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The macroeconomic implications of zero growth: a post-Keynesian approach

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This paper tries to clarify some important aspects of the zero-growth discussion, in particular the consistency of stable zero growth with positive profits and a positive real interest rate. Starting from an accounting perspective, the authors analyse the implications of zero growth and clarify the stability conditions of such an economy. This is complemented with a monetary circuit approach – which, like any model, has to respect the national income and financial accounting conventions. The latter allows the authors to show that a stationary economy, that is, an economy with zero net investment, is compatible with positive profits and interest rates. They also argue that a stationary economy does not generate systemic financial instability, in the sense of rising or falling financial-assets– or financial-liabilities–income ratios, if the financial balances of each macroeconomic sector are zero. In order to analyse the dynamic stability of such an economy, they make use of an autonomous demand-led growth model driven by government expenditures. They show that a stable stationary state, with zero growth, positive profits and a positive interest rate, is possible in that model. However, the stable adjustment of government-expenditures–capital and government-debt–capital ratios to their long-run equilibrium values requires specific maxima for the propensity to consume out of wealth and for the rate of interest, assuming a balanced government budget and zero retained earnings of the firm sector.

Keywords: *ecological macroeconomics, post-Keynesian economics, stationary-state economics, growth imperative*

JEL codes: *Q01, O44, P10*

1 INTRODUCTION

The limit to economic growth imposed by nature has been pointed out by many authors over several decades. In the 1970s, the work by Daly (1974), Georgescu-Roegen (1971) and Meadows et al. (1972) had already warned about the degradation of the Earth's carrying capacity. Economic activities are constrained by the first and second law of thermodynamics, the complexity of intertwined natural processes and the exhaustibility of natural resources. Despite these constraints, about half of the carbon emissions released into the atmosphere from the burning of fossil fuels have occurred

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since the early 1990s (Wallace-Wells 2019), and the urgency of transitioning towards an economy that respects planetary boundaries is evident.¹

The urgency of the socio-ecological transition is broadly recognised and it has become a top priority in the international political agenda. The ideas and proposals of how to make such a transition happen are of the most diverse nature. Many of the existing approaches assume – or trust in – the possibility of decoupling economic growth from negative environmental impacts (Asafu-Adjaye et al. 2015; OECD 2015). Others are sceptical and argue that a non-growing or even a de-growing economy is necessary if we are to achieve ecological sustainability (Jackson 2017; Kallis 2011). Largely influenced by the work of Daly (1973; 1996), who presents the concept of a stationary-state economy, zero-growth and de-growth proponents suggest that to meet ambitious ecological targets, we will need to go through a process of sustainable de-growth, which involves the downscaling of society's throughput, that is, a decrease of material production and consumption (Kallis 2011) that will most likely lead to a stagnant or shrinking economy.

The latter might involve such a deep transformation of the economy and society that the possibility of such a transition within a capitalist system has been questioned (Kallis 2011). Specifically, it is argued that growth is a systemic requirement of capitalism (Binswanger 2009; Harvey 2007), in other words, that capitalism is bound to a 'growth imperative'. This involves aspects such as the use of debt, interest, or the eternal search for profit, market share, and accumulation as mechanisms to remain competitive (Kovel 2002; Richters/Siemoneit 2017; 2019).

Several post-Keynesian and ecological economists have also addressed these questions using different types of models and assumptions. Fontana/Sawyer (2013; 2015; 2016) provide important conceptual attempts at integrating ecological constraints into post-Keynesian macroeconomics. They present a simple post-Kaleckian demand-led growth model and distinguish the warranted growth rate and the full employment growth rate from the growth rate allowed by ecological footprint. They argue that these growth rates are independent of each other and that there is no automatic adjustment that aligns them. Since achieving an ecologically sustainable growth rate will require major adjustments of the growth in the capital stock and the effective labour force, economic policy interventions will be crucial for the transition towards ecological sustainability. However, stability issues of (close to) stationary-state economies are not examined.

Lange (2018), who analyses the conditions for sustainable economies without growth in different theories, concludes that post-Keynesian theory can be compatible with zero growth. In a scenario with technological change, reductions in working hours and compensatory wage increases are found to be necessary to avoid rising unemployment. Furthermore, positive profits must be matched with a sufficiently high level of consumption out of profits. Consumption out of profits and out of wages must equal overall income, which in other words means that saving must be equal to zero. However, his study does not include any stability analysis.

Rosenbaum (2015) tackles the issue of stable zero growth and technological progress using a Kaleckian model with fixed capital costs. Prices are set as a mark-up over unit total costs, which is problematic because unit fixed capital costs vary with the level of output. Target rate-of-return pricing would thus have been an adequate approach. He introduces depreciation, but without differentiating capital scrapping and reinvestment from depreciation, in contrast to Bhaduri (1972), Casseti (2006) and Hein (2021), and discusses different cases for zero growth and its stability. However, as shown by Monserand (2020), there are several further inconsistencies in the model which mean that, overall, Rosenbaum (2015)

1. See Priewe (2022) for a recent extensive review.

is not proving what he claims, that is, the consistency of positive profits with stable zero growth under certain circumstances. Monserand (2019) provides a more convincing approach of discussing zero or de-growth in a basic neo-Kaleckian distribution and growth model. He analyses the possibility of an equilibrium with a zero or negative rate of accumulation while verifying the Keynesian goods market equilibrium stability condition. He shows that the integration of autonomous consumption and/or government deficits allows for a stable goods market equilibrium with zero investment but positive profits. However, he only focuses on the existence and stability of the goods market equilibrium, without looking at the financing side and the related issue of financial stability.

Analysing the viability of positive interest rates in a stationary economy, Berg et al. (2015) combine a stock–flow consistent (SFC) model with an input–output approach. They show that an equilibrium, that is, constant stock–flow ratios, is possible, depending on the parameters regarding the propensity to consume out of wealth and the rate of interest on deposits, which is the only income from financial assets received by households, which also receive all the firms' profits. In their model, the government runs a balanced budget. This is also the case in Cahen-Fourot/Lavoie (2016), who consider an SFC stationary economy and an endogenous determination of debt in the stationary state to show that models with credit-money and positive interest rates are compatible with a stationary economy. They show the latter is possible through the balancing of saving out of income with consumption out of wealth. Similarly, Jackson/Victor (2015) also find that a minimum consumption out of wealth is required for a stationary state in their SFC model with a more differentiated banking sector, including a central bank and commercial banks. However, in Cahen-Fourot/Lavoie (2016) the dynamic adjustment towards the stationary state is not considered, while Berg et al. (2015) and Jackson/Victor (2015) provide numerical robustness checks but no general stability analysis.

Richters/Siemoneit (2017) have clarified in their review of several models that a stationary state with positive profits and interest rates is only possible under the condition that each sector is running neither financial deficits nor surpluses.² The latter means that there are no retained profits in the corporate sector, that there are balanced government budgets, and that saving out of household income is compensated for by consumption out of wealth; in an open economy we would also need a current-account balance. Only under these conditions would the ratios of financial assets or liabilities to income (or the capital stock) remain constant. However, Richters/Siemoneit (2017) do not examine the dynamic stability of a zero-growth equilibrium.

On the one hand, our paper aims to clarify the requirements for the macroeconomic stability of a zero-growth economy in a systematic way. On the other hand, we aim to clarify the conditions under which a stable zero-growth economy allows for positive profits and a positive interest rate. We will only focus on the goods market equilibrium and on systemic financial stability in the sense of constant and stable asset- or debt-capital (or -income) ratios for a closed one-good economy without technological change. Extending the models to the open economy will be left for future work. The same is true for the issues of full employment in a zero-growth economy, as well as technological change, productivity growth and structural change. These last issues are, in our view, important to discuss – in particular, for the traverse towards a sustainable economy. However, we will not attempt to do this here. Our contribution is thus rather modest and basic, but we hope to contribute to a clarification of these fundamental concerns.

2. Their review includes Berg et al. (2015), Binswanger (2009; 2015), Cahen-Fourot/Lavoie (2016), Douthwaite (2000), Farley et al. (2013), Godley/Lavoie (2007), Jackson/Victor (2015) and Lietaer et al. (2012).

Bearing in mind the requirement pointed out by Richters/Siemoneit (2017), we begin by outlining the macroeconomic implications for zero growth from a macroeconomic accounting perspective in Section 2. In Section 3, we analyse these requirements in a monetary circuit approach which, of course, obeys national accounting conventions, but more explicitly traces the monetary flows in the model economy from credit creation for initial finance to credit repayment and destruction. In Section 4, we then analyse the dynamic stability of a zero-growth economy, including private saving and investment functions, as well as endogenously determined government-expenditures– and government-debt–capital ratios in the long run. We do this by making use of an autonomous demand-led growth model driven by government expenditures. Section 5 summarises and concludes.

2 AN ACCOUNTING PERSPECTIVE ON STABLE ZERO GROWTH

Departing from an accounting perspective, in this section we seek to clarify the requirements for stable zero growth, with regard to the goods market and the financial market. For the stability of the goods market, effective demand must be sufficient to generate and reproduce stationary output over time. From national income accounting, output (Y_p), here net of depreciation, is given as the sum of private consumption out of rentiers' income (C_R) and out of wages (C_W), government consumption expenditures (G), net investment (I), revenues from exports of goods and services (Ex), and expenditures on imports of goods and services (Im), all variables in real terms:

$$Y_p = C_R + C_W + G + I + Ex - Im. \quad (1)$$

In what follows we are assuming that depreciations are reinvested, so that we can focus on output and income, net of depreciations. For total income (Y) we have to include government interest payments to rentiers ($R_G = iB_G$), with B_G for the stock of government debt and i for the rate of interest on that debt. This income has to be added to the income generated in production, which is equal to the sum of total wages (W) and total profits ($\Pi = \Pi_F + R_F$). Profits from production is the sum of retained profits (Π_F) and distributed profits (including interest and dividends) equal to rentiers' income from firms (R_F). Assuming that both wages and profits are taxed, wages can be split into net wages and taxes on wages ($W = W^n + T_W$), retained profits into net retained profits and taxes on retained profits ($\Pi_F^T = \Pi_F^n + T_F$), rentiers' income from firms into their net income from firms and taxes on that income ($R_F = R_F^n + T_{RF}$), and rentiers' income from the government into net interest revenues from the government and taxes on those revenues ($R_G = R_G^n + T_{RG}$). Rentiers' total net income is $R^n = R_F^n + R_G^n = R_F - T_{RF} + R_G - T_{RG}$, and rentiers' total tax payments are $T_R = T_{RF} + T_{RG}$. For total income we thus obtain:

$$\begin{aligned} Y &= Y_p + iB_G = I + C_R + C_W + G + iB_G + Ex - Im = \Pi_F + R_F + R_G + W \\ &= \Pi_F^n + T_F + R_F^n + T_{RF} + R_G^n + T_{RG} + W^n + T_W = \Pi_F^n + R^n + W^n + T. \end{aligned} \quad (2)$$

From this, we obtain for the sectoral financial balances:

$$\begin{aligned} &\Pi_F^n - I + R^n - C_R + W^n - C_W + T_W + T_F + T_R - G - iB_G + Im - Ex \\ &= FB_F + FB_R + FB_W + FB_G + FB_f \\ &= 0, \end{aligned} \quad (3)$$

with $FB_F = \Pi_F^n - I$ as the corporate financial balance, $FB_R = S_R = R^n - C_R$ as the rentiers' households' financial balance, equivalent to saving out of rentiers' income, $FB_W = S_W = W^n - C_W$ as the workers' households' financial balance, equivalent to saving out of wages, $FB_G = T_W + T_F + T_R - G - iB_G = T - G - iB_G$ as the government financial balance, and $FB_f = Im - Ex$ as the foreign sector financial balance.

For a stationary economy at some target level of output ($Y_{P,I=0}^T$) we need zero net investment, that is, $I = 0$. For such an economy to be financially stable, the financial balances of the different macroeconomic sectors should each be zero at the stationary target level of output to avoid ever-rising debt-income ratios of any sector – as has also been clarified by other authors such as Richters/Siemoneit (2017). Otherwise, some sectors would build up financial assets over time whereas others would accumulate the counterpart financial liabilities. We would thus see rising financial-assets-income ratios, as well as increasing financial-liabilities-income ratios, violating our condition for the financial stability of a stationary economy. For equation (3), this implies that saving out of rentiers' and workers' net incomes each have to be zero ($S_R = S_W = 0$), governments have to run a balanced budget ($T - G - iB_G = 0$),³ and net exports and hence the current account have to be equal to zero too ($Ex - Im = 0$). Furthermore, for a financially stable stationary economy, equation (2) becomes:

$$\begin{aligned} Y &= Y_{P,I=0}^T + iB_G = C_R + C_W + G + iB_G = R_F + R_G + W \\ &= R_F^n + T_{RF} + R_G^n + T_{RG} + W^n + T_W = R^n + W^n + T. \end{aligned} \tag{4}$$

Since retained profits are zero, taxes are now given as the sum of taxes on rentiers' income and taxes on wages ($T = T_R + T_W$). The condition of zero financial balances of each sector also implies:

$$C_R = R^n = R_F^n + R_G^n = \Pi^n + (iB_G)^n. \tag{5}$$

A zero-growth economy is thus consistent with positive net profits and a positive rate of interest, if rentiers' consumption is positive. In other words, positive profits and a positive rate of interest do not require a growing economy from this accounting perspective. In the next section, we will confirm these results by taking a closer look at the related financial flows in a monetary circuit approach.

3 ZERO GROWTH IN A MONETARY CIRCUIT MODEL

In this section, we will complement the accounting perspective with a monetary circuit approach, similar to but more explicitly than Fontana/Sawyer (2013; 2015; 2016).⁴ This approach is firmly based on the view of endogenous credit-money, and a key feature is the role of the banking sector in its ability to create credit-money. Expenditures can only happen if the economic agent is able to finance such expenditure, that is, if the agent has access to credit-money, which can be generated by the banking sector 'out of nothing'.

3. We would argue that even for a government which can issue debt in its own currency and which is supported by a national central bank, ever-rising government debt-income ratios pose some financial instability risk, in particular in an open economy with capital mobility.

4. On the monetary circuit school, see Bossone (2001; 2003), Graziani (1989; 1994; 2003), Hein (2008: ch. 10.2), Lavoie (2014: ch. 4.3), Lavoie/Seccareccia (2016) and Seccareccia (1996; 2003), for example.

Table 1 Balance-sheet matrix for a zero-growth closed economy

	Workers' households	Rentiers' households	Firms	Government	Banks	Σ
Deposits	0	$+D_R$	0	0	$-D_R$	0
Loans	0	$+B_{GR}$	0	$-(B_{GR} + B_{GB})$	$+B_{GB}$	0
Equity	0	$+E_R$	$-E_R$	0	0	0
Capital	0	0	K	0	0	K
Σ	0	$+E_R + B_{GR} + D_R$	$+E_F$	$-(B_{GR} + B_{GB})$	0	$K = E_F + E_R$

The simple model for a pure credit economy without a central bank and hence without central bank money is composed of five sectors, as shown in the balance-sheet matrix in Table 1. We have a commercial banking sector which is able to generate short-term credit (B^S) as well as to grant long-term credit (B). Other sectors may hold deposits with the banking sector, where such deposits are the most liquid financial asset. Below, we will assume that the interest rate on short-term credit and deposits is zero and that any interest on long-term credit received by banks is immediately transferred to the rentiers as the owners of the banks. The second sector is a firm sector whose capital stock (K) is long-term financed by equity held by shareholders/rentiers (E_R) and by the firms themselves as accumulated retained earnings (E_F). The firm sector thus does not issue debt and is not financing its capital stock by long-term credit. The government sector is the indebted sector in our model and has issued long-term bonds held by rentiers and by banks in the past. The rentiers' households hold equity issued by the firms, long-term bonds issued by the government, and may also hold deposits with the banks. The workers' households do not hold any assets nor issue liabilities. The stock accounting consistency requires:

$$K = E_F + E_R. \quad (6)$$

For a zero-growth equilibrium economy, with zero net investment ($I = 0$) and with initial government debt, inherited from past positive growth-rate periods, and thus interest payments of the government to the rentiers ($iB_G = iB_{GR} + iB_{GB}$), our accounting equation (4) for income and expenditures holds again.

Furthermore, from Section 2, we know that the prevention of systemic financial stability requires that the financial balances of each sector have to be equal to zero. This means that retained profits of the firm sector are zero and the rentiers receive all the profits as dividends. Saving out of workers' and out of rentiers' income needs to be zero, too. This means that workers and rentiers have to spend their net income after taxes for consumption goods. Furthermore, the government will have to run a balanced budget.

Figure 1 shows the four phases of the monetary circuit for a zero-growth economy with initial government debt, where F represents firms, Gov the government, HH_R rentiers' households, and HH_W workers' households. In the first phase of the circuit, short-term initial finance (with no interest rate being charged on such finance) is provided from the banks to the firms (B_F^S) and to the government (B_G^S). The initial finance for firms consists of wages and profits/dividends to be paid in advance to workers' and rentiers' households ($B_F^S = W + \Pi$). The initial finance for the government consists of planned government consumption expenditures plus government interest payments on the stock of debt to the rentiers ($B_G^S = G + iB_G$).

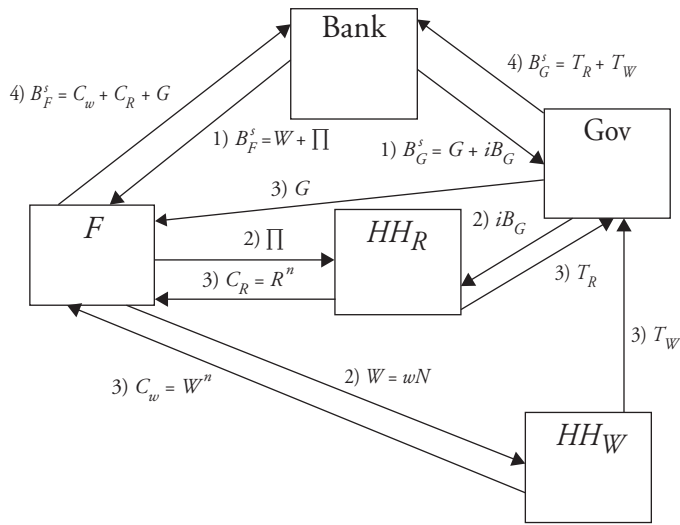


Figure 1 A monetary circuit for a zero-growth economy with a government and without interest on initial finance

The initial finance allows income payments to be made in advance to the rentiers' and workers' households in the second phase. In our case, this would correspond to the interest payments from the government to the rentiers (iB_G), the profits/dividends from the firms to the rentiers (Π), and wages paid by firms, which are equal to the nominal wage rate multiplied by the number of employed persons ($W = wN$).

Income received then allows for expenditures in the third phase (that is, the reflux phase). Rentiers and workers pay taxes (T_R, T_W) to the government and spend their net incomes on consumption goods ($C_R = R^n, C_W = W^n$). The government now also spends its initial finance on government consumption (G).

The expenditures in the third phase make sure that the firms and the government receive the funds that enable them in the fourth phase to repay initial finance and hence short-term credit to the banks and thus to close the circuit. In the course of the monetary circuit, profits of firms are realised and a positive interest rate on government debt is also consistent with a stable stationary economy. Endogenous credit creation (and destruction) with positive interest rates and profits is thus possible in a stationary economy and, as such, does not impose a growth bias on the economy.

Table 2 presents the transaction-flow matrix for our simple zero-growth economy. It displays the transactions between different sectors within a period and reflects the structure of the national accounting system. The first eight rows represent output and income from the spending and income approach and show a zero net saving for each sector. The lower part represents the changes in financial assets and liabilities, the sum of which for each sector also has to be zero in a stable stationary economy, in which no sector should build up financial assets or liabilities. Of course, the portfolio structure of each sector may change, within the constraints given by consistent accounting. For example, if the liquidity preference of the rentiers' household rises and they prefer to hold more deposits instead of government bonds, this implies (given a constant net asset position) that they have to reduce credit granted to the government while banks increase their long-term credit

Table 2 Transaction–flow matrix for a zero-growth closed economy

	Workers' households	Rentiers' households	Firms' current	Firms' capital	Government	Banks	Σ
Taxes	$-T_W$	$-T_R$	0	0	$+T_W + T_R$	0	0
Government consumption	0	0	$+G$	0	$-G$	0	0
Consumption	$-C_W$	$-C_R$	$+C_W + C_R$	0	0	0	0
Investment	0	0	0	0	0	0	0
Wages	$+W$	0	$-W$	0	0	0	0
Retained profits	0	0	0	0	0	0	0
Distributed profits/ dividends	0	$+\Pi$	$-\Pi$	0	0	0	0
Interest payments	0	$+R_G$	0	0	$-R_G$	0	0
Σ	0	0	0	0	0	0	0
Change in deposits	0	$-/+dD_R$	0	0	0	$+/-dD_R$	0
Change in loans	0	$-/+dB_{GR}$	0	0	$+/-B_{GR}$ $+/-B_{GB}$	$-/+dB_{GB}$	0
Change in equity	0	$-/+dE_R$	0	$+/-dE_F$	0	0	0
Σ	0	0	0	0	0	0	0

to the government. In other words, in a stable zero-growth economy, portfolio shifts are possible as long as net saving of each sector remains zero.

4 AN AUTONOMOUS DEMAND-LED GROWTH MODEL WITH ZERO GROWTH

Having so far clarified the properties of a stationary economy from an accounting and a monetary circuit perspective, including the related stock consistencies, we will now integrate these properties into a dynamic model. For this purpose, we will use an autonomous demand-led growth model, a type of model which has become popular in heterodox macroeconomics and which has recently been merged with the Kaleckian distribution and growth models.⁵ These models are based on the work of Serrano (1995a; 1995b), who proposed a ‘Sraffian supermultiplier’ model driven by autonomous demand, and have since been further developed and applied by other Sraffian authors.⁶ Starting with Allain (2015) and Lavoie (2016), Kaleckian authors, such as Allain (2019; 2021), Dutt (2019; 2020), Hein (2018), Hein/Woodgate (2021), Lavoie/Nah (2020), Nah/Lavoie

5. See, for example, the recent special issues in *Metroeconomica*, 2019, 70(2) and in the *Review of Keynesian Economics*, 2020, 8(3).

6. Such as Cesaratto (2015), Cesaratto/Di Bucchianico (2020), Cesaratto et al. (2003), Dejuan (2005), Deleidi/Mazzucato (2019), Di Bucchianico (2021), Fazzari et al. (2013; 2020), Freitas/Christianes (2020), Freitas/Serrano (2015; 2017), Girardi/Pariboni (2016), Pariboni (2016) and Vieira Mandarino et al. (2020).

(2017; 2019a; 2019b) and Palley (2019) have also applied this type of model by introducing a Sraffian supermultiplier process into some variants of the Kaleckian distribution and growth models. In general terms, these models have tried to explain growth episodes through the growth of an autonomous demand component, such as autonomous consumption, residential investment, exports, or government expenditures.⁷ Kaleckian authors have also shown that autonomous demand growth can tame Harroldian instability under some weak conditions and that the paradox of thrift and the potential paradox of costs can also hold for the long-run growth path when the economy converges towards some normal rate of capacity utilisation, even if not affecting the long-run growth rate.

Sraffian supermultiplier models and the integration of autonomous demand growth into Kaleckian models have been critically discussed, in particular because of the implied full endogeneity of investment with respect to output growth in the long run – that is, fully induced investment – and it has been questioned whether any type of expenditure growth can be fully autonomous with respect to variations of income and output in the long run, for which these models have been designed (Nikiforos 2018; Skott 2019). Of course, these are valid concerns. Nonetheless, we consider an autonomous demand-led growth model driven by government expenditures as a useful starting point for the analysis of the stability of zero growth. Indeed, there are doubts regarding the long-run autonomy of (parts of) consumption, residential investment and exports with regard to output and income growth, in particular because of the endogeneity of the ability to long-term finance these expenditures independently of current income. However, these concerns are less valid for government expenditures, in particular if governments can issue debt in domestic currency, as has been argued by Hein (2018) and Hein/Woodgate (2021). Furthermore, treating private investment as fully induced by demand growth allows for an endogenous adjustment of the private sector to politically enforced zero growth, although some readers might consider this mechanism as too simple, avoiding the difficult problem of imposing zero net investment and zero retained earnings on the corporate sector.

Our autonomous demand-led growth model follows Hein (2018) and Hein/Woodgate (2021), which are among the first autonomous demand-led growth models explicitly addressing financial dynamics and stability. The dynamic model will build on the closed economy model structure developed in the previous sections. We will also introduce taxes, as in Dutt (2020), and following our requirements derived above, a balanced government budget, as in Allain (2015). To simplify the model, only taxes on capital income are considered. The model structure can thus also be presented by the balance-sheet matrix in Table 1, ignoring deposits, and by the transaction-flow matrix in Table 2, ignoring taxes on wages and potential changes in the portfolio composition in the lower part of that table.

In the short run, defined by given government-expenditures- and government-debt-capital ratios, the model may generate a goods market equilibrium with positive capital accumulation and saving rates. In the long run, however, when government-expenditures- and government-debt-capital ratios become endogenous, the model converges towards the autonomous growth rate of government expenditures, which is set equal to zero. We examine the conditions under which this long-run convergence will lead to stable equilibria for government-expenditures- and government-debt-capital ratios – and thus to a stable stationary economy with positive profits and a positive rate of interest.

In the model, the pre-tax profit share in production ($b = \Pi/Y_p$) is determined by mark-up pricing of firms in an oligopolistic goods market. With given institutional conditions in the goods market, prices are constant, and we can set the price level at $p = 1$, such

7. See Fiebiger (2018), Fiebiger/Lavoie (2019), Girardi/Pariboni (2016), Girardi et al. (2020), Perez-Montiel/Manera (2020) and Perez-Montiel/Pariboni (2021) for some empirical applications.

that nominal and real variables coincide. Since retained earnings in a stable stationary economy have to be zero, rentiers receive all the profits from production (hY_P) and the interest paid by the government on the stock of debt (iB_G). We assume that workers do not save and only rentiers, with a given tax rate (t_R), save a fraction of their net income after taxes $[(1 - t_R)(hY_P + iB_G)]$ according to their propensity to save (s_R). Furthermore, they consume a fraction of their wealth ($B_G + K$) according to their propensity to consume out of wealth (c_{RW}), which in effect lowers their saving out of current income accordingly. Normalising all variables by the firms' capital stock, such that we have a rate of capacity utilisation ($u = Y_P/K$), a government debt–capital ratio ($\lambda = B_G/K$) and a profit rate in production ($r = \Pi/K = hu$), the saving rate ($\sigma = S/K$) is given as:

$$\begin{aligned}\sigma &= s_R(1 - t_R)(hu + i\lambda) - c_{RW}(1 + \lambda) \\ &= s_R(1 - t_R)hu + \lambda[is_R(1 - t_R) - c_{RW}] - c_{RW}, \\ 0 &< s_R \leq 1, 0 < c_{RW}.\end{aligned}\tag{7}$$

Firms adjust the capital stock via net investment (I) according to the expected trend rate of growth of output and sales (α), which determines their animal spirits, such that potential output given by the capital stock grows in line with expected demand. They will slow down (accelerate) the rate of capital accumulation ($g = I/K$) whenever the actual rate of capacity utilisation falls short of (exceeds) the normal or the target rate of utilisation (u_n):

$$g = \alpha + \beta(u - u_n), \quad \beta > 0.\tag{8}$$

Government expenditures (G) for goods and services grow at a rate γ and drive our model. The government-expenditures–capital ratio ($b = G/K$) is given as:

$$b = \frac{G_0 e^{\gamma t}}{K}.\tag{9}$$

Since we assume that only rentiers' income is being taxed, the tax–capital ratio ($\tau = T/K$) is given by:

$$\tau = t_R(hu + i\lambda), \quad 0 \leq t_R < 1.\tag{10}$$

Hence, we obtain the following balanced budget condition required for stable long-run zero growth, which, for the sake of simplicity, we also assume to hold for the short run:

$$\tau = t_R(hu + i\lambda) = b + i\lambda.\tag{11}$$

In a stationary economy with a stock of government debt inherited from the past and a positive rate of interest to be paid on that debt, governments thus need a primary surplus in order to run a balanced budget.

4.1 Short-run equilibrium

In the short run, firms will vary capacity utilisation to adjust output to demand, with given government-expenditures– and debt–capital ratios. With a balanced government budget, the goods market equilibrium is given by:

$$\begin{aligned}\sigma + \tau &= g + b + i\lambda \\ \sigma &= g.\end{aligned}\tag{12}$$

The Keynesian/Kaleckian stability condition for the short-run goods market equilibrium is:

$$\frac{\partial \sigma}{\partial u} - \frac{\partial g}{\partial u} > 0 \Rightarrow s_R(1 - t_R)b - \beta > 0. \quad (13)$$

From equations (7), (8), (9), (11) and (12), we obtain the short-run goods market equilibrium rate of capacity utilisation with a balanced government budget:

$$u^* = \frac{\alpha - \beta u_n + c_{RW} + [c_{RW} - s_R(1 - t_R)i]\lambda}{s_R(1 - t_R)b - \beta}. \quad (14)$$

The corresponding short-run equilibrium values for the rate of profit and the rate of accumulation are:

$$r^* = hu^* = \frac{h\{\alpha - \beta u_n + c_{RW} + [c_{RW} - s_R(1 - t_R)i]\lambda\}}{s_R(1 - t_R)b - \beta}. \quad (15)$$

$$g^* = \frac{(\alpha - \beta u_n)s_R(1 - t_R)b + \beta\{c_{RW} + [c_{RW} - s_R(1 - t_R)i]\lambda\}}{s_R(1 - t_R)b - \beta}. \quad (16)$$

Furthermore, from the balanced budget condition in equation (11), we can get the rate of utilisation associated with this balanced budget:

$$u = \frac{b + (1 - t_R)i\lambda}{t_R b}. \quad (17)$$

From equations (14) and (17) we obtain the short-run equilibrium tax rate required for a balanced budget:

$$t_R^* = \frac{(s_R b - \beta)(b + i\lambda)}{h(\alpha - \beta u_n + c_{RW} + s_R b) + [c_{RW} b + (s_R b - \beta)i]\lambda}. \quad (18)$$

Using this equilibrium tax rate, we can rewrite our short-run equilibrium values for the rates of capacity utilisation, profit, and capital accumulation as follows:

$$u^* = \frac{\alpha - \beta u_n + c_{RW}(1 + \lambda) + s_R b}{s_R b - \beta}. \quad (19)$$

$$r^* = \frac{h[\alpha - \beta u_n + c_{RW}(1 + \lambda) + s_R b]}{s_R b - \beta}. \quad (20)$$

$$g^* = \frac{(\alpha - \beta u_n)s_R b + \beta[c_{RW}(1 + \lambda) + s_R b]}{s_R b - \beta}. \quad (21)$$

Figure 2 illustrates a possible short-run equilibrium. As can be seen, in the short run, firms' assessment of the trend rate of growth may be different from the growth rate of autonomous demand, which is set to zero here. Therefore, even if we had zero net financial balances of each sector at the normal rate of capacity utilisation (that is, a balanced government budget and consumption out of wealth exactly compensating saving out of rentiers' income), capacity utilisation would deviate from that normal rate, and capital accumulation, saving and growth may thus be positive in the short run.

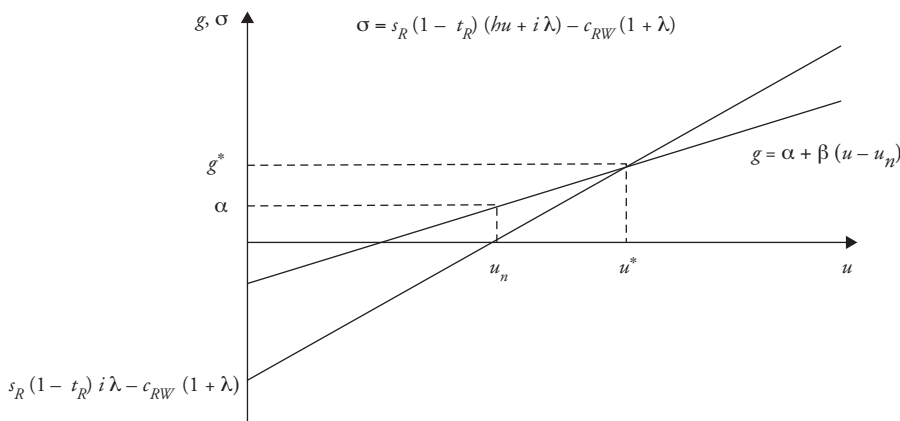


Figure 2 Short-run equilibrium

Table 3 Response of long-run stable zero growth equilibrium towards changes in exogenous variables in the short run and in the long run

	Short run			Long run				
	u^*	r^*	g^*	u^{**}	r^{**}	g^{**}	$b^{**} > 0$	$\lambda^{**} > 0$
s_R	–	–	–	0	0	0	–	+
c_{RW}	+	+	+	0	0	0	+	–
b	–	–	–	0	+	0	+/–	+
u_n	–	–	–	+	+	0	+/–	+
i	–	–	–	0	0	0	–	+
t_R	+	+	+	0	0	0	+	–
b	+	+	+					
λ	+	+	+					

Note: In the short run, there are two possible cases regarding t_R and b : In case 1, t_R is exogenous while b is endogenous, while in case 2, b is exogenous and t_R endogenous. Rows 5 and 6 represent the first case and row 7 the second case.

Table 3 contains the short-run comparative statics of our model, which are of the usual neo-Kaleckian type. The paradox of thrift holds, we have positive wealth effects on all endogenous variables, and aggregate demand is wage-led. Higher tax rates and higher government expenditures are expansionary (balanced budget multiplier) and higher interest rates are contractionary with an exogenous tax rate, as in equations (14)–(16), because of an inverse relationship with government expenditures. However, if government expenditures are exogenous, a higher interest rate has no effect, as in equations (19)–(21). A higher tax rate or higher government expenditures are expansionary; the same is true for a higher government-debt–capital ratio if government expenditures are exogenous.

4.2 Long-run equilibrium

In the long run, following Dutt’s (2019; 2020) proposal of ‘rational’ or – more appropriately expressed – ‘reasonable’ expectations on behalf of firms, expectations about the trend

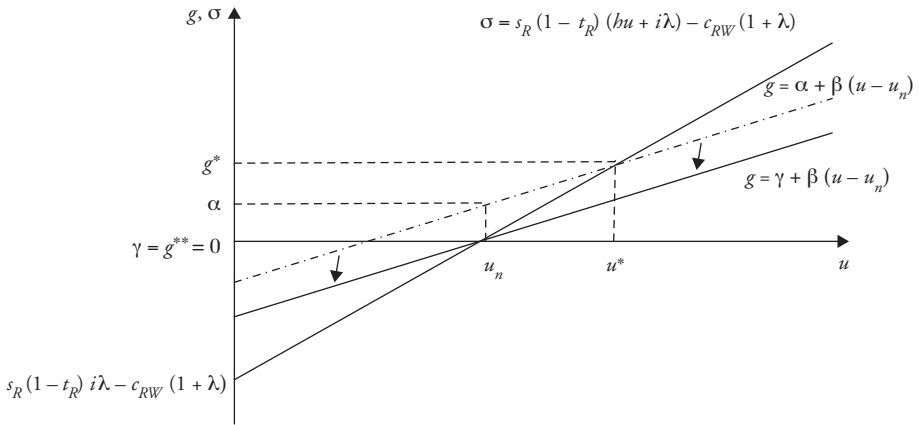


Figure 3 Long-run equilibrium

rate of growth of the economy adjust to the autonomous growth rate of government expenditures, equal to zero in our model economy:

$$\alpha = \gamma = 0. \tag{22}$$

We should thus see an adjustment of the goods market equilibrium toward the normal rate of capacity utilisation and the autonomous growth rate of government expenditures, as shown in Figure 3.

For the long-run equilibrium, we have to consider that the government-expenditures– and debt–capital ratios are endogenous. Their time rates of change $\dot{x} = \partial x / \partial t$ are given as:

$$\dot{b} = b(\gamma - g) = b[\gamma - \alpha - \beta(u^* - u_n)]. \tag{23}$$

$$\dot{\lambda} = b + i\lambda - \tau - \lambda g. \tag{24}$$

A balanced budget ($b + i\lambda - \tau = 0$) turns equation (24) into:

$$\dot{\lambda} = -\lambda g = -\lambda[\alpha + \beta(u^* - u_n)]. \tag{25}$$

For the long-run equilibrium, we need $\dot{b} = 0$ and $\dot{\lambda} = 0$ in equations (23) and (25). This generates the following trivial long-run equilibrium, with r_n as the normal rate of profit, that is, the rate of profit at normal capacity utilisation:

$$u^{**} = u_n. \tag{26}$$

$$r^{**} = hu_n = r_n. \tag{27}$$

$$g^{**} = \gamma = 0. \tag{28}$$

$$b^{**} = 0. \tag{29}$$

$$\lambda^{**} = 0. \tag{30}$$

However, we can also derive more meaningful long-run equilibria for our model in which we have positive government-expenditures– and debt–capital ratios. Plugging the long-run

equilibrium rate of capacity utilisation from equation (26) into the short-run goods market equilibrium rate of capacity utilisation from equation (14) gives:

$$u_n = \frac{\alpha + c_{RW} + [c_{RW} - s_R(1 - t_R)]\lambda}{s_R(1 - t_R)h}. \quad (31)$$

Rearranging, and including the long-run requirement of a stationary economy ($\alpha = \gamma = 0$), provides the long-run equilibrium government-debt-capital ratio:⁸

$$\lambda^{**} = \frac{s_R(1 - t_R)hu_n - c_{RW}}{c_{RW} - s_R(1 - t_R)i}. \quad (32)$$

Furthermore, from the balanced budget condition in equation (11), using equations (26) and (32), we obtain:

$$b^{**} = t_R hu_n - (1 - t_R)i\lambda^{**} = t_R hu_n - \frac{(1 - t_R)i[s_R(1 - t_R)hu_n - c_{RW}]}{c_{RW} - s_R(1 - t_R)i}. \quad (33)$$

In what follows, we will examine the dynamic stability of the non-zero equilibria in equations (32) and (33), making use of the dynamic equations (23) and (25) and the short-run goods market equilibrium in equation (19). The corresponding Jacobian matrix is given by:

$$\mathbf{J} = \begin{pmatrix} \frac{\partial \dot{b}}{\partial b} & \frac{\partial \dot{b}}{\partial \lambda} \\ \frac{\partial \dot{\lambda}}{\partial b} & \frac{\partial \dot{\lambda}}{\partial \lambda} \end{pmatrix}. \quad (34)$$

Evaluated at the long-run equilibrium values b^{**} and λ^{**} , we get:

$$\frac{\partial \dot{b}}{\partial b} = \frac{-\beta s_R b^{**}}{s_R h - \beta}. \quad (23a)$$

$$\frac{\partial \dot{b}}{\partial \lambda} = \frac{-\beta c_{RW} b^{**}}{s_R h - \beta}. \quad (23b)$$

$$\frac{\partial \dot{\lambda}}{\partial b} = \frac{-\beta s_R \lambda^{**}}{s_R h - \beta}. \quad (25a)$$

$$\frac{\partial \dot{\lambda}}{\partial \lambda} = \frac{-\beta c_{RW} \lambda^{**}}{s_R h - \beta}. \quad (25b)$$

For the local stability in this 2×2 dynamic system, the trace of the Jacobian has to be negative and the determinant needs to be non-negative. For our system we get:

$$Tr \mathbf{J}^{**} = \frac{\partial \dot{b}}{\partial b} + \frac{\partial \dot{\lambda}}{\partial \lambda} = \frac{-\beta s_R b^{**}}{s_R h - \beta} + \frac{-\beta c_{RW} \lambda^{**}}{s_R h - \beta} = \frac{-\beta(s_R b^{**} + c_{RW} \lambda^{**})}{s_R h - \beta}. \quad (35)$$

8. The same results can be derived by starting from the goods market equilibrium formulation in equation (19) together with equation (11) for the balanced government budget and equation (26) for the long-run equilibrium rate of capacity utilisation.

$$Det\mathbf{J}^{**} = \frac{\partial \dot{b}}{\partial b} \frac{\partial \dot{\lambda}}{\partial \lambda} - \frac{\partial \dot{b}}{\partial \lambda} \frac{\partial \dot{\lambda}}{\partial b} = 0. \tag{36}$$

A determinant equal to zero implies that we have a zero root model, with a continuum of locally stable equilibria, which means that our long-run equilibrium government-expenditures– and debt–capital ratios are path-dependent. Since $s_R b - \beta > 0$ has to hold for short-run goods market equilibrium stability, positive long-run equilibrium values for the government-expenditures– and debt–capital ratios b^{**} and λ^{**} ensure that $Tr\mathbf{J}^{**} < 0$, such that we have a stable long-run equilibrium.

We thus have to look at the conditions for positive equilibrium values for b^{**} and λ^{**} in equations (32) and (33). For $\lambda^{**} > 0$ in equation (32), we need:

$$s_R(1 - t_R)hu_n > c_{RW} > s_R(1 - t_R)i \quad \Rightarrow \quad r_n > \frac{c_{RW}}{s_R(1 - t_R)} > i \tag{32a}$$

or

$$s_R(1 - t_R)hu_n < c_{RW} < s_R(1 - t_R)i \quad \Rightarrow \quad r_n < \frac{c_{RW}}{s_R(1 - t_R)} < i. \tag{32b}$$

Since condition (32b) implies that the rate of interest on safe government bonds exceeds the rate of profit in production, which will make production difficult to sustain, given the ‘risks and troubles’ involved here, we will continue with condition (32a).

In order for λ^{**} and b^{**} to assume positive values in equation (33) it is necessary that $\frac{t_R hu_n [c_{RW} - s_R(1 - t_R)i] - (1 - t_R)i [s_R(1 - t_R)hu_n - c_{RW}]}{c_{RW} - s_R(1 - t_R)i} > 0$, which implies:

$$\frac{c_{RW} t_R hu_n}{(1 - t_R)(s_R hu_n - c_{RW})} > i \Rightarrow \frac{c_{RW}}{s_R(1 - t_R)} > \frac{i r_n}{t_R r_n + (1 - t_R)i} = \frac{i}{t_R + (1 - t_R)i/r_n}. \tag{33a}$$

Since $r_n > i$ implies that $\frac{i}{t_R + (1 - t_R)i/r_n} > i$, for positive and stable long-run equilibria for both b^{**} and λ^{**} in a stationary economy, we need:

$$s_R(1 - t_R)hu_n > c_{RW} > \frac{s_R(1 - t_R)ihu_n}{t_R r_n + (1 - t_R)i}, \tag{37}$$

which is equivalent to:

$$hu_n > \frac{c_{RW}}{s_R(1 - t_R)} > \frac{ihu_n}{t_R hu_n + (1 - t_R)i} \quad \Rightarrow \quad r_n > \frac{c_{RW}}{s_R(1 - t_R)} > \frac{i}{t_R + (1 - t_R)i/r_n}. \tag{38}$$

The normal rate of profit – that is, the rate of profit at normal capacity utilisation – has to exceed the rate of interest scaled by the denominator in equation (38), in order to allow the propensity to consume out of wealth relative to the rentiers’ propensity to save out of their net income to assume a value consistent with stable long-run equilibrium.

The comparative dynamics for changes in the long-run equilibrium with respect to exogenous parameters are also summarised in Table 3. In the long run, utilisation is given by the normal rate and capital accumulation and growth by the zero growth rate of autonomous government expenditures. Of course, a higher target rate of utilisation raises the long-run equilibrium rate of capacity utilisation, and a higher profit share raises the long-run equilibrium profit rate. The propensities to save out of rentiers’ income and

to consume out of wealth, as well as the interest rate and the tax rate, have no effect on the long-run equilibrium rates of utilisation and accumulation, and only affect long-run equilibrium government-expenditures– and debt–capital ratios, usually in opposite directions.

5 CONCLUSIONS

In this paper we started with the assumption that zero growth may emerge as a possibility to tackle the climate crisis and other environmental constraints. After a short review of some of the related literature, we tried to contribute to the debate about long-run stability of zero growth with positive profits and a positive rate of interest in a capitalist, monetary production economy. We have focused on the stability of the goods market equilibrium and on the prevention of systemic financial instability, in the sense of cumulative increases in financial-assets– or financial-liabilities–income ratios, for a closed economy without technical change. Whereas the stable goods market equilibrium requires sufficient demand generation to sustain a constant level of production and income, systemic financial stability requires zero financial balances of each macroeconomic sector. This implies that a corporate sector with zero net investment does not retain any profits, that saving of private households out of income is exactly balanced by consumption out of wealth, and that the government budget runs a balanced budget in the long run.

We have analysed the requirements for zero growth from a national income accounting perspective, and we have shown that zero growth, positive profits and a positive rate of interest are consistent with each other, provided that rentiers' consumption is positive. Then we complemented this analysis and supported our results with a monetary circuit approach showing that endogenous credit generation (and destruction) is compatible with zero growth, positive profits and a positive rate of interest. Of course, none of these approaches contains behavioural equations, which allow us to analyse the dynamic adjustment towards a zero growth equilibrium.

Therefore, in the final step we analysed the short- and long-run stability of zero growth within a Kaleckian autonomous demand-led growth model. In this model, net investment responds to deviations of capacity utilisation from target utilisation in the short run, but adjusts to firms' sales growth expectations determined by autonomous government-expenditure growth in the long run. For the sake of simplicity, we have assumed that governments balance their budget not only in the long run, but also in the short. In the long run, the autonomous growth rate of government expenditures – set equal to zero – determines the growth rate of the system. For stable adjustment of government-expenditures–capital and government-debt–capital ratios to their positive long-run equilibrium values we have derived that the rate of interest has to be below the normal rate of profit and that the propensity to consume out of wealth relative to the rentiers' propensity to save out of their net income has to be in a corridor defined by the normal rate of profit and the rate of interest. Within these limits, stable zero growth with positive profits and a positive rate of interest are thus possible. However, these conditions are quite restrictive, because they also require balanced government budgets and zero retained profits of the corporate sector, as we have assumed throughout the model analysis.

Of course, our analysis has only addressed some very basic issues. The analysis was limited to a closed economy, but the basic principles could be applied to an open economy too. Furthermore, we have only addressed goods market and systemic financial stability in a one-good economy without technological change. Issues of structural change (also in an international dimension), technical progress, and maintaining full employment under these conditions have not been tackled. These issues, in our view, are important for

overall macroeconomic stability and for the traverse towards a sustainable economy, in particular. Moreover, despite showing the conditions for stability, we did not delve into the political feasibility of our findings. We have shown that a stable zero-growth economy with positive profits and a positive interest rate is possible. However, meeting the related conditions might imply a significant transformation of capitalism as we know it; to what degree remains open for further debate.⁹ Our contribution is thus rather modest and basic, but we hope to have contributed to a clarification of these basic concerns.

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9. See Herr (2022) for an attempt at outlining some institutional requirements based on the works of Keynes and Schumpeter.

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