Labor market stability in a zero-growth economy: a post-Keynesian perspective

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Abstract
Although traditionally post-Keynesians tackle unemployment issues through the stimulation of aggregate demand, boosting demand indefinitely is no longer possible if we consider environmental constraints. In fact, according to several ecological economists, meeting the environmental targets of the Paris agreements will involve a halt in economic growth or even degrowth. Within this context, it is argued that important interventions in the labor market will be necessary to avoid rising unemployment. In this paper, we consider the dynamic stability of the labor market in a zero-growth economy (ZGE) with productivity growth in a Kaleckian autonomous demand-led growth model. In the model, net investment responds to deviations of capacity utilization from target utilization in the short run, but in the long run, it adjusts to firms' sales growth expectations determined by autonomous government expenditures growth. In the long run, the autonomous growth rate of government expenditures – set initially equal to zero – determines the growth rate of the system and the rate of capacity utilization converges towards the normal rate of capacity utilization. We examine the conditions under which the long-run convergence leads to a stable employment rate. In the basic model, however, the long-run conditions necessary for a stable employment rate are not met, suggesting, as already pointed out by ecological economists and several post-Keynesians, that policy interventions are necessary for the stability of the labor market in a ZGE. Hence, we consider whether the government is able to stabilize the labor market by endogenizing the growth rate of autonomous spending, which instead of converging to zero in the long run, will respond to deviations of the employment rate from a previously established target.

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1. Introduction

Evidence suggests that if we are to respect carbon budgets and meet the Paris agreements of a maximum of 1.5 or 2 degrees Celsius increase in mean global temperature above pre-industrial levels, economies will have to go through a process of degrowth in throughput (Hickel and Kallis, 2019). The current levels of decoupling of economic growth from negative environmental impacts are far too low to make the reduction in throughput compatible with ever-expanding economies. Therefore, many ecological economists argue that the socio-ecological transition will likely entail zero growth or degrowth in GDP. The latter highlights the importance of understanding zero-growth economies as well as degrowing economies and analyzing the conditions under which the overall macroeconomic stability of such economies can be sustained.

Although economic growth is to a large extent considered a systemic need of capitalism, there is an increased interest in analyzing whether there is in fact a growth imperative[1]. In this respect, Richters and Siemoneit (2017) have shown that a stationary economy can be compatible with positive interest rates and positive profits. However, for such an economy to be stable, several strict conditions must be met, which would involve a transformation of capitalism as we know it. Specifically, no sector can run financial deficits or surpluses, implying that there are no retained profits in the corporate sector, governments must run a balanced budget, and saving out of household income must be compensated for by consumption out of wealth or some other autonomous consumption. In an open economy, a current account balance is also necessary. Only by meeting these conditions can systemic financial fragility and instability in the sense of rising debt-income ratios be prevented. Similarly, Hein and Jimenez (2022) clarify in a stepwise process that a stationary state that meets the conditions just mentioned is compatible with positive profits, endogenous credit, and a positive interest rate. Furthermore, they examine the conditions under which a stationary equilibrium is dynamically stable in a Kaleckian distribution and growth model driven by autonomous government demand.

These are some important initial contributions to the understanding of zero-growth economies and their stability. However, the focus has been placed on the goods market and the systemic financial stability, while, to our knowledge, the dynamic stability of the labor market in a zero-growth economy has not been explored. Yet the importance of tackling this issue is largely recognized. In fact, according to Richters and Siemoneit (2017), most theories of a growth imperative can be reduced to the issue of 'jobs' or more generally, 'income through gainful work'.

[1] A growth imperative can be understood as "a system immanent mechanism that the economy has to grow to maintain economic stability" (Richters and Siemoneit, 2017, p.2)

Moreover, the challenge of keeping employment stable in a zero-growth economy is widely recognized in the degrowth community and in general, ecological economists have acknowledged the core relevance of the labor market in the socio-ecological transition. Jackson and Victor (2011) call the relationship between growth, productivity, and work, central in the study of what they then called macroeconomics for sustainability. Particularly for a zero-growth economy, they emphasize the importance of reconciling labor productivity growth with full employment.

Given that economic growth has been often seen as necessary to reduce unemployment levels (Rezai et al. 2013, Scrieciu et al. 2013), post-Keynesian economists have also expressed concern about the levels of employment associated with zero growth or degrowth (Fontana and Sawyer, 2014). Following post-Keynesian logic, if economies could grow indefinitely, it would still be possible to boost aggregate demand and thus tackle unemployment issues. However, as soon as aggregate demand stagnates, so does the demand for labor, leading to what Jackson and Victor (2011) call the 'productivity trap' with rising unemployment. Hence, post-Keynesian economists have argued that policy interventions such as reduction in working hours will be essential for the stability of the labor market (Fontana and Sawyer, 2014, 2016).

Within this framework, this paper aims at analyzing the dynamic stability of the labor market in a zero-growth economy with productivity growth. Thus, the key question is whether an economy with a stagnant demand and increasing productivity can be compatible with a stable long-run employment path. First, we will explore whether the inclusion of feedback effects between productivity growth, the employment rate, and distribution allows for a dynamically stable labor market, without the need of government interventions. Second, we consider a scenario where the government takes the task of stabilizing the labor market upon itself. To do so, a post-Keynesian perspective is considered. In section 2, after briefly clarifying how post-Keynesians treat labor market issues, we analyze the implications of zero growth on the labor market from an accounting perspective. In section 3, we discuss the integration of productivity growth into the analysis of zero-growth economies and present an autonomous demand-led growth model driven by government expenditures in section 4, where we explore if a stationary economy can be compatible with a stable employment rate.

2. The implications of zero growth for the labor market: a post-Keynesian approach

Post-Keynesian economists have increasingly tried to integrate ecological constraints into their analytical framework. To do so they have resorted extensively to ecological economics, increasing the exchange between both schools of thought. According to Kronenberg (2010), these approaches share a lot of common ground when it comes to the understanding of the macroeconomy, making the exchange of ideas possible.

However, as pointed out by Strunk et al (2022) when it comes to labor issues, there is still work to do to integrate post-Keynesian economics (PKE) and ecological economics.

To analyze the stability of the labor market in a zero-growth economy from a post-Keynesian perspective, it must be stressed that the labor market in PKE is not a market in a Walrasian sense. Instead, post-Keynesians concentrate on the role of aggregate demand in the determination of output and thus they emphasize the importance of high levels of demand to keep unemployment levels low. This is because labor demand, which determines the level of employment, is derived demand coming from the goods market, while labor supply is either not modeled explicitly, which is usually the case if an economy is operating below full capacity, or, it is assumed that demand will create its own supply (Strunk et al, 2022). Therefore, the demand-side focus of PKE often leaves the labor market as a residual and not as a the locus for policy intervention (Strunk et al, 2022).

Thus, although PKE is interested in issues around labor such as structural unemployment and functional income distribution, it lacks a unified theory of the labor market and the focus is commonly placed on the stimulation of product demand. However, the latter becomes problematic once ecological constraints are integrated, as can be illustrated from a macroeconomic accounting perspective. Assuming that economies have a target level of output (Y^T) that respects ecological constraints, as in Hein and Jimenez (2022) or similarly, which is compatible with a sustainable ecological footprint, as in Fontana and Sawyer (2022), we can decompose this level of output in the following way:

$$Y^T = \frac{Y}{H}\frac{H}{N}\frac{N}{L}L = ynEL. \qquad (1)$$

where y is labor productivity, given by the ratio of output (Y) to hours worked (H), n is the number of hours worked per employee, given by the ratio of hours worked (H) to the number of employees (N), and E is the employment rate, given by the ratio of the number of employees to the labor force (L). Rearranging, we obtain that the employment rate is equal to:

$$E = \frac{N}{L} = \frac{Y^T}{ynL} \qquad (2)$$

Following equation (2), to avoid rising unemployment in a stationary economy and thus preserve the stability of the labor market, we must find ways to align the labor demand generated by stationary output with the labor supply. Expressing equation (2) in growth rates, we get that:

$$\hat{E} = \hat{Y} - \hat{l} - \hat{n} - \hat{y} \qquad (3)$$

Hence, it is evident that if the economy is fixed at the target level of output (that is, $\hat{Y} = 0$), the employment rate will fall as productivity, population, and working time per employee grow. Therefore, in a scenario of rising productivity, if we want to avoid increasing unemployment, we must either reduce working hours, prevent productivity rises, or find ways to reduce the need to work (hence a smaller labor force).

Given the latter, a central argument in ecological economics is that if we want to achieve a stable socio-ecological transition, a substantial reform in wage labor is necessary and thus labor market issues and interventions play a central role in their analysis. Following Weiss and Cattaneo (2017), policies such as a reduction in working time could even be the single silver bullet in the transition. Other authors have advocated for similar policies such as basic income, basic services, and work sharing as alternatives to decouple labor and income (Andersson, 2010; Zwickl et al, 2016; Howard et al, 2019). Regarding a possible reduction in productivity or at least to prevent rises in it, the literature suggests a process of structural change, (for example Jackson and Victor, 2011) with the shrinking brown sectors and promotion of green labor-intensive sectors.

Post-Keynesian economists, in their efforts to consider ecological constraints, have also recognized the importance of labor market interventions in the face of an ecological transition. Fontana and Sawyer (2014, 2016) argue that there are no automatic market forces that align a growth rate consistent with a sustainable ecological footprint with the growth rate of labor supply, and therefore interventions are necessary to reduce the growth in the effective labor force (such as reductions in annual working hours or the length of working life). They argue that this necessary adjustment can be achieved through employment legislation regarding the length of the working week, trade union bargaining, and norms set by the public sector employment (Fontana and Sawyer, 2022). Similarly, Lange (2018) finds that although post-Keynesian theory can be compatible with zero growth, in a scenario with technological change, reductions in working hours and compensatory wage increases will be necessary to avoid rising unemployment. However, these authors are not performing a dynamic stability analysis of the labor market, as intended in this paper. Furthermore, they don't discuss in detail the feedback effects between the employment rate and other variables, which could potentially help stabilize the labor market in the long run.

3. Productivity growth in a zero-growth economy

Several models dealing with zero-growth economies assume a non-depreciating capital stock, which implies that issues of technological change and productivity growth are avoided (as is the case in Monserand, 2019; Hein and Jimenez, 2022). Since investment leads to the introduction of new technologies, if we assume a non-depreciating capital stock in a zero-growth economy, where by definition, net investment is zero, the channel to introduce technological change is eliminated by assumption. However, by considering capital scrapping and depreciation, the story changes. If economies wish to maintain the capital stock at a certain level, the depreciated capital must eventually be replaced. Therefore, it is through capital scrapping, i.e. replacement investment, that technical change is introduced.

Assuming that technical progress is labor-saving and capital embodied, as the capital is scrapped and replaced, labor productivity will increase, and the labor-output ratio fall. In other words, we would be assuming Harrod-neutral technical change as in Cassetti (2003), Dutt (2003), and Hein and Tarassow (2010), which will have important implications for the labor market, given that in a zero-growth economy, labor productivity gains are not offset with economic growth. Therefore we expect unemployment to rise, assuming everything else equal (see equation (2)).

From the previous paragraphs, it becomes clear that labor productivity is positively affected by the dynamics of the capital stock. Therefore, we will consider (gross) capital accumulation as one of the determinants of productivity growth. Furthermore, following authors such as Casetti (2003), Naastepad (2006), and Hein and Tarassow (2010), we can also consider a wage-push variable as a determinant of productivity growth. The argument is that with a low (high) rate of unemployment, we expect an increasing (decreasing) bargaining power of the workers, hence nominal and real wages will speed up (slow down), generating pressure towards an increasing (decreasing) wage share and therefore a decreasing (increasing) profit share. Since in a zero-growth economy with productivity growth we expect, ceteris paribus, a falling employment rate, we will likely have a negative feedback effect from rising unemployment, and therefore an increasing profit share, on productivity growth.

In the following section, an autonomous demand-led growth model is presented. First, we will show that the model considering feedback effects does not produce a stable path for the employment rate. Second, we introduce a new mechanism into the model; the government as a stabilizing force by endogenizing the growth of autonomous spending and subsequently derive the steady state and analyze its stability.

4. Autonomous demand-led growth model

Taking into account the properties of a stationary economy from an accounting perspective mentioned in the introduction and discussed in detail in Richters and Siemoneit (2017) and Hein and Jimenez (2022), we proceed to integrate them into a dynamic model for a zero-growth economy with productivity growth. We will consider an autonomous demand-led growth model to analyze the dynamic stability of the labor market in a stationary economy. Autonomous demand-led growth models have become popular in heterodox macroeconomics and have been recently merged with Kaleckian distribution and growth models. The models are based on Serrano's (1995a, 1995b) Sraffian supermultiplier model driven by autonomous demand and have been further developed and applied by Sraffian as well as Kaleckian authors[2]. Broadly speaking, these

[2] Sraffian authors such as Such as Cesaratto (2015), 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.

models have been useful to explain growth periods through the growth of an autonomous demand component, such as autonomous consumption, government expenditures, residential investment, or exports. They have also been useful to Kaleckian authors who have shown that autonomous demand growth can tame Harrodian instability under some weak conditions. Moreover, they have shown that when the economy convergences towards some normal rate of capacity utilization, the paradox of thrift and the potential paradox of costs hold for the long-run growth path, even if not affecting the long-run growth rate.

Although the models have been subject to some criticism, such as the implied full endogeneity of investment with respect to output growth in the long run, that is, fully induced investment, and the full autonomy of expenditure growth from income and output in the long run (Nikiforos, 2018; Skott, 2019), an autonomous demand-led growth model is a useful starting point for the analysis of the stability of a zero-growth economy, as stressed by Hein and Jimenez (2022). Considering private investment as fully induced by demand growth allows us to have an endogenous adjustment of the private sector to a politically enforced zero growth. Although it can be considered a very simple mechanism, it prevents the problem of imposing zero net investment on the corporate sector. When it comes to the concerns about the full long-run autonomy of parts of consumption, such as residential investment and exports, these are less valid for government expenditures, as also recognized by Hein (2018) Hein and Woodgate (2021).

Hence, in this section, we consider a closed economy model, with taxes, as in Dutt (2020) a balanced government budget, as in Allain (2015), and depreciation and capital scrapping and replacement, as in Hein (2019). For simplicity, only taxes on capital income are considered. In the short run, characterized by a given distribution, the model can generate a goods market equilibrium with positive capital accumulation and profit rates. In the long run, we first consider a scenario with endogenous productivity and distribution. The model converges towards the autonomous growth rate of government expenditures, which for this stationary economy, is initially exogenous and equal to zero. We then examine if the long-run convergence can lead to a stable employment rate. Subsequently, we consider a version of the model with an endogenous autonomous component. This version represents one where the duty of stabilization falls upon the government through fiscal policy.

As usual in Kaleckian models, the pre-tax profit rate in production ($h=\Pi/Y_P$) is determined by mark-up pricing of firms in an oligopolist goods market. We assume constant prices, that is, we can set the price level at p=1 such that nominal and real variables are the same. In the short run, the mark-up is fixed and therefore we have a given distribution. In the long run, we integrate distributional dynamics into the model,

(2020) and Kaleckian authors such as Allain (2019, 2021), Dutt (2019, 2020), Hein (2018), Hein/Woodgate (2021), Lavoie/Nah (2020), Nah/Lavoie (2017, 2019a, 2019b) and Palley (2019) as will be explained in subsection 4.2. Given that retained earnings in a stable stationary economy must be zero, rentiers receive all the profits from production (hY_P). By assumption, only rentiers save a fraction of their net income, according to their propensity to save (s_R). They also consume a fraction of their wealth according to their propensity to consume out of wealth (c_{RW}), lowering their saving out of current net income [$(1-t_R)(hY_P)$] accordingly. Since we also introduce depreciation of the capital stock (δ), we obtain the following saving rate ($\sigma = \frac{S}{K}$), after normalizing all variables by the firms' capital stock:

$$\sigma = \frac{S}{K} = s_R(1 - t_R)(hu) - c_{RW} + \delta, \;\; 0 < s_R \leq 1, \; 0 < c_{RW}, \delta \geq 0 \quad (4)$$

where $u = Y_P/K$ is the rate of capacity utilization. The gross investment function (I) includes net investment and replacement investment determined by capital scrapping (ρ). Firms adjust the capital stock through net investment according to their expected trend rate of output and sales (α) and they slow down the rate of capital accumulation (g) when the actual rate of capacity utilization (u) is below the normal rate (u_n):

$$g = \frac{I}{K} = \alpha + \beta(u - u_n) + \rho, \;\; \beta > 0, \; \rho \geq 0 \quad (5)$$

Government expenditures (G) for goods and services drive our model and grow at a rate γ. The government expenditures-capital ratio (b) is given by:

$$b = \frac{G_0 e^{\gamma t}}{K} \quad (6)$$

Given that only rentiers' income is taxed, we have the following tax-capital ratio:

$$\tau = t_R hu \quad (7)$$

Hence, we obtain the balanced budget condition required for stable long-run zero growth:

$$\tau = t_R hu = b \quad (8)$$

For simplicity, we assume this condition to hold also in the short-run. Taking into account the determinants of productivity discussed in section 3 yields the following productivity growth function:

$$\hat{y} = f(g, h) = a_0 + \varepsilon g - \theta h \quad (9)$$

Productivity growth is thus positively affected by capital accumulation and negatively by the profit share. As can be seen in equation (9), a change in the profit share has a unique inverse relationship with productivity growth.

2.1 Short-run equilibrium

In the short run, firms adjust output to demand by varying capacity utilization, with a given government expenditures-capital ratio and a given distribution. Assuming a balanced budget, the goods market equilibrium is given by:

$$\sigma + \tau = g + b \qquad (10)$$
$$\sigma = g$$

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

$$\frac{\partial \sigma}{\partial u} - \frac{\partial g}{\partial u} > 0 \Longrightarrow s_R(1 - t_R)h - \beta > 0 \qquad (11)$$

From equations (4), (5), and (10) we obtain the short-run goods market equilibrium rate of capacity utilization with a balanced government budget:

$$u^* = \frac{\alpha - \beta u_n + c_{WR} + \rho - \delta}{s_R(1 - t_R)h - \beta} \qquad (12)$$

as well as the short-run equilibrium values for the accumulation, profit rate, and productivity growth:

$$g^* = \frac{(\alpha - \beta u_n)\, s_R(1 - t_R)h + \beta(c_{WR} + \rho - \delta)}{s_R(1 - t_R)h - \beta} \qquad (13)$$

$$r^* = h[\frac{\alpha - \beta u_n + c_{WR} + \rho - \delta}{s_R(1 - t_R)h - \beta}] \qquad (14)$$

$$\hat{y}^* = a_0 + \varepsilon[\frac{(\alpha - \beta u_n)\, s_R(1 - t_R)h + \beta(c_{WR} + \rho - \delta)}{s_R(1 - t_R)h - \beta}] - \theta h \qquad (15)$$

In the short run, firms' assessment of the trend rate of growth may deviate from the growth rate of autonomous demand. Therefore, even if we had zero net financial balances of each sector at the normal rate of capacity utilization (i.e. a balanced government budget and consumption out of wealth exactly compensating for saving out of rentiers' income), in the short run, capacity utilization can deviate from the normal rate, and capital accumulation, saving and growth may be positive.

Furthermore, we can obtain the rate of utilization associated with the balanced budget condition in equation (8):

$$u = \frac{b}{t_R h} \qquad (16)$$

Hence from equations (12) and (16), we obtain the tax rate required for a balanced budget:

$$t_R = \frac{(s_R h - \beta) b}{h(\alpha - \beta u_n + c_{WR} + \rho - \delta + b\, s_R)} \tag{17}$$

Making use of equation (17), the short-run equilibrium values for capacity utilization, the profit rate, capital accumulation, and productivity growth can be rewritten as follows:

$$u^* = \frac{\alpha - \beta u_n + c_{WR} + s_R b + \rho - \delta}{s_R h - \beta} \tag{18}$$

$$r^* = \frac{h[\alpha - \beta u_n + c_{WR} + s_R b + \rho - \delta]}{s_R h - \beta} \tag{19}$$

$$g^* = \frac{s_R h(\alpha + \rho - \beta u_n) + \beta(c_{WR} + s_R b - \delta)}{s_R h - \beta} \tag{20}$$

$$\hat{y}^* = a_0 + \varepsilon \left[\frac{s_R h(\alpha + \rho - \beta u_n) + \beta(c_{WR} + s_R b - \delta)}{s_R h - \beta}\right] - \theta h \tag{21}$$

The comparative statics of the model in the short-run, summarized in table 1, are as expected in a Kaleckian model; we have the paradox of thrift, positive wealth effects on all the endogenous variables, and wage-led demand. Higher taxes and government expenditures are expansionary (balanced budget multiplier). Higher scrapping leads to higher capital accumulation and hence higher productivity growth.

Table 1: Response of the short-run equilibrium towards changes in exogenous variables

	u^*	r^*	g^*	$\hat{y}^*$
s_R	-	-	-	-
c_{WR}	+	+	+	+
h	-	-	-	-
u_n	-	-	-	-
t_R	+	+	+	+
b	+	+	+	+
δ	-	-	-	-
ρ	+	+	+	+

4.2 Long-run equilibrium without government intervention

In the long run, we follow Dutt's (2019, 2020) proposal of 'rational' or—more appropriately expressed—'reasonable' expectations on behalf of the firms, which means that expectations about the trend rate of growth of the economy adjust to the autonomous growth rate of government expenditures, equal to zero in our model economy:

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

Hence, there should be an adjustment of the goods market equilibrium toward the normal rate of capacity utilization and the autonomous growth rate of government expenditures. For the long-run equilibrium, we have to consider that distribution and productivity are endogenous. To endogenize distribution in the long run, we follow Dutt (2012), who, based on Kalecki (1943), discusses four main determinants of the mark-up, and therefore distribution: industrial concentration, sales promotion activities, increases in overhead costs, and power of the trade unions. To study a zero-growth economy with productivity increases, we will concentrate on the power of the trade unions as a determinant of distribution. In other words, we will consider labor market dynamics as a determinant of the bargaining power of workers. The argument is that powerful firms can affect the markup, tending to increase the profit share and affecting negatively their efforts to increase productivity.

According to Dutt (2012), there are two ways to endogenize labor market conditions. The first one is the 'growth formulation', which assumes that increases in the real wage are a result of employment growing faster than the labor supply. The second one, called the 'level formulation' links wage dynamics to the unemployment rate. Since in a zero-growth economy, productivity growth will lead to, ceteris paribus, higher unemployment (see equation 3), in this model we will consider the level formulation in the long run. This formulation implies that changes in the real wage depend negatively on the unemployment rate, which dynamically can be expressed in terms of the profit share and the employment rate, e, with the equation:

$$\dot{h} = \xi(E_o - E) \tag{23}$$

Where ξ is a speed of adjustment parameter, E_o is the employment rate at which the real wage is stationary, and E is the employment rate, which following Taylor et al (2016), will be expressed as a positive function of capital accumulation and a negative function of productivity:

$$E(\hat{y}, g*), \frac{\partial E}{\partial g} > 0 \qquad (24a)$$

Or equivalently, given equation (28):

$$E(\hat{y}, \gamma, \rho), \frac{\partial E}{\partial \hat{y}} < 0, \frac{\partial E}{\partial \gamma} > 0, \frac{\partial E}{\partial \rho} > 0 \qquad (24b)$$

Furthermore, following equation (9), the time rate of change in labor productivity is given by:

$$\dot{y} = y\hat{y} = y(a_0 + \varepsilon g - \theta h) = y(a_0 + \varepsilon[\alpha + \beta(u - u_n) + \rho] - \theta h) \quad (25)$$

For the long-run equilibrium, we need $\dot{\mathrm{h}} = 0, \dot{\mathrm{y}} = 0$ in equations (23) and (25). We obtain the following long-run equilibrium:

$$E^{**} = E_o \qquad (26)$$

$$\hat{y}^{**} = 0 \Longrightarrow \varepsilon g = \theta h - a_0 \qquad (27)$$

Since $u = u_n$, then in the long run we have that:

$$g = \gamma + \rho = \rho \qquad (28)$$

Hence, we can rewrite (27) as follows:

$$h^{**} = \frac{a_0 + \varepsilon\rho}{\theta} \qquad (29)$$

In what follows, we will examine the dynamic stability of the equilibria in equations (26) and (29) making use of the dynamic equations (23) and (25) and the short-run goods market equilibrium in equation (18). The corresponding Jacobian matrix is given by:

$$J = \begin{bmatrix} \frac{\partial \dot{h}}{\partial h} & \frac{\partial \dot{h}}{\partial y} \\ \frac{\partial \dot{y}}{\partial h} & \frac{\partial \dot{y}}{\partial y} \end{bmatrix} \qquad (30)$$

We have that:

- $\frac{\partial \dot{h}}{\partial h} = -\xi \frac{\partial E}{\partial g} \frac{\partial g}{\partial u} \frac{\partial u}{\partial h}$
- $\frac{\partial \dot{h}}{\partial y} = 0$

- $\frac{\partial \dot{y}}{\partial h} = -y[\varepsilon\beta \frac{\partial u}{\partial h} + \theta]$
- $\frac{\partial \dot{y}}{\partial y} = \hat{y}$

Therefore, substituting in the Jacobian matrix, we obtain:

$$J = \begin{bmatrix} -\xi \frac{\partial E}{\partial g} \frac{\partial g}{\partial u} \frac{\partial u}{\partial h} & 0 \\ -y[\varepsilon\beta \frac{\partial u}{\partial h} + \theta] & \hat{y} \end{bmatrix} \quad (31)$$

For the local stability of this 2x2 dynamic system, the trace of the Jacobian has to be negative and the determinant needs to be positive. The trace of the Jacobian matrix is equal to:

$$TrJ = \frac{\partial \dot{h}}{\partial h} + \frac{\partial \dot{y}}{\partial y} = -\xi \frac{\partial E}{\partial g} \frac{\partial g}{\partial u} \frac{\partial u}{\partial h} + \hat{y} > 0 \quad (32)$$

While the determinant is equal to:

$$DetJ = -\xi \frac{\partial E}{\partial g} \frac{\partial g}{\partial u} \frac{\partial u}{\partial h} \hat{y} = 0 \quad (33)$$

However, as we can see in equation (32), the stability condition of a negative trace is not met in this 2x2 system. The latter suggests that without any intervention, we are not able to guarantee the stability of the modelled system. In the next subsection, we consider a government that intervenes in the economy with the mission of stabilizing the labor market.

4.2 Long-run equilibrium with government intervention

In this section, following Nomaler et al (2021), we consider whether endogenizing the growth rate of autonomous demand allows for a steady state that is consistent with a stable employment rate. Thus the growth rate of autonomous demand becomes a policy variable. For that purpose, we consider equations (25) and (34) as our two dynamic equations. As seen in equation (34), the government responds to deviations in the employment from an established target level E_T:

$$\dot{\gamma} = \xi(E_T - E) \quad (34)$$

As in the previous section, employment is a function of productivity and capital accumulation

$$E(\hat{y}, g), \frac{\partial E}{\partial \hat{y}} < 0, \frac{\partial E}{\partial g} > 0 \qquad (35)$$

Or equivalently:

$$E(\hat{y}, \gamma, \rho), \frac{\partial E}{\partial \hat{y}} < 0, \frac{\partial E}{\partial \gamma} > 0, \frac{\partial E}{\partial \rho} > 0 \qquad (36)$$

The corresponding Jacobian matrix is given by:

$$J = \begin{bmatrix} \frac{\partial \dot{\gamma}}{\partial \gamma} & \frac{\partial \dot{\gamma}}{\partial y} \\ \frac{\partial \dot{y}}{\partial \gamma} & \frac{\partial \dot{y}}{\partial y} \end{bmatrix} \qquad (37)$$

We have that:

- $\frac{\partial \dot{\gamma}}{\partial \gamma} = -\xi \frac{\partial E}{\partial \gamma}$
- $\frac{\partial \dot{\gamma}}{\partial y} = 0$
- $\frac{\partial \dot{y}}{\partial \gamma} = \varepsilon y$
- $\frac{\partial \dot{y}}{\partial y} = \hat{y}$

Therefore, substituting in the Jacobian matrix, we obtain:

$$J = \begin{bmatrix} -\xi \frac{\partial E}{\partial \gamma} & 0 \\ \varepsilon y & \hat{y} \end{bmatrix} \qquad (38)$$

The trace of the Jacobian matrix, is equal to:

$$TrJ = \frac{\partial \dot{\gamma}}{\partial \gamma} + \frac{\partial \dot{y}}{\partial y} = -\xi \frac{\partial E}{\partial \gamma} + \hat{y} < 0 \qquad (39)$$

While for the determinant, we get that:

$$DetJ = -\xi \frac{\partial E}{\partial \gamma} \hat{y} \geq 0 \qquad (40)$$

Evaluating equations (39) and (40) at the long-run equilibrium values from equation (27) and (35), we obtain a negative trace and a determinant equal to zero. A determinant equal to zero implies that we have a zero root model, with a continuum of locally stable equilibria, meaning that our long-run equilibrium productivity and growth rate of government expenditures are path-dependent.

Conclusions

If respecting planetary boundaries and transitioning towards environmentally sustainable economies requires a halt in economic growth, it is crucial to understand the conditions under which such economies can remain stable. This paper aims at contributing to this discussion by considering the dynamic stability of the labor market in a zero-growth economy with labor productivity growth. The latter is challenging within a post-Keynesian framework since usually, without consideration for ecological constraints, post-Keynesians tackle unemployment issues through the stimulation of demand. If boosting demand has limits, then we expect unemployment to surge and we expect interventions in the labor market to be necessary.

We consider a Kaleckian autonomous demand-led growth model to examine the stability of the labor market (in the sense of a stable employment rate). In the model, net investment responds to deviations of capacity utilization from target utilization in the short run but adjusts to firms' sales growth expectations determined by autonomous government expenditures growth in the long run. In the initial version of the model, in the long run, the autonomous growth rate of government expenditures – set equal to zero – determines the growth rate of the system and the rate of capacity utilization converges towards the normal rate of capacity utilization.

We examine the conditions under which the long-run convergence leads to a stable employment rate and a stable productivity growth equal to zero. However, the long-run stability of the labor market in a zero-growth economy cannot be guaranteed, even if we consider the feedback effects between employment, distribution and productivity. These findings suggests that interventions in the labor market are crucial to make the long-run convergence compatible with a stable employment rate. Therefore, we then consider a version of the model where the government takes the stabilization burden upon itself. For that purpose, the growth in the autonomous demand component is endogenized. Through this channel, we find that the long-run convergence towards zero growth can be compatible with a stable employment rate. However, the findings show that the government must intervene and stabilize the system through fiscal policy.

Although discussing and analyzing the appropriate type of government interventions is outside the scope of this paper, they could, and should, align with the suggestions found in the ecological economics literature. Mastini et al (2021) suggest policies for a just transition such as the provision of universal basic services, a job guarantee program aiming at care work, community services and habitat restoration. Additionally, such a program can work as a channel to implement other degrowth policies such work-time reduction. That way, as the government shortens the working week, it pressures the private sector to do the same (Mastini et al 2021) and therefore contribute to the decoupling of income from work.

The key finding, however, is that in the simple model presented, it is possible to have a stable labor market in a zero growth economy, but only with an appropriate fiscal response. The latter implies, that whenever the economy experiences an exogenous (positive) productivity shock, the autonomous component (and therefore the economy) should grow at a rate which compensates for the effect that labor productivity growth has on the employment rate, until the economy reaches a new locally stable equilibria. Making evident that, as ecological economists suggest, if an economy cannot longer resort to economic growth without considering ecological constraints, then labor market interventions are crucial for the stability of the labor market.

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