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Axe : Dynamiques du Capitalisme et Analyses Post-Keynésiennes

Degrowth in a neo-Kaleckian model of growth and distribution?

A theoretical compatibility and stability analysis

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Abstract: Situated at the interface between post-Keynesian and ecological economics, this article investigates the theoretical possibilities for a degrowth transition to take place while preserving macroeconomic stability. More precisely, the objective is to find whether in a neo-Kaleckian model of growth and distribution an equilibrium with a zero or even negative rate of accumulation can coexist with the Keynesian stability condition being verified. Our results are threefold. First, we confirm that adding the rate of depreciation to the canonical model allows for such an equilibrium to exist, but argue in favor of considering animal spirits rather than the depreciation factor as a potential policy variable for the management of the degrowth transition. Second, other elements such as overhead labour, a tax on capital, an autonomous component in consumption expenditures and a budget deficit can all give this result and provide more 'space' for the equilibrium with a negative rate of accumulation. Finally, we use the mechanism of the Sraffian supermultiplier to illustrate that combined political action and adoption of a more ecological mode of living can be the drivers of a stable degrowth transition. After the transition is completed, the stabilisation of aggregate consumption maintains the economy in a stationary state, at an ecologically sustainable level.

Keywords: Neo-Kaleckian, Degrowth, Transition, Stability, Autonomous consumption, Supermultiplier.

JEL Codes: E12, E21, E23, O44, Q01.

Note: This work has been presented to a variety of research communities at the following events: 22nd FMM Conference in Berlin, 10/2018; 6th International Degrowth Conference,in Malmö, 08/2018; 8th Congress of AFEP in Reims, 07/2018; CUSP Workshop on Economic Theory for the Anthropocene in Guilford, 07/2018; 2nd International Post-Keynesian and Institutionalist Conference in Grenoble, 12/2017; 12th Conference of the European Society for Ecological Economics in Budapest, 06/2017; and the PhD seminar of CEPN in Paris, 06/2017.
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1 Introduction

The current mode of living in rich countries is ecologically unsustainable. As the levels of production and consumption grew exponentially over the last several decades, many environmental problems worsened. Today, not only the issue of climate change is more problematic than ever before but several other 'planetary boundaries' have been overshooted, such as biodiversity loss (Rockström et al. 2009; Steffen et al. 2015).

Moreover, there is now a multitude of arguments and evidence against the possibility for an absolute decoupling between economic production and the degradation of the environment (including greenhouse gases emissions) that would be of sufficient magnitude to meet ambitious environmental targets while keeping the economy growing or even stagnating (Jackson 2009, 2016; Kallis 2018; Victor 2012). 'Green growth' is therefore not a satisfying option, and the logical conclusion that should be drawn is that GDP will have to shrink. As Kallis (2011) puts it, 'The goal of sustainable degrowth is not to degrow GDP. GDP will inevitably decline as an outcome of sustainable degrowth, but the question is whether this can happen in a socially and environmentally sustainable way'.

This reduction of GDP should not happen uniformly though: the idea is not to produce and consume less of the same, but 'less and differently' (Kallis 2018). Moreover, fortunately, among rich countries well-being is almost non-correlated with average GDP per capita (Easterlin et al. 2010). This means that there is room for reducing GDP per capita without reducing well-being. Well-being may even increase as a result of a deep socio-ecological change: this is one of the main claims of the degrowth community (Demaria et al. 2013).

One of the main issues though consists in finding ways to manage the macroeconomy without growth, as well as with a negative rate of growth during the degrowth transition toward a stationary state. Although ecological economics and post-Keynesian economics share a lot of common assumptions and understandings of how modern economy function (Kronenberg 2010), work situated at the interface between the two is very recent. Some

works try to establish a theoretical framework for this interface (Fontana and Sawyer 2013, 2016), several focus on better integrating energy, environment and the macroeconomy (Berg, Hartley, and Richters 2015; Dafermos, Nikolaidi, and Galanis 2017; Naqvi 2015; Taylor, Rezai, and Foley 2016) and a majority of them are concerned with the study of zero-growth economies (Cahen-Fourot and Lavoie 2016; Jackson and Victor 2015, 2016; Lange 2016; Rosenbaum 2015). Only a few authors have dealt with the issue of negative rates of accumulation (Padalkina 2012; Victor 2012). This is problematic since, if we take seriously the diagnosis mentioned above, the economies of rich countries should go through a phase a diminishing GDP.

This article investigates the theoretical possibilities for a degrowth transition to take place while preserving macroeconomic stability. More precisely, the objective is to find whether in a neo-Kaleckian model of growth and distribution an equilibrium with a zero or even negative rate of accumulation can exist while the Keynesian stability condition is verified.

The article is organised as follows. Section 2 presents the core of the neo-Kaleckian model and the notations used throughout this article. Section 3 exposes the main propositions made so far and highlights some shortcomings of them. It also shows that by combining these propositions and changing the parameter one focuses on, the shortcomings can be overcome. Section 4 presents a more complete and realistic model in which there is more space for a stable equilibrium of negative growth, and discusses some policy variables to manage the transition. Section 5 emphasises the role of aggregate consumption for the dynamics of the transition and shows that complementary political action and changes in the mode of living can drive the transition and bring momentarily the rate of growth of the economy to a negative value before stabilising at zero for an ecologically sustainable stationary state. Section 6 concludes.

2 The neo-Kaleckian model of growth and distribution

The core of the neo-Kaleckian model of growth and distribution is composed of three main equations dealing with the rate of profit, saving and investment (Dutt 1984; Rowthorn 1981). In this simple version, we consider the case of a closed economy with no government, where a unique type of good is produced by firms that are owned by capitalists and which only employ direct labour (no overhead labour). For simplicity, technological change is assumed away here.

The gross profit rate is given by:

$$r = \frac{P}{pK} = \frac{P}{pq}\frac{q}{q_{fc}}\frac{q_{fc}}{K} = \frac{\pi u}{\nu} \tag{1}$$

where P stands for nominal gross profits, q for output, q_{fc} for output at full capacity utilisation, π for the profit share, u for the rate of capacity utilisation and ν for the capital to capacity ratio. Unless specified otherwise, the price level p is set with a mark-up θ on unit direct costs. Thus the profit share remains constant as long as there is no change in the mark-up:

$$\pi = \frac{\theta}{1+\theta} \tag{2}$$

As only the capitalists are assumed to save (Kalecki 1971), the ratio of aggregate saving S to the nominal capital stock is:

$$g^s = \frac{S}{pK} = \frac{s_p P}{pK} = s_p r \tag{3}$$

As for the investment function, we use the "Kalecki-Steindl" version (Dutt 1990):

$$g^i = \frac{I}{pK} = \gamma + \gamma_u u + \gamma_r r \tag{4}$$

At the equilibrium on the goods market, $I = S$, and the rate of utilisation

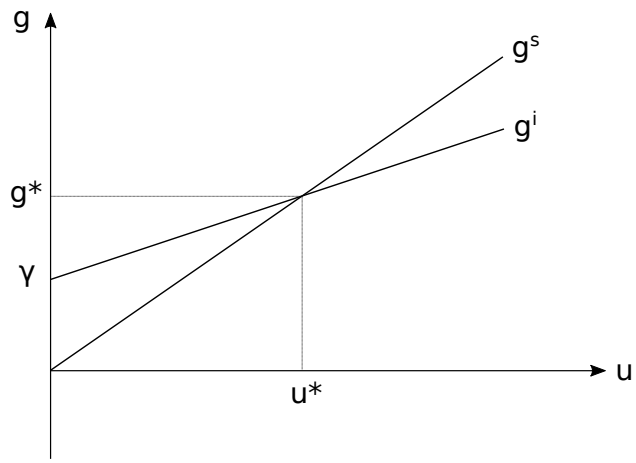

Figure 1: The canonical neo-Kaleckian model in the case of Keynesian stability.

and rate of accumulation are:

$$u^\star = \frac{\gamma}{(s_p - \gamma_r)\frac{\pi}{\nu} - \gamma_u} \tag{5}$$

$$g^\star = \frac{s_p \gamma \pi / \nu}{(s_p - \gamma_r)\frac{\pi}{\nu} - \gamma_u} \tag{6}$$

For the Keynesian stability condition to hold, the denominator has to be positive:

$$s_p > \gamma_r + \frac{\nu}{\pi}\gamma_u \tag{7}$$

which represents the usual condition that aggregate saving has to react more to a change in utilisation rate than aggregate invesment does, or the slope of the saving curve has to be greater than that of the investment curve. Figure 1 illustrates this canonical model in the case of Keynesian stability.

3 Zero growth in Kaleckian models: a short review

In this section, we propose a short critical review of recent works that investigated zero and/or negative growth equilibria in Kaleckian models.

3.1 Zero growth and the rate of profit: Cahen-Fourot and Lavoie (2016)

Within a simple Cambridgian-Kaleckian framework, Cahen-Fourot and Lavoie (2016) show that in a zero-growth full stationary state, profits net of depreciation do not have to be equal to zero but rather can be strictly positive. The key feature allowing for this is the consumption out of wealth from capitalists, which cancels out with their saving out of profits. This brings net overall saving to zero[1][2], which is consistent with the requirement of a net investment rate equal to zero in order to have no net accumulation.

Cahen-Fourot and Lavoie also show that these positive profits, and the fact that $r > g$, do not necessarily imply that the wealth of capitalists grows over time nor that inequality keeps increasing, a result achieved by Jackson and Victor (2016) as well.

However Cahen-Fourot and Lavoie do not specify any investment function. Thus their model is static in the sense that they cannot conduct a stability analysis to determine the reaction of the economy in case of fluctuations in the rate of utilisation around the state of zero growth. To our

[1]Saving should of course not be confused with savings, the latter refering to wealth which is greater than zero.

[2]A similar result could be obtained by simply assuming directly that the propensity to save out of profits is equal to zero. Both options are actually equivalent, since the consumption out of wealth term represents the fact that capitalists decide upon their consumption level not only based on their level of income but also on their stock of wealth. Their effective expenses though are made with the money they get from their income (i.e. profits) - or occasionaly from borrowing - but they do not need to sell out capital assets for this consumption out of wealth. Indeed in the zero-growth full stationary state this wealth stays constant, and everything plays as if capitalists were consuming the entirety of their profits.

knowledge, Padalkina (2012) provides the first attempt to such an investigation.

3.2 Animal spirits and the taxation of saving: Padalkina (2012)

In this subsection we expose part of the contribution made by Padalkina (ibid.)[3] and suggest some shortcomings of it.

An important conclusion of Padalkina (ibid.) is that in the canonical neo-Kaleckian model presented in section 2, it is impossible to reconcile zero growth, keynesian stability and a positive rate of utilisation[4]. Indeed the equilibrium rate of growth can be zero on condition that either i) animal spirits are depressed so that the parameter γ in the investment function (4) is equal to zero, while the slope of the saving curve remains positive, but this implies zero production[5]; or ii) animal spirits are even more depressed (γ is negative) and either the propensity to save s_p or the profit share π is equal to zero, but in that case the keynesian stability condition is violated as g^s is flat while g^i has a positive slope.

This apparent impossibility can be overcome relatively easily by considering slightly less simplistic versions of the neo-Kaleckian model of growth and distribution. In fact a version within this family of models can be summarised by the saving and investment functions, or curves, let aside the pricing mechanism. In order to reach a state of zero growth while preserving Keynesian stability, and starting from a state of positive growth within the simplest model (as shown in figure 1), not only the investment curve must shift downwards (through a change in animal spirits for instance, as

[3]The article explores the conditions for a zero-growth equilibrium to be stable in both neo-Kaleckian and post-Kaleckian models of growth and distribution. Here we only analyse the neo-Kaleckian part of it.

[4]To be exact, the neo-Kaleckian model Padalkina uses is slightly different from the one presented in section 2, since the investment function in her model does not include the rate of profit. However for the question we are concerned with in this article, it is easy to see that the conclusions are totally identical.

[5]This becomes evident after noticing that in this configuration g* and u* are proportional to each other (see equations (5) and (6))

suggested in Padalkina (2012) and Rosenbaum (2015)) but the saving curve also has to. Indeed, as long as the intercept of the saving curve is zero, one cannot avoid the problem pointed out by Padalkina of either keynesian instability or zero utilisation rate[6]. Once g^s is shifted down though, g* and u* are no longer proportional to each other and u* can be positive while g* is equal to zero. Padalkina (2012) proposes to do so with a tax on saving out of profits and wages that would not depend on the rate of utilisation. The attempt is incomplete and not really convincing though. Indeed the tax scheme she puts forward is eventually not independent from the rate of utilisation, since the tax depends on profits and wages which themselves depend on the rate of utilisation. Padalkina (ibid.) also briefly mentions a tax on factors of production, following the idea of George (1879) of a tax on land, without developing it fully. We will see in a subsequent section that a tax on fixed capital can increase the possibilities for a stable zero-growth equilibrium to exist, but first let us investigate the role of capital depreciation for non-growing or degrowing economies.

3.3 The depreciation of capital: Rosenbaum (2015)

As noticed previously, both the saving and investment curves have to shift down in order to "leave space" for the existence of a stable zero-growth equilibrium. To achieve this Rosenbaum (2015) proposes to use the depreciation of capital as a variable which, through its effect on the rate of profit, moves both curves downward. Indeed the depreciation of capital can be considered a fixed cost in the sense that it does not depend on the rate of utilisation[7]. This cost reduces the rate of profit which, net of depreciation, is given by:

$$r^n = \frac{P - D}{pK} = \frac{\pi u}{\nu} - \delta \tag{8}$$

[6]Moreover, as long as the intercept of the saving curve is zero, the model cannot show a negative rate of growth at all

[7]There are various arguments in favour of considering the rate of capital depreciation as a constant or as a function of either the rate of utilisation or of technological change. For a discussion on this see for example Lavoie (1992, p. 318). Rosenbaum chooses to make it a function of technological change only.

where P still stands for nominal gross profits. Capital depreciation is represented by D in nominal terms and δ as a share of existing capital pK. Like in the simple model of section 2, the gross profit share π remains constant and equal to $\theta/(1+\theta)$ under simple markup pricing. As the rate of profit is a component of the intercept of both g^s and g^i curves, these two shift down when one adds depreciation into the model or when the depreciation factor increases. According to Rosenbaum (2015), this effect allows for a management of the rate of growth by public authorities, who would be able to make the economy reach the zero-growth target by tuning the depreciation factor. In our view this is problematic in two regards.

First, due to the phenomenon of the paradox of costs an increase in the depreciation factor leads to an *increase* in the rate of growth, rather than to a decrease as suggested by Rosenbaum. Indeed, the shift downward is not of the same magnitude for the two curves, since the coefficient for the rate of profit is not the same in equations 3 and 4. This can be seen on figure **??** with the intercepts of both curves. One could argue that the rate of growth is still managable by means of changes in the depreciation factor, this time using the policy tool in the right direction (i.e. taking the paradox of costs into account). However, here comes the second issue: Rosenbaum (ibid.) argues that because "tax rules and technical regulations and norms" can affect the decisions of withdrawal of pieces of equipment, "depreciation can indeed be a policy variable". In our opinion, this is not convincing. For a policy variable to be effective, the time scale of its effects should be smaller or of the same order of magnitude as the time scale of the phenomenon it acts upon. Elaborating and implementing new technical regulations and norms is a slow process, and the subsequent effects on capital withdrawal and investment decisions also require time to take place. This cannot be used as a way to manage the rate of growth, that varies quarterly or yearly.

More importantly, by focusing on the command and control of zero growth Rosenbaum seems to depart from the original reason why zero growth is desirable: reducing our environmental impact as much as possible. With this in mind, a tax, regulation or norm that speeds up the adoption of the cleanest technologies should always be welcome, even if the corresponding

investments cause additional economic activity, as long as the overall effect is environmentally beneficial. It would not make sense to restrain from making these investments for the sake of keeping the rate of growth at zero. In other words, the "macroeconomic rebound effect" (Barker, Dagoumas, and Rubin 2009; Rezai, Taylor, and Mechler 2013; Saunders 2000) of green investments should not be a reason for not engaging in the ecological transition.

3.4 Combining depreciation of capital and management of animal spirits

Drawing on this discussion about the rate of capital depreciation and the difficulty to manage it purposefully, we suggest that the depreciation rate δ be a constant and animal spirits γ be considered a parameter to be influenced in order to manage the equilibrium rate of growth, rather than the other way round. For instance, one can achieve the hypothetical policy goal of keeping the rate of growth at zero. Mathematically, one can compute the value of the parameter γ that brings the rate of accumulation to zero, for a given value of depreciation δ. Let us do this briefly: in the saving and investment equations (3) and (4) of the simple model of section 2, we now substitute the rate of profit r with the net rate of profit r^n of equation (8)[8]. The equilibrium rate of utilisation and rate of accumulation are transformed as follows:

$$u^\star = \frac{\gamma + (s_p - \gamma_r)\delta}{(s_p - \gamma_r)\frac{\pi}{\nu} - \gamma_u} \tag{9}$$

$$g^\star = s_p \frac{\gamma\pi/\nu + \gamma_u\delta}{(s_p - \gamma_r)\frac{\pi}{\nu} - \gamma_u} \tag{10}$$

[8]Indeed, capitalists save a proportion of the profits left after depreciation has been substracted from them, not a proportion of gross profits. Also, it seems logical to think that when gauging the rate of profit in order to make investment decisions, capitalists are able to estimate the rate of depreciation and look at the net rate of profit rather than at the gross rate.

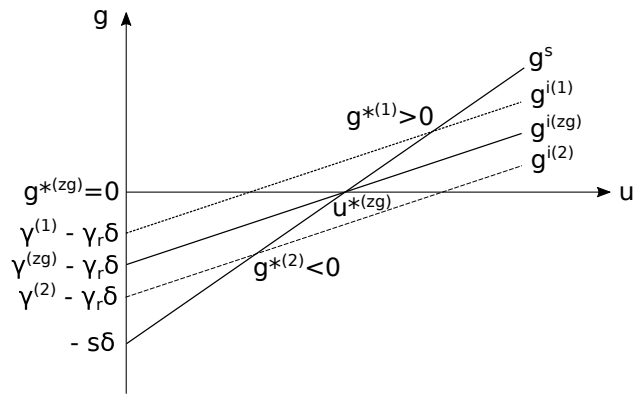

Figure 2: Stable equilibria of positive, zero and negative rates of growth in a neo-Kaleckian model of growth and distribution with capital depreciation.

and the level of animal spirits that brings about zero growth is:

$$\gamma^{(zg)} = -\frac{\nu\gamma_u\delta}{\pi} < 0 \tag{11}$$

As shown in figure 2, if investors are more optimistic than this level ($\gamma^{(1)} > \gamma^{(zg)}$), the equilibrium rate of growth becomes positive; if they are more pessimistic ($\gamma^{(2)} < \gamma^{(zg)}$), the rate of growth becomes negative. At zero growth, the rate of utilisation remains positive[9]:

$$u^{\star(zg)} = \frac{\nu\delta}{\pi} \tag{12}$$

The keynesian stability condition remains the same as in section 2, and is explicited in equation (7). This condition poses no problem of compatibility with condition (11) on the level of animal spirits to reach zero growth. Hence we have shown here that a canonical neo-Kaleckian model to which the depreciation of capital is added gives the possibility to concile keynesian stability, zero growth and a positive rate of utilisation. There is even the

[9] A rough approximation with $\nu = 3$, $\delta = 10\%$ and $\pi = 0.35$ gives the value 86% for the rate of utilisation at zero growth. The model is rudimentary, therefore numerical values should not be given too much importance. Nevertheless this approximation suggests that in a non-growing economy, the rate of utilisation does not need to be particularly low.

possibility for a stable equilibrium with negative rate of growth. Rosenbaum (2015) achieved this result already but, as we have argued, in this simple model the policy variable for the management of the rate of growth should be animal spirits rather than the rate of capital depreciation. Here we shall give a few arguments and examples supporting the idea that animal spirits can be managed to some extent, indirectly though as this variable is not directly at reach for public authorities.

First, political discourses are currently used extensively by rulers in order to steer business confidence upwards. The success of these is conditional though, as capitalists usually wait for pro-business reforms to eventually, maybe, increase investment. The reverse observation might not hold though: the effects of political discourses that would set a macroeconomic objective of no growth, or even negative growth during a certain period of transition, might not be conditional on concrete pro-labour measures. Investors may well become pessimistic shortly after such political announcements.

Second, credit guidance may be used in order to slow down or restrict investments in specific sectors, be it for reason of direct or indirect environmental harm (e.g. car industry or advertisement services). As demand for goods and services provided by other sectors would not increase particularly due to these measures, investment in these sectors would not increase either and aggregate investment would decrease. Though credit is not made explicit in our model, we argue that such credit guidance may translate into more pessimistic animal spirits. Additionally, quotas on productive capacities in some sectors may go in the same direction. Such quotas may appear overly intrusive for the functioning of a (regulated) market economy, however one should notice that they have been used extensively in the past (including in western capitalist countries) and still are today, for instance for fisheries in the European Union.

4 A more complete neo-Kaleckian model for the study of a degrowing economy

In this section we set out a more complete model, which provides a greater possibility for a stable negative equilibrium rate of growth to be reached than in the model presented in the previous section. We derive the equilibrium values for the rates of utilisation, profit and accumulation, and discuss which parameters could be used as policy variables to conduct or accompany the degrowth transition. This discussion will eventually lead us to the need for developing more thoroughly the role that autonomous consumption expenditures can play in driving the transition, which we do in section 5.

4.1 Setting the model out

The core of the model is taken from the seminal work of Rowthorn (1981). It consists of the canonical neo-Kaleckian model of growth and distribution of section 2 to which are added a government deficit, the depreciation of capital, managerial labour and a tax on profits[10] (ibid.). To this we add the fact that white-collar workers save part of their income (Lavoie 1992, p. 344) but not only: blue-collar workers also save a share of their salaries. Having the propensity to consume of workers lower than unity allows us to model an autonomous component of consumption expenditures, of which we make use in section 5.

For the purpose of clarity, let us lay all the equations of the model out.

Prices are set with a mark-up θ on direct unit costs, and the gross profit share remains constant as long as the mark-up does not change:

$$\pi = \frac{\theta}{1+\theta} \tag{2}$$

Production requires both direct (or variable) labour L_v and indirect (or

[10]The tax on profits introduced by Rowthorn (1981) is in fact proportional to the stock of physical capital. For this reason we use the term 'tax on capital' in the rest of the article.

fixed) labour L_f. Indirect labour is paid a constant multiplicative premium σ with respect to the base wage rate w. The total wage bill is thus:

$$W = W_v + W_f = wL_v + \sigma wL_f \tag{13}$$

The number of overhead workers is in fixed proportion f to the number of variable labour required when the economy operates at full capacity (Rowthorn 1981).

The expression for the net rate of profit is changed compared to previous sections. Profits are now reduced not only by depreciation costs but also by overhead labour costs and the tax on capital. Assuming that nominal depreciation D and the tax on capital T_K are proportional to the nominal capital stock pK, the net rate of profit reads[11]:

$$r^n = \frac{pq - W - D - T_K}{pK} = \frac{\pi u}{\nu} - \sigma f(1-\pi)/\nu - \delta - t_K \tag{14}$$

Where the rate of depreciation δ and the tax rate on capital t_K are constant. Denoting the sum of all fixed costs expressed as a share of nominal capital by ϕ:

$$\phi = \sigma f(1-\pi)/\nu + \delta + t_K \tag{15}$$

we get the following condensed expression for r^n:

$$r^n = \frac{\pi u}{\nu} - \phi \tag{16}$$

The investment function is the same as in section 2, with the net rate of profit as an argument as we explained in section 3.4:

$$g^i = \gamma + \gamma_u u + \gamma_r r^n \tag{17}$$

[11]See Rowthorn (1981, p. 8) for a more detailed derivation of this expression. For a clear exposition of the Kaleckian model with overhead costs, see for instance Lavoie (2014, pp. 322-328).

We can rewrite it as an affine function of the rate of utilisation:

$$g^i = (\gamma_u + \gamma_r \pi/\nu)u + \gamma - \gamma_r \phi \tag{18}$$

The saving function is more substantially modified compared to the previous sections. Private saving now comes from capitalists and from workers of both types. We assume the consumption function of workers, taken all together, to be of the following form:

$$C_{workers} = c_{wv} W_v + c_{wf} W_f + Z \tag{19}$$

where Z stands for the autonomous consumption expenditures of all workers taken together. Saving from workers is thus equal to:

$$S_{workers} = W - C_{workers} = s_{wv} W_v + s_{wf} W_f - Z \tag{20}$$

where s_{wv} and s_{wf} are the propensities of variable and fixed labour to save out of their wages. Saving (or rather dissaving) also occurs from the public sector, the deficit of which we call B. Using P^{net} for nominal net profits, total saving thus reads:

$$S = s_p P^{net} - B + s_{wv} W_v + s_{wf} W_f - Z \tag{21}$$

Expressing it as a share of the stock of nominal capital, with $z = Z/(pK)$, we obtain the new saving function:

$$g^s = s_p r^n - b + \frac{(1-\pi)s_{wv}}{\nu} u + \frac{(1-\pi)s_{wf}}{\nu} \sigma f - z \tag{22}$$

Rearranging as an affine function of the rate of utilisation gives:

$$g^s = [s_p \pi + s_{wv}(1-\pi)]u/\nu - [s_p \phi + b + z - (1-\pi)s_{wf}\sigma f/\nu] \tag{23}$$

4.2 Analysis of the model

Before turning to the study of equilibrium values for the rates of utilisation, profit and accumulation, let us make a few observations on the saving and investment functions (or curves) of this more complete model.

First, we see that any fixed cost shifts both curves downward (though not by the same distance), as was the case for depreciation costs. Moreover, both the public deficit b and autonomous consumption z shift the saving curve further down. All this gives more 'space' for an equilibrium to take place in the area of negative rate of accumulation. Saving out of wage by managers goes in the opposite direction, moving the saving curve upward. Overall though, the presence of overhead labour in the model brings the curve lower than in their absence: the additive term in the function is $-(s_p - s_{wf})(1 - \pi)\sigma f/\nu$ which is negative with the usual assumption that the propensity to save out of profits is larger than that out of wages.

Second, the presence of saving out of wage by variable labour makes the saving curve steeper, as can be seen with equation (23). This makes the stability condition more easily verified.

$$u^\star = \frac{(\gamma + b + z)\nu + (s_p - \gamma_r)\phi\nu - s_{wf}(1-\pi)\sigma f}{(s_p - \gamma_r)\pi + s_{wv}(1-\pi) - \gamma_u\nu} \tag{24}$$

Using equation 16 and rearranging, one obtains the equilibrium net profit rate:

$$r^{n\star} = \frac{(\gamma + b + z)\nu + \gamma_u\phi\nu - s_{wv}(1-\pi)\phi - s_{wf}\pi(1-\pi)\sigma f/\nu}{(s_p - \gamma_r)\pi + s_{wv}(1-\pi) - \gamma_u\nu} \tag{25}$$

And making use of the saving equation 22, after some calculation we get the expression for the equilibrium rate of growth:

$$g^\star = \frac{1}{(s_p - \gamma_r)\pi + s_{wv}(1-\pi) - \gamma_u\nu} * \Big[[s_p\gamma + (b+z)\gamma_r]\pi + (b+z+s_p\phi)\gamma_u\nu + s_{wv}(1-\pi)(\gamma - \gamma_r\phi) - s_{wf}(1-\pi)(\gamma_u\nu + \gamma_r\pi)\sigma f/\nu\Big] \tag{26}$$

One can now derive the Keynesian stability condition:

$$s_p > \gamma_r + \gamma_u \nu/\pi - s_{wv}(1-\pi)/\pi \tag{27}$$

which confirms our previous claim the the condition is more easily verified in this model than in the canonical one.

Although the expressions for the equilibrium rates of utilisation, profit and accumulation are heavy, the same reasoning as in section 3.4 can be made regarding the possibility for a stable equilibrium of zero or negative accumulation while maintaining the rate of utilisation at a positive value. Figure 2 is still relevant here, with only the intercepts of both curves being lower (at least in the case of government deficit, balanced budget or not-too-large surplus) and the saving curve being steeper. Using equation (22) we find that when the equilibrium rate of accumulation is brought to zero (for example due to sufficiently pessimistic animal spirits), then the equilibrium rate of utilisation is equal to:

$$u^{\star(zg)} = \frac{(s_p\phi + b + z)\nu - s_{wf}(1-\pi)\sigma f}{s_p\pi + s_{wv}(1-\pi)} \tag{28}$$

This expression is positive for any positive value of the government deficit as well as in the case of a balanced budget or of a not-too-large surplus[12]. The utilisation rate at zero growth may hit the theoretical lower bound of zero only if the government runs a too large budget surplus.

An important feature of the present model is its ability to show the non-proportionality of the rates of profit and of accumulation.[13] Indeed, although the more simple model of section 3.4 is able to show a positive rate of utilisation while the rate of growth is zero[14], the same does not hold for the net

[12]As we mentionned earlier in the discussion about the effect of saving out of wages by overhead labour on the position of the saving curve, the 'hidden' term containing s_{wf} inside the term $s_p\phi$ more than compensates the (negative) second term of the numerator.

[13]Cahen-Fourot and Lavoie (2016) also find this feature in their model, thanks to the consumption out of wealth by capitalists. Our model shows that this is achievable through parameters relative to the public sector and/or to the consumption function of workers.

[14]This is due to depreciation costs. In fact, any fixed cost (as well as a government deficit or autonomous consumption expenditures) makes $u^\star$ and $g^\star$ not proportional to

rate of profit. This is clear when examining the saving equation $g^s = s_p r^n$: if the rate of accumulation is equal to zero (resp. negative), the net rate of profit is equal to zero (resp. negative), which is certainly problematic in a capitalist economy. Due to the budget deficit and autonomous consumption expenditures though, the present model breaks this proportionality and allows for a positive net rate of profit while the rate of accumulation is zero or even negative. Equation 22 gives the condition for having $r^\star > g^\star$:

$$b + z > (1 - \pi)(s_{wv} u^\star + s_{wf} \sigma f)/\nu \tag{29}$$

An analysis of and discussion about the influence of various parameters $(t_K, \sigma, f, b, \pi, s_p, s_{wv}, s_{wf})$ on equilibrium rates of utilisation, profit and growth remains to be done, as the present document is a work in progress.

5 Autonomous consumption expenditures as a driver for the degrowth transition

The analysis above showed that a number of parameters, related to governmental intervention or to the behaviour of private agents, could influence the equilibrium rate of accumulation and potentially bring it to negative values. Such cases, however, look more like recessions than desired degrowth. Indeed pessimistic capitalists slowing down the investment rate or increasing their thriftiness, or the government reducing its deficit is quite far from the idea of a 'voluntary transition towards a just, participatory, and ecologically sustainable society' (Degrowth 2010). In this section we propose a mechanism that corresponds more to the idea of degrowth. Essentially, we assume that a number of radical changes take place both in the realm of infrastructures, collective and individual values and behaviour, leading all together to a reduction in aggregate (monetary) consumption.

More precisely, democratic government action (at various institutional levels) radically changes transportation infrastructures in favor of ecological

each other any more, which allows for this result.

mobility[15], insulates every building (residential, tertiary and public), gets the advertisement industry to shrink, brings foreseen obsolescence to an end and makes manufacturers design long-lasting, ecologically sourced and made, repairable goods. Such a set of changes are not by themselves sufficient to dramatically curb consumption and greenhouse gas emissions, as it does not prevent from rebound effects to take place. However, they make it possible for people (and businesses and other institutions) to have a much more ecological mode of living. The essential idea here is the constrained, or forced, expenditures are drastically reduced: people do not need to buy, insure, fuel, maintain and eventually replace a private car any more; they do not need to heat or cool their home as much; nor do they need to replace (artificially) broken non-repairable home appliances and furniture etc. They are also less prone to consuming goods and services they would not have consumed, had advertisement not pushed them into doing so.

Arguably, all these constrained expenditures as well as half-voluntary purchases are loosely linked to the current income of people, and are more correlated to the particular local and general environment in which individuals evolve. This explains why we choose to model this ensemble of expenditures via the concept of autonomous consumption expenditures; and as we have argued above, the set of radical changes we presented allow for these autonomous expenditures to progressively diminish, if people take (individually and collectively) the opportunity to do so instead of 'rebounding'. A key argument in the degrowth paradigm is that this diminution of aggregate consumption does not translate into a loss of well-being, but rather the opposite, thanks notably to environmental and health benefits as well as stronger social bonds.

In the following two subsections, we first expose briefly the mechanism by which the dynamics of autonomous consumption expenditures manage to drive the rate of accumulation in the medium run, thanks to the so-called 'Sraffian supermultiplier effect' (F. Serrano 1995; F. L. Serrano 1995). Then

[15]This means abandoning the private car - even electricity powered - and dramatically reducing road freight, replacing it with low-carbon public transport, cycling and other human-powered means of transport, and rail freight.

we illustrate the use of this effect for the dynamics of a degrowth transition driven by the change in autonomous consumption expenditures.

5.1 Autonomous consumption expenditures and the rate of accumulation in the medium run

In section 4 we introduced autonomous consumption expenditures Z, and the notation $z = Z/pK$ for a more convenient analysis. The equilibrium values we found for the rates of utilisation, profit and accumulation were calculated considering that z is a constant. Therefore, we will call them short run equilibrium values. In the medium run though, both the stock of capital pK and the value of autonomous consumption expenditures Z can vary. Thus z becomes a variable which influences the equilibrium values of the rates of utilisation, profit and accumulation. These values are different in the medium run than in the short run. In the rest of the article, values with two stars as an exponent represent medium run equilibrium values. We use the same notations and follow the same steps as Lavoie (2016, pp. 178-184) to show how in our model, through the Sraffian supermultipllier effect, the rate of accumulation of the whole economy converges toward the rate of growth of autonomous expenditures (F. Serrano 1995; F. L. Serrano 1995; F. Serrano and Freitas 2015). Here we deal with autonomous consumption expenditures, but similar conclusions can be derived with the study of autonomous government expenditures Allain (2015). Let us denote by $\bar{g}_z$ the exogenous rate of growth of autonomous consumption expenditures Z. Because both direct unit costs and the mark-up over them are assumed to remain constant, prices remain constant as well. Hence, the rate of growth of the z variable is given by:

$$\hat{z} = \hat{Z} - \hat{K} = \bar{g}_z - g^\star \tag{30}$$

We shall now check 'whether the behaviour of z is dynamically stable or not, that is, whether it will converge to a stable value' (Lavoie 2016, p. 178). In order to do so we need to compute $d\hat{z}/dz$ Using equations (26) and (30)

we find:

$$\frac{d\hat{z}}{dz} = -\frac{\gamma_u \nu + \gamma_r \pi}{(s_p - \gamma_r)\pi + s_{wv}(1-\pi) - \gamma_u \nu} \tag{31}$$

This expression is strictly negative as long as there is short-run Keynesian stability. In that case, the model is dynamically stable and the variable z converges in the medium run toward a certain value $z^{\star\star}$ (Lavoie 2016, p. 179). This in turn means that the medium run equilibrium rate of accumulation $g^{\star\star}$ is equal to the rate of growth of $\bar{g}_z$ of autonomous consumption expenditures[16] (ibid., p. 179).

Replacing the left member in the investment and saving equations by this exogenous rate of growth $\bar{g}_z$, we can derive the equilibrium values for the rate of utilisation and for the z variable:

$$u^{\star\star} = \frac{\bar{g}_z - \gamma + \gamma_r \phi}{\gamma_u + \gamma_r \pi / \nu} \tag{32}$$

$$z^{\star\star} = [s_p \pi + s_{wv}(1-\pi)]u^{\star\star}/\nu - [s_p \phi + b + \bar{g}_z - s_{wf}(1-\pi)\sigma f/\nu] \tag{33}$$

So far, we have shown that the rate of accumulation of the whole economy is drawn to equate in the medium run the rate of growth of autonomous consumption expenditures, and we have derived the medium run equilibrium values for the rate of utilisation and the z variable. In order to illustrate this mechanism more easily with the movements of the saving curve, we shall examine how the equilibrium value of z varies when the rate of growth $\bar{g}_z$ changes:

$$\frac{dz^{\star\star}}{d\bar{g}_z} = \frac{(s_p - \gamma_r)\pi + s_{wv}(1-\pi) - \gamma_u \nu}{\gamma_u \nu + \gamma_r \pi} \tag{34}$$

As long as the short-run Keynesian stability condition is verified, this expression is positive. This means than whenever the rate of growth of autonomous consumption expenditures $\bar{g}_z$ decreases (increases), the medium run equilibrium value of z decreases (increases) and, as a result, the saving curve progressively shifts upward (downward). Indeed, $z^{\star\star}$ is part of the intercept of the saving curve, with a minus sign (cf. equation (23) and figure 3).

In the next subsection, we will illustrate how this mechanism and dynam-

[16] cf. equation (30) with the left member equal to zero.

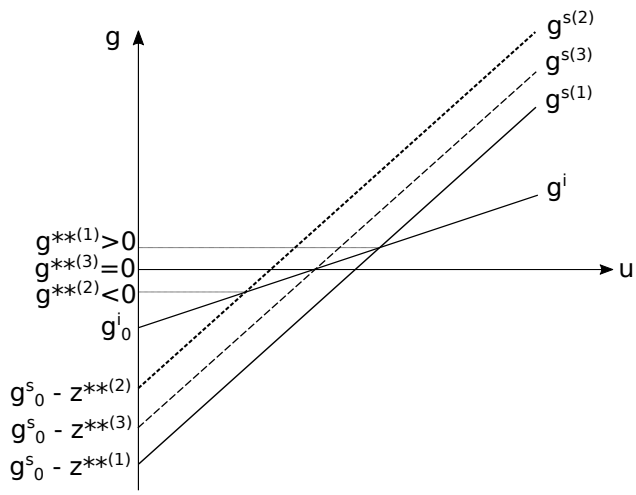

Figure 3: A highly schematised degrowth transition driven by changes in the rate of growth of autonomous consumption expenditures.

ics can play a role in the macroeconomics of the degrowth transition.

5.2 Supermultiplying the degrowth transition

The degrowth transition, in terms of rate of accumulation, is illustrated in figure 3 and can be schematised as follows.[17] The initial state, which we associate with the superscript (1), is an equilibrium of positive rate of accumulation. During the core of the transition, the rate of growth of autonomous consumption expenditure $\bar{g}_z$ diminishes from an initial positive value to a negative value, meaning that the dynamics of these expenditures are reversed, passing from an increasing to a decreasing trend. The equilibrium value $z^{\star\star}$ decreases, and the saving curve shifts upward. We associate this phase with the superscript (2). Essentially, this is the well known paradox of thrift playing its role since during this phase the average propensity to save of workers increases as a result of their change in mode of living. Once the radical changes described in the introduction of section 5 have occured and a

[17]For the clarity of exposition in figure 3, we grouped together all the terms making up the intercept of the investment curve in the term g_0^i and did the same for the saving curve except for the term $-z^{\star\star}$ that is explicited.

majority of people have adopted an ecological mode of living, aggregate autonomous consumption expenditures progressively stabilise, $\bar{g}_z$ increases and passes from its negative value to zero and so does the rate of accumulation. Thus the degrowth transition leads to a stationary state at an ecologically sustainable level, represented in situation (3).

6 Conclusion

In this article, we investigated the possibilities for a stable equilibrium of zero or negative rate of accumulation to exist within neo-Kaleckian models of growth and distribution. This type of model has been studied extensively by many post-Keynesian authors, but only a couple of them looked for stable equilibria of zero or negative rate of accumulation. The results of our investigation are multiple.

First, we confirmed that adding the rate of depreciation to the canonical model allows for such equilibria to exist, but argued in favor of considering animal spirits rather than the depreciation factor as a potential policy variable for the management of the degrowth transition.

Second, we showed that any fixed cost can give this result, and that by including several of them simultaneously in the model there is more 'space' for the equilibrium with a negative rate of accumulation. Adding both an autonomous component to consumption expenditures and a budget deficit also goes in this direction.

Finally, we used the mechanism of the Sraffian supermultiplier to illustrate that a set of ambitious and radical changes, combining political action and the adoption of a more ecological mode of living, can drive the degrowth transition while preserving macroeconomic stability. The paradox of thrift plays a role in linking the changes in aggregate consumption and in the rate of accumulation. After the transition is completed, the stabilisation of aggregate consumption maintains the economy in a stationary state, at an ecologically sustainable level.

Work remains to be done with respect to the issue of unemployment as

aggregate production shrinks. One of the next steps should be to include a working time reduction scheme in this model. We should also take a closer look at the public deficit, and include more diversified taxes. Indeed, during the degrowth transition the tax base is reduced as production and consumption decrease. If public spending is to remain at satisfactory levels, especially in terms of social protection, the public deficit may well reach record high levels. Although not a problem as such, this might undermine the political feasability of the degrowth transition. Hence, some tax rates should probably increase, the challenge being to make these changes in a just and equitable manner.

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