain some powerful descriptive insights on the determinants and dynamics of the current account and net asset accumulation.

The focus of the paper is on that cyclical dynamics predominantly induced by a distributional-output fluctuations in profit-led economies arising from strong reaction of wages on employment and of aggregate demand on distribution/real exchange rate changes, that is, a steep distributive upward sloping and relatively flat downward sloping aggregate demand curve in the capacity utilization - distribution plan. A sufficiently steep distributive curve can be the result of organized labor and increasing bargaining power at high level of employment, while a sufficiently flat effective demand curve may be the outcome of a high sensitivity of the real exchange rate and output to wage changes. This is likely to be the case for an export oriented economy that is experiencing high levels of growth and capacity utilization.

We showed that the distribution/capacity utilization cyclical pattern affects the external balance under alternative causal determination of the macrobalance (passive savings or passive current account). We are also well aware that distributional/capacity utilization cyclical behavior may be generated under some other specification of the effective and distributional relations that can be able to explain fluctuations in the exchange and current account balance in low growth and/or indebted economies.

The descriptive power of the framework relies, in fact, on the relevance of economic institutions, social and labor relations.

Alternative modern macroeconomic frameworks such as the intertemporal approach to the current account derive their prescription from general implications obtained under the assumption full employment, marginal cost pricing and perfect foresight (or rational expectations) and need to explain trade imbalances as equilibrium outcomes of the intertemporal allocation of expenditure and to exclude a role for the exchange rate in the trade balance.

In the proposed framework, the exchange rate responds to changes in the aggregate demand via distribution and may affect the current account via traditional trade elasticities as well as via income distribution and savings generation. The relation between exchange rate and current account can be complex and non univocal, but role of the exchange rate as a relative price relevant for macroadjustment can be preserved.

5 Appendix A: Labor market and endogenous productivity

In section 2.1.2 we simply described a distributive curve as a labor market equilibrium representation in the (u, ψ) plane, and we stated a possible adjusting mechanism.

As emphasized in Bowles and Boyer (1988, 1989), labor effort is a crucial endogenous variable in a model that takes into account social relations. The effectiveness of the work done in a hour depends both on the work and social environment: the overall labor market's and the individual firm's work conditions determine the job loss cost for workers and therefore the power of the employer to induce work effort per hour worked. Define ω_f as the single firm's wage rate per hour worked, ω_a the wage offered by any other firm and consider the employment rate h as a proxy of the probability of reemployment. Threatened by a job loss cost equal to the difference between their current wage and the expected wage in case of lay off, $(\omega_f - h\omega_a)$, a sort of employment rent, workers will exert effort according to a reaction function $\varepsilon = \varepsilon\left[\omega_f, \omega_a, h\right]$ with the general properties of being increasing in the wage paid by the employing firm, $\partial\varepsilon/\partial\omega_f > 0$, but in a decreasing manner, $\partial\varepsilon^2/\partial\omega_f^2 < 0$, and being decreasing in the alternative wage, $\partial\varepsilon/\partial\omega_a < 0$, and the employment rate, $\partial\varepsilon/\partial h < 0$ the components of the expected reemployment wage $h\omega_a$. Such work effort function can be easily dealt with in a logarithmic form

$$\varepsilon = \ln(\omega_f - h\omega_a).$$

Firms' profit maximization or minimization of labor cost per effective work unit, ω/ε, is obtained at the equilibrium wage

$$\omega^o = \varepsilon \left(\frac{\partial\varepsilon}{\partial\omega_f}\right)^{-1}.$$

The labor cost minimizing wage rate offered by any single competitive firm ω^o, in our specification

$$\omega^o = (\omega^o - h\omega_a)\ln\left(\omega^o - h\omega_a\right), \tag{23}$$

is therefore a function of ω_a and h which are taken as given by any single competitive firms but vary in the aggregate.

Differentiation of (23) shows the effect of rising employment on the single firm's optimal wage rate. The rise in workers' probability of reemployment raises their expected alternative wage, lowers their employment rent and work effort: firms can restore an optimal wage/effort ratio by raising the offered wage rate and consequently labor productivity,

$$\frac{d\omega^o}{dh} = \left(2 - h\frac{\omega_a}{\omega^o}\right)\omega_a. \tag{24}$$

However, as pointed out by Bowles and Boyer, the effect of employment on the single firms' equilibrium wage rate is just the basis of a larger multiplicative effect leading to higher aggregate wage responses to any given employment change: an initial rise in the employment rate induces single firms to increase their offered wage, but when they observe a rise in workers' alternative wage ω_a are consequently forced to further raise their own wages until the optimal wage-effort ratio is obtained. The aggregate effect becomes

$$\frac{d\omega}{dh} = \frac{d\omega^o}{dh}\left(1 - \frac{h}{\omega_a}\frac{d\omega^o}{dh}\right)^{-1} = \frac{\left(2 - h\frac{\omega_a}{\omega^o}\right)\omega_a}{1 - h\left(2 - h\frac{\omega_a}{\omega^o}\right)},$$

where the latter equation is obtained using (24).

Optimality for any single firm and the equilibrium for the firms sector as a whole is obtained at the uniform wage rate $\omega = \omega_f = \omega_a$, which implies

$$\frac{d\omega}{dh} = \frac{(2-h)\,\omega}{(1-h)^2}. \tag{25}$$

Integrating (25) we obtain a market real wage as a function of the employment rate $\omega^* = \omega^*[h]$

$$\omega^* = c\frac{\exp\left(\frac{1}{1-h}\right)}{1-h}; \tag{26}$$

where c is an integration constant which pins down the minimum real salary for $h = 0$ as $\omega_{\min} = c\exp(1)$.

Recalling that in equilibrium $\varepsilon[h] = \ln((1-h)\,\omega^*[h])$, the market optimal wage and the work effort functions are,

$$\omega^* = \frac{c\exp\left(\frac{1}{1-h}\right)}{1-h} = (1+ulk)\,c\exp(1+ulk), \tag{27}$$

and

$$\varepsilon^* = \frac{1}{1-h} = 1 + ulk \tag{28}$$

respectively, with the second equalities of both functions obtained recalling that $h = ulk/\varepsilon$. Indeed, at the equilibrium, the employment rate can be expressed as a function of capacity utilization alone: $h = ulk/(1+ulk)$.

The equilibrium wage share $\psi^* = \omega^* l/\varepsilon^*$ is our *distributive curve*

$$\psi^* = lc\exp\left(\frac{1}{1-h}\right) = lc\exp(1+ulk),$$

As mentioned in above, we define τ as an adjustment speed constant and assume a linear adjustment of the kind

$$\dot{\psi} = \tau\left(\psi^{*} - \psi\right).^{9}$$

6 Appendix B: Stability analysis

The general form of our Jacobian is

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

The Routh-Hurwitz conditions:
(i) $Tr[J] < 0$,
(ii) $Det[J] < 0$, and
(iii) $Det[J_1] + Det[J_2] + Det[J_3] > 0$, and
(iv) $-Tr[J](Det[J_1] + Det[J_2] + Det[J_3]) + Det[J] > 0$,
where J_i are the principal minors of order 2 of the Jacobian, are necessary and sufficient conditions for the system's stability.

In our case they require

(i) $Tr[J] = -\lambda\left(s[\psi^{*}] - \alpha\pi + \xi a\right) - \tau - (g^{*} - s_p j) < 0$

(ii) $Det[J] = \partial\dot{u}/\partial u \begin{vmatrix} \partial\dot{\psi}/\partial\psi & \partial\dot{\psi}/\partial b \\ \partial\dot{b}/\partial\psi & \partial\dot{b}/\partial b \end{vmatrix} - \partial\dot{u}/\partial\psi \begin{vmatrix} \partial\dot{\psi}/\partial u & \partial\dot{\psi}/\partial b \\ \partial\dot{b}/\partial u & \partial\dot{b}/\partial b \end{vmatrix} +$
$\partial\dot{u}/\partial b \begin{vmatrix} \partial\dot{\psi}/\partial u & \partial\dot{\psi}/\partial\psi \\ \partial\dot{b}/\partial u & \partial\dot{b}/\partial\psi \end{vmatrix} < 0$

$$Det[J] = (-)\begin{vmatrix} - & 0 \\ + & - \end{vmatrix} - (-)\begin{vmatrix} + & 0 \\ - & - \end{vmatrix} (+)\begin{vmatrix} + & - \\ - & + \end{vmatrix} < 0$$

(iii) the sum of the principal minors' determinants, $Det[J_1] + Det[J_2] + Det[J_3]$, is

$$\begin{vmatrix} \partial\dot{\psi}/\partial\psi & \partial\dot{\psi}/\partial b \\ \partial\dot{b}/\partial\psi & \partial\dot{b}/\partial b \end{vmatrix} + \begin{vmatrix} \partial\dot{u}/\partial u & \partial\dot{u}/\partial b \\ \partial\dot{b}/\partial u & \partial\dot{b}/\partial b \end{vmatrix} + \begin{vmatrix} \partial\dot{u}/\partial u & \partial\dot{u}/\partial\psi \\ \partial\dot{\psi}/\partial u & \partial\dot{\psi}/\partial\psi \end{vmatrix} =$$

$$\begin{vmatrix} - & 0 \\ + & - \end{vmatrix} + \begin{vmatrix} - & + \\ - & - \end{vmatrix} + \begin{vmatrix} - & - \\ + & - \end{vmatrix} > 0$$

and therefore for a sufficiently large trace and $Det[J_1] + Det[J_2] + Det[J_3]$ and a small absolute value of the determinant ($\partial\dot{u}/\partial\psi$, $\partial\dot{\psi}/\partial u$, $\partial\dot{\psi}/\partial\psi$, and $\partial\dot{b}/\partial\psi$ tend to be large and $\partial\dot{u}/\partial b$ and $\partial\dot{b}/\partial b$ small, in absolute values), condition *(iv)* is satisfied.

[9]We note that under the hypothesis of perfect information of any firm's real wage and the condition of uniformity $\omega = \omega_f = \omega_a$, any market wage rate ω could represent a Nash equilibrium from which no single firm has any incentive to deviate (firms are only concerned about differential between their ω_f and other firms' ω_a). Such equilibrium among decentralized and competing wage setters can falter in condition of scarce observability, wrong perception and lack of trust on other firms' intentions.

Once the wage changes have been set off, firms will converge to the wage rate consistent with the current level of employment h and minimum salary $\omega_{\min}$.

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