How Short Is the Short Run in the Neo-Kaleckian Growth Model?

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ABSTRACT

The paper provides an analytical solution to the differential equation that regulates the motion of the neo-Kaleckian model in the short run. After presenting a simple open economy neo-Kaleckian model with government activity, the paper analytically derives an expression for the time of adjustment, defined as the time required for the system to make a *k* percent adjustment from one steady-state to another. The solution shows that there is an inverse relationship between the time of adjustment and (i) the strength of the Keynesian stability condition; (ii) the behavior of entrepreneurs underlying their decisions to more rapidly/slowly respond to changes in goods market conditions. Last, the model is calibrated for the US, showing that the vicinity of the new equilibrium is reached after a period of about 5 quarters under a baseline calibration. By formally analyzing the out-of-equilibrium trajectory of the neo-Kaleckian model, this contribution moves away from the method of comparative dynamics and provides a historical-time representation of the model's traverse.

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1. Introduction

> Because of the domination of the equilibrium mode of thought, most economists unkowingly evacuate time from their analysis, exactly like Mr. Jourdain spoke prose: equilibrium economics is really timeless economics.
>
> Q2 Henry (1987, p.472)

The neo-Kaleckian growth model has been mainly criticized because of its failure to provide a long-run convergence of the rate of capacity utilization to the normal one (Skott 2012; Dávila-Fernández, Oreiro, and Punzo. 2019; Girardi and Pariboni. 2019). A partial admission of the difficulties of neo-Kaleckian models in explaining long-run phenomena has also been recently recognized by Lavoie (2018, p.9): 'Maybe the mistake was to speak of long-run equilibria; perhaps there would have been no controversy if from the beginning we had called them medium-run equilibria.'

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While the Kaleckian literature and its critiques have focused on issues related to the stability of the Neo- and Post-Kaleckian models of growth and distribution (Del Monte 1975; Lavoie 2010; Skott 2010; Franke 2017), little to no attention has been paid to the formal analysis of the traverse from one steady-state position to another. As a consequence, even if we admit that the neo-Kaleckian model ought to be restricted to short- or medium-run analysis, it is still left to know what the short and medium runs actually are. More specifically, what needs to be proven is that the neo-Kaleckian model moves between steady-state positions in a time span that the existing literature identifies as either short or medium run.

Accordingly, the first research goal of this paper is to seek an analytical solution to the differential equation that describes the short-run adjustment mechanism of a simple open economy neo-Kaleckian model with government activity. Second, the paper aims to explicitly find a solution to the system in terms of the time of adjustment, thus exploring *how short is the short run* in the neo-Kaleckian model by means of model calibration. Methodologically, the paper follows the line of research pioneered by Sato (1963, 1964, 1980) in analyzing the adjustment period in Neoclassical growth models.

The remainder of the paper is organized as follows. Section Two presents a simple open economy neo-Kaleckian model with government activity, characterized by the endogeneity of the rate of capacity utilization in the short run. Section Three discusses the ordinary differential equation that explains the motion of the neo-Kaleckian system in the short run, providing a general solution to it. Subsequently, the resulting equation is then expressed in terms of the adjustment period t_k required for a k percent adjustment from one steady-state position to another second one. Section Four calibrates the model for the US in line with existing studies and BEA data, showing that the neo-Kaleckian model provides for a very fast pace of adjustment of saving to investment. Last, Section Five concludes, summarizing the findings of the paper.

2. A Simple Open Economy neo-Kaleckian Model with Government Activity

This section presents a simple version of an open economy neo-Kaleckian model with government activity for the analysis of short-run dynamics.

In order to derive the growth model, let us first start with the output equation of an open economy with government activity:

$$Y_t = C_t + I_t + G_t + (X_t - M_t) \tag{1}$$

where the current level of aggregate output (Y_t) is defined as the sum of aggregate consumption (C_t), private investment (I_t), public expenditures (G_t) and net exports $(X_t - M_t)$. Consumption, investment, government spending, exports and imports can be modeled as follows:

$$C_t = \overline{C_{0t}} + c(1-t)Y_t \tag{2}$$

$$I_t = [\alpha_t + \beta u_t]K_t \tag{3}$$

$$G_t = \overline{G_t} \tag{4}$$

$$X_t = \overline{X_t} \tag{5}$$

$$M_t = mY_t \tag{6}$$

Equation (2) assumes that aggregate consumption is partly induced – via the tax-adjusted propensity to consume $c(1-t)$ - and partly autonomous from the current level of income ($\overline{C_{0t}}$). Investment (equation 3) is modeled in line with the neo-Kaleckian treatment of capital formation as (linearly) dependent on the rate of capacity utilization ($u_t = Y_t/Y^p$), as postulated by Steindl (1952) and formalized in the 80s by Rowthorn (1981), Dutt (1984), Taylor (1983) and Amadeo (1986). More specifically, the parameter α reflects 'the animal spirits of firms, for instance, expectations about the future trend rate of sales growth' (Lavoie 2014, p. 361), while the parameter β represents the sensitivity of the investment rate to changes in the actual rate of capacity utilization (u_t). Both α and β are assumed to be positive.[1] Government spending (equation 4) and exports (equation 5) are both treated as autonomous expenditures, the first because public consumption and investment depend on the arbitrary decisions of the general government, the second because exports depend on foreign demand, which depends in turn on foreign income. For the sake of simplicity, imports of goods and services are assumed to be linearly dependent on the level of income, via the propensity to import m (equation 6).

Given equations (2) and (4), and considering that $s = 1 - c(1-t)$ is the tax-adjusted propensity to save, we can write the domestic saving equation as follows:

$$S_t = Y_t - C_t - G_t = Y_t - \overline{C_{0t}} - c(1-t)Y_t - \overline{G_t} = sY_t - \overline{C_{0t}} - \overline{G_t} \tag{7}$$

Dividing equation (7) by the capital stock (K_t), we can obtain the saving rate (σ_t), with v denoting the capital-capacity ratio.:

$$\sigma_t = \frac{S_t}{K_t} = s\frac{Y_t}{K_t} - \frac{\overline{C_{0t}}}{K_t} - \frac{\overline{G_t}}{K_t} = s\frac{Y_t}{Y^p}\frac{Y^p}{K_t} - \frac{\overline{C_{0t}}}{K_t} - \frac{\overline{G_t}}{K_t} = \frac{su}{v} - \frac{\overline{C_{0t}}}{K_t} - \frac{\overline{G_t}}{K_t} \tag{8}$$

The accumulation rate (g_t) is obtained by dividing equation (3) by the capital stock (K_t):

$$g_t = \frac{I_t}{K_t} = \alpha + \beta u_t \tag{9}$$

Lastly, given equations (5) and (6), we can obtain the net export rate (b_t):

$$b_t = \frac{X_t - M_t}{K_t} = \frac{\overline{X_t}}{K_t} - m\frac{Y_t}{Y^p}\frac{Y^p}{K_t} = \frac{\overline{X_t}}{K_t} - \frac{mu_t}{v} \tag{10}$$

As discussed by Blecker and Setterfield (2019, p. 192), the goods market equilibrium condition requires that the saving rate has to be equal to the sum of the accumulation and net

[1]Since the analysis is restricted to short-run dynamics, the paper abstains from the consideration of a normal degree of utilization, in line with the original vision of Steindl (1952) and Kalecki (1954). Therefore, the model does not provide for a return to a normal degree of capacity utilization, under the assumption – widely acknowledged by Kaleckian authors – that the rate of capacity utilization is an endogenous variable, at least in the short run. For a more-in-depth discussion, see Hein (2014), Lavoie (2014) and Blecker and Setterfield (2019).

export rates:

$$\sigma_t = g_t + b_t \tag{11}$$

Therefore, after equating and rearranging equations (9), (10) and (11), we can obtain the short-run goods market equilibrium as follows:

$$\frac{(s+m)u^*}{v} - z = \alpha + \beta u^* \tag{12}$$

where z denotes the ratio of autonomous expenditures to the capital stock. Similarly to Lavoie (2016), the ratio is assumed to be constant in the short run:

$$z = \frac{\overline{Z_t}}{K_t} = \frac{\overline{C_{0t}}}{K_t} + \frac{\overline{G_t}}{K_t} + \frac{\overline{X_t}}{K_t} \tag{13}$$

Last, let us solve the model for the equilibrium rate of capacity utilization (u^*):

$$u^* = \frac{\alpha + z}{(s+m)/v - \beta} = \frac{(\alpha + z)v}{s + m - \beta v} \tag{14}$$

The model leads to a stable equilibrium if and only if the denominator in equation (14) is positive. This implies that the short-run stability condition is met if saving adjusts faster than investment and the trade balance to changes in the rate of utilization, as discussed by Hein (2014, p.290).

The simple open economy version of the neo-Kaleckian model presented here maintains all the fundamental properties of Kaleckian analysis:[2]

1. Growth is demand-led through the investment channel;
2. The rate of capacity utilization is endogenous in the short-run, bearing the brunt of the adjustment of saving to investment and the trade balance;
3. A positive change in the animal spirits parameter (α) boosts accumulation (equation 3);
4. The paradox of thrift holds in the short run: an increase in the economy-wide tax-adjusted propensity to save (s) lowers the equilibrium utilization and accumulation rates;

Having sketched the basics of the model and its steady-state, let us now move to the consideration of out-of-equilibrium dynamics, formally analyzing the characteristics of the short-run traverse.

[2]It is worth noting that the paper relies on the consideration of a unique economy-wide tax-adjusted propensity to save. The main reason is to move beyond the traditional Cambridge assumption that wage earners do not save, thus making the analysis in Sections Three and Four more consistent with economic reality (Barbieri-Góes 2020). This way, however, issues related to shifts in the functional distribution of income take a back seat. In order to bring them back, the analysis should be extended by modeling the economy-wide propensity to save as equal to the average of the propensities to save out of wages and out of profits weighted by the respective factor shares and assuming the former to be greater than the latter, in line with the Kaleckian and Post-Keynesian literature. For the sake of analytical tractability, the paper abstains from this further step, that would, however, permit to recover two further postulates of Kaleckian analysis, i.e., the ideas that demand and growth are wage-led and that the paradox of cost holds in the short run. For a more extensive discussion, see Hein (2014, Sec. 7.2).

3. Analysis of the Adjustment Period

Firms are assumed to react to any supply-demand mismatch in the goods market through quantity adjustments. More specifically, with the principle of effective demand at work, firms will increase 'output and hence the rate of capacity utilization whenever aggregate demand [D_t below, *note of the author*] exceeds aggregate supply' (Lavoie 2014, p. 363).[3] Framing the adjustment in terms of changes in the utilization rate, it follows that:

$$\frac{\mathrm{d}u}{\mathrm{d}t} = u_t \frac{\mathrm{d}Y/\mathrm{d}t}{Y_t} = \frac{\mu(D_t - Y_t)}{Y_t}\frac{Y_t}{Y^p} = \frac{\mu(I_t + X_t - M_t - S_t)}{K}\frac{K}{Y^p} = \mu v(g_t + b_t - \sigma_t) \quad (15)$$

where μ is a parameter measuring the intensity and speed with which supply adjusts to demand. The parameter needs to be positive for the adjustment to be possible in the assumed direction, but not greater than 1 (instantaneous adjustment): $0 < \mu \leq 1$.

Rewriting and rearranging equation (15) in light of equations (9, 10 and 11), it follows that:

$$\frac{\mathrm{d}u}{\mathrm{d}t} = \mu[(\alpha + z)v - (s + m - \beta v)u_t] \quad (16)$$

Equation (16) is of key importance, as it constitutes the first-order linear differential equation that explains the motion of the neo-Kaleckian model in the short run. It postulates that entrepreneurs adjust the utilization of productive capacity on the basis of goods market conditions. More specifically, whenever investment demand and the trade balance fall short of (exceeds) the supply of savings, the rate of capacity utilization will decrease (increase) to match the new equilibrium in the goods market, making possible the *ex-post* adjustment of saving to investment and net exports. Moreover, the equation captures all the fundamental properties of the neo-Kaleckian model moving towards its new steady-state, postulating that changes in the rate of capacity utilization are positively related to changes in the animal spirits parameter (α) and the autonomous demand-capital ratio (z), and negatively related with changes in the tax-adjusted propensity to save (s), in line with the paradoxes of thrift. The general solution[4] of equation (16) is given by:

$$u_t = \frac{(\alpha + z)v - C\exp[-t\mu(s + m - \beta v)]}{s + m - \beta v} \quad (17)$$

where C is the constant of integration.[5]

Let us consider the case of an increase in the parameter capturing animal spirits (α).[6] Accordingly, from equation (14), it follows that the old and new steady-state values of the

[3] Given that the process takes place in the short run, potential output will not increase with output changes. Therefore, the percentage change of the rate of capacity utilization will be equal to that of output.

[4] The ordinary differential equation in equation (16) can be easily solved with most statistical software. For a formal proof, see Appendix 1.

[5] For further discussion, see Appendix 1.

[6] It is worth stressing that the mathematical derivation would yield the same result for the time of adjustment t_k even if the initial change would be in s, m, β or v. The analysis starts with a change in the parameter α merely because the mathematical derivation becomes more straightforward. In other terms, a shock in the parameters determining the Keynesian stability condition would affect the speed of the dynamic adjustment, but not its time structure, which is regulated by equation (26).

capacity utilization rate are, respectively:

$$u_0^* = \frac{(\alpha_0 + z)v}{s + m - \beta v} \quad \text{and} \quad u_1^* = \frac{(\alpha_1 + z)v}{s + m - \beta v} \tag{18}$$

Since $\alpha_1 > \alpha_0$, the new equilibrium rate of capacity utilization (u_1^*) will be greater than the initial one (u_0^*), i.e., $u_1^* > u_0^*$.

When the increase in animal spirits – from α_0 to α_1 – occurs at time $t = 0$, the system is still in its initial steady state corresponding to u_0^*, beginning the process of convergence to the position corresponding to the new equilibrium u_1^*. Accordingly, as the adjustment mechanism is now triggered, the general solution of the differential equation (16) will reflect the new value of the animal spirits parameter (α_1). In other terms, equation (17) at time $t = 0$ becomes:

$$u_0 = \frac{(\alpha_1 + z)v - \mathrm{C}\exp[-0\mu(s + m - \beta v)]}{s + m - \beta v} = \frac{(\alpha_1 + z)v - \mathrm{C}}{s + m - \beta v} \tag{19}$$

However, as discussed before, at $t = 0$ the system is in its short-run initial equilibrium, implying that u_0 in equation (19) must be equal to u_0^* in equation (18):

$$\frac{(\alpha_1 + z)v - \mathrm{C}}{s + m - \beta v} = \frac{(\alpha_0 + z)v}{s + m - \beta v} \tag{20}$$

Simplifying and rearranging, we have that the constant of integration C is equal to:

$$C = (\alpha_1 - \alpha_0)v \tag{21}$$

Therefore, equation (17) can be rewritten as follows:

$$u_t = \frac{(\alpha_1 + z)v - (\alpha_1 - \alpha_0)v\exp[-t\mu(s + m - \beta v)]}{s + m - \beta v} \tag{22}$$

At this stage, we ought to consider the difference between the two steady-states in equation (18):

$$\Delta u^* = u_1^* - u_0^* = \frac{(\alpha_1 - \alpha_0)v}{s + m - \beta v} \tag{23}$$

Let us now denote with t_k the time period corresponding to a k (percent) adjustment to the new steady-state value u_1^*. Accordingly, the amount of the adjustment in capacity utilization at time t_k is given by $k\Delta u^* = u_k - u_0^*$, implying that:

$$u_k = u_0^* + k\Delta u^* = \frac{(\alpha_0 + z)v + kv(\alpha_1 - \alpha_0)}{s + m - \beta v} \tag{24}$$

where u_k is the value of u_t at time t_k. Therefore, u_k must be equal to u_t in equation (22) with $t = t_k$. Equating the former with equation (24), it follows that:

$$\frac{(\alpha_1 + z)v - (\alpha_1 - \alpha_0)v\exp[-t_k\mu(s + m - \beta v)]}{s + m - \beta v} = \frac{(\alpha_0 + z)v + kv(\alpha_1 - \alpha_0)}{s + m - \beta v} \tag{25}$$

Simplifying and rearranging, we can explicitly solve equation (25) in terms of the adjustment period t_k, as follows:

$$t_k = \frac{-\ln(1-k)}{\mu(s+m-\beta v)} \tag{26}$$

Equation (26) provides an analytical relation between the adjustment period (more specifically, a k percent of the adjustment) and the other relevant parameters of the neo-Kaleckian model presented in Section Two. At first glance, it can be easily noted that there is an inverse relationship between the strength of the Keynesian stability condition and the time of adjustment, i.e., the greater $(s+m-\beta v)$, the smaller the k percent adjustment period t_k. Moreover, the time of adjustment t_k is inversely related with the parameter μ, that captures the speed and intensity with which entrepreneurs decide to adjust production to demand in the goods market.

Taken together, the two conditions mentioned in the previous paragraph imply that the time required for the utilization rate to adjust to a new steady-state position is fundamentally influenced by (i) the structure of production and demand embedded in the parameters determining the Keynesian stability condition (s, m, β and v) and (ii) the behavior of entrepreneurs underpinning their decisions to more rapidly/slowly respond to an aggregate demand shock by adjusting production (μ). In other terms, the more responsive is production to aggregate demand changes, and the more dynamic the behavior of entrepreneurs to such changes, the shorter will be the adjustment period.

Summing up, the inspection of equation 25 allows to state the following fundamental results:

1. The adjustment period does not depend neither on the initial nor on the new value of animal spirits (α);
2. The adjustment period does not depend neither on the initial nor on the new value of the autonomous demand-capital ratio (z);
3. The greater the propensity to save (s), the shorter the adjustment period;
4. The greater the propensity to import (m), the shorter the adjustment period;
5. The greater the capital-capacity ratio (v), the longer the adjustment period;
6. The greater the sensitivity of accumulation to changes in the rate of capacity utilization (β), the longer the adjustment period;
7. The greater is the speed and intensity of the adjustment of production to demand (μ), the shorter the adjustment period;
8. The greater the percentage of adjustment (k), the longer the adjustment period.

4. Parameter Values and Adjustment Time

This section provides a parameter calibration of the neo-Kaleckian model, in order to find an approximate time length for a given percentage of the adjustment to a new steady-state.[7] By relying on existing studies and BEA data, the calibration is carried out in light of the empirical evidence for the US economy in the period between 2002 and 2019, i.e., the years encompassing the Great Moderation and the Global Financial Crisis, before the COVID-19 Recession.

[7]The interested reader may refer to Gallo (2022) for a similar numerical exercise regarding the long-run traverse in demand-led growth models.

In order to be able to coherently interpret the results in calendar time, it is important to point out that we need to assume *a priori* that the adjustment of saving to investment does not occur faster than the unit period inherent in the data (Gandolfo 2012). In other terms, if we were to use an annual calibration (as most of the existing literature does), we would need to assume that the adjustment does not take place within a year. In the opposite case, it would be difficult to derive a plausible discrete-time representation of the adjustment process, as shown by Gandolfo (2012). For this reason, using an annual calibration is somewhat problematic in the case of fast processes. Accordingly, the model is calibrated at a quarterly frequency, under the more realistic assumption that the adjustment does not occur at higher frequencies (daily, weekly or monthly). Calibrating the accumulation rate and all other relevant parameters to account for quarter-on-quarter growth ensures that the unit period can be interpreted as a single quarter. Therefore, assuming that a quarter is a sufficiently small time step, we can then coherently provide a continuous-time representation of a discrete process.

In order to calibrate the quarterly capital-capacity ratio (v), let us decompose it as follows:

$$v = \frac{K}{Y^p} = \frac{K}{I}\frac{I}{Y}\frac{Y}{Y^p} = \frac{h_t u_t}{g_t} \tag{27}$$

Therefore, the capital-capacity ratio depends positively on the investment share (h_t) and on the rate of capacity utilization (u_t) and negatively on the accumulation rate (g_t). The benchmark value of the ratio is obtained from the analysis of capital dynamics in the US, in line with Fazzari, Ferri, and Variato. (2020, Supplementary Appendix). The authors abstain from the complicated matter of measuring capital and the problem of aggregating heterogeneous capital goods, thus not relying on BEA fixed assets data. Instead, they make use of national accounts and investment data to calibrate the capital-actual output ratio. In particular, they do so by starting from the empirical observation of the average investment share from 2002 to 2016 (equal to 12.5 percent) and of the annual gross capital accumulation rate (10.9 percent) - obtained as the sum of a yearly growth rate of 2.5 percent and a 8.4 percent depreciation rate. In quarterly frequency, the latter observation implies an accumulation rate of 2.62 percent.[8] With a private non-residential investment share of 12.65 percent and a rate of capacity utilization of 77 percent equal to the average measure of utilization from 2002 to 2019 equation (27) yields a quarterly capital-capacity ratio of 3.72.[9]

The value of the economy-wide propensity to save (s) is set to 0.5, in line with the empirical estimation of Blecker, Cauvel, and Kim. (2022) and the recent evidence and calibration exercise by Fazzari, Ferri, and Variato. (2020, Supplementary Appendix).

[8]The quarterly growth rate is obtained using the formula $g_{qtr} = (1 + g_{yr})^{1/4} - 1$.

[9]The adopted value of the investment share is just slightly above the one used by Fazzari, Ferri, and Variato. (2020), as the data is extended until the last quarter of 2019. In order to measure capacity utilization, the paper makes use of the average value of the Federal Reserve Board (FRB) measure of utilization from 2002 to 2019 (for data sources, see Appendix 2). It should be noted that there is no definite consensus on whether the FRB index is the most appropriate measure of the degree of capacity utilization. For a critical discussion, the reader should refer to Nikiforos (2016) and Gahn and González. (2020). However, the empirical controversies on the use of FRB data are centered on the discussion of the stationarity of the series and thus on the opportunity of using it to properly measure long-run variations of utilization. The purpose of the current exercise is rather different, as the average value of the rate of capacity utilization is used as a mere benchmark; the adoption of a different measure of utilization to calibrate the model would have no effect on the overall results.

The value of the propensity to import (m) is obtained by calculating imports of goods and services in percent of GDP from 2002Q1 to 2019Q4 and averaging the time series; the result yields $m = 17$ percent.

The expected growth rate of sales (α) is calibrated using quarterly real GDP growth as a proxy of expected revenues, yielding an average growth rate of 0.51 percent at quarterly rates from 2002 to 2019. Furthermore, the parameter that captures the impact of the rate of capacity utilization on accumulation (β) and the autonomous demand-capital ratio (z) are both set to match the above-mentioned steady-state values of the degree of capacity utilization and the quarterly accumulation rate.[10] Let us now move to the discussion of the value of the parameter capturing the speed and intensity of the adjustment of production to demand (μ). Given the difficulty associated with inferring it from empirical evidence, we assume it to be 0.75 in the baseline scenario, then allowing it to vary between a lower value of 0.5 and a higher value of 0.9. This implies that every quarter entrepreneurs respond to goods market conditions by adjusting production in a order of magnitude between 50 percent and 90 percent of the change in demand.

The parameter values are summarized in Table 1.

Under the baseline parameter constellation (with $\mu = 0.75$), we can now explicitly compute the adjustment period.[11] Defining vicinity to the new steady-state position as 90 percent of the total adjustment, it follows that:

$$t_{0.90} = \frac{-\ln(1-0.90)}{0.75(0.5+0.17-0.0274 \times 3.72)} \approx 5 \text{ quarters} \approx 1 \text{ year} \tag{28}$$

Therefore, the model approaches the new steady-state in about 1 year, reaching it almost entirely (99 percent of the total adjustment) in about 2 years:

$$t_{0.99} = \frac{-\ln(1-0.99)}{0.75(0.5+0.17-0.0274 \times 3.72)} \approx 10 \text{ quarters} \approx 2 \text{ year} \tag{29}$$

The results slightly change when we assume a different speed of adjustment of production to demand (μ). In particular, reducing μ to 0.5 lengthen the time required for a 90 percent and 99 percent adjustment to about 8 and 16 quarters, respectively. Conversely, a faster adjustment in the goods market ($\mu = 0.9$) produces a slight reduction of the time required to approach the new steady-state position u_1^* (with $t_{0.90} \approx 4$ quarters and $t_{0.99} \approx 9$ quarters).

Figure 1 provides a graphical illustration of the adjustment process under the parameter calibration described above, following an initial increase in the expected growth rate of sales (α) and allowing for three different values of μ. The dotted lines match the time needed for a 90 percent adjustment to the new equilibrium u_1^* under the three different parameter sets.

Therefore, under the baseline parameter calibration, vicinity (90 percent) of the new equilibrium in the model is reached after a period of about 5 quarters (9 quarters for 99

[10] It is worth noting that since neither a nor z have an effect on the length of the adjustment period, their calibration is merely carried out for expositional purposes.

[11] Since the main scope of the paper is analytical rather than empirical, it does not include a sensitivity analysis, thus deriving the qualitative results from the benchmark values reported above. However, the interested reader may easily perform a re-parameterization of the neo-Kaleckian model using the resource reported in the Online Appendix 3.

Table 1. Parameter values.

Par.	Description	Value	Source
v	Capital-capacity ratio (quarterly)	3.7204	Author's calculation, based on Fazzari, Ferri, and Variato. (2020)
s	Propensity to save	0.5	Fazzari, Ferri, and Variato. (2020); Blecker, Cauvel, and Kim. (2022)
m	Propensity to import	0.17	Author's calculation, based on BEA data (See Appendix 2)
α	Animal spirits	0.0051	Author's calculation, based on BEA data (See Appendix 2)
β	Impact of u_t on the accumulation rate	0.0274	Author's calculation
z	Autonomous demand-capital ratio	0.1126	Author's calculation
μ	Speed of adjustment (quarterly)	0.75; 0.5; 0.9	Author's assumption
k	Percentage of the adjustment	0.90; 0.99	–

Source: author's calculation, various sources (see Appendix 2).

percent of the adjustment). This consideration implies that, in historical time, the neo-Kaleckian model presented here is characterized by a relatively fast pace of adjustment, compatible with the time span of short-run processes as defined by Angeletos, Collard, and Dellas. (2020).

Before drawing conclusions from the analysis conducted above, two important remarks are in order. First, the analysis of the short-run traverse in the neo-Kaleckian model rests on a framework that, although simple, embeds an open economy with government activity and autonomous consumption spending. Conducting the same calibration exercise on a simpler model that does not account for foreign trade, government activity and/or autonomous consumption may lead to misleading conclusions regarding the time of adjustment needed for the transition between steady states.[12] Second, even though the calibration exercise is conducted in light of empirical evidence for the US economy, this does not imply that economic reality follows the same adjustment path postulated by the model. In other terms, the analysis does not provide any empirical support whatsoever to the Kaleckian claim that the rate of capacity utilization is endogenous in the short run, nor to the implication of a stable convergence of saving to investment. Rigorous econometric analysis aimed at supporting or disproving Kaleckian investment and output theory is therefore still needed, leaving space to further research on the matter.

5. Concluding Remarks

The paper presents a simple open economy neo-Kaleckian model with autonomous components of aggregate demand. Most importantly, it finds an analytical solution to the differential equation that regulates the motion of the neo-Kaleckian model in the short run. In line with the methodology introduced by Sato (1963, 1964, 1980), the analysis provides and discusses a general solution to the ordinary differential equation that explains out-of-equilibrium dynamics in the model. Subsequently, the effect of an increase in animal spirits is considered, rewriting the general solution of the neo-Kaleckian model in terms of the time of adjustment t_k, i.e., the time required for the system to make a k percent adjustment to the new steady-state.

[12] I wish to thank Robert Blecker for pointing this out to me.

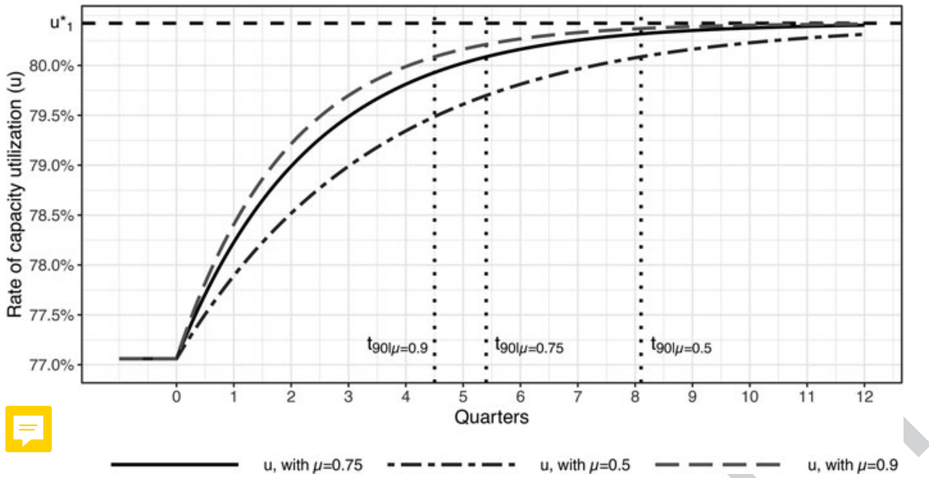

Figure 1. The adjustment of the rate of capacity utilization to an increase in α at $t = 0$. Source: authors' representation

The explicit analysis of the short-run traverse in the neo-Kaleckian model yields few fundamental results. First, the time of adjustment is not affected by changes neither in the animal spirits parameter (α) nor in the autonomous demand-capital ratio (z). Second, the adjustment period depends negatively on the propensity to save (s) and on the propensity to import (m). Third, t_k is in a direct relation with the capital-capacity ratio (v) and with the sensitivity of accumulation to changes in the rate of capacity utilization (β). Fourth, there is an indirect relation between the speed and intensity of the adjustment of production to demand (μ) and the time of adjustment. Taken together, these conditions imply that the time it takes for the utilization rate to adjust is largely determined by (i) the structural determinants of production and demand embedded in the Keynesian stability condition and (ii) the behavior of entrepreneurs underlying their decisions to adjust production more quickly or slowly in response to a change in goods market conditions. In other words, the more responsive production is to aggregate demand changes, and the more dynamic the behavior of entrepreneurs to such changes, the shorter will be the adjustment period.

Last, the paper performs a parameterization of the neo-Kaleckian model in line with empirical evidence and recent Post-Keynesian literature. The calibration exercise shows that, under a reasonable parameter constellation, vicinity of the new equilibrium defined as 90 percent of the total adjustment is reached after a period of about 4 to 9 quarters (depending on the value of μ), and the model almost settles in the new steady state (99 percent of the adjustment) after about 9 to 16 quarters. This result, implying a relatively fast pace of adjustment compatible with short-run processes, provides more solid foundation to Lavoie's (2018, p. 9) claim reported in the introduction that the neo-Kaleckian model is better suited for short and medium-run analysis rather than for giving a proper representation of long-run macrodynamics. While the investment theory upon which the neo-Kaleckian model rests needs to be further assessed empirically, the analysis of the short-run traverse conducted in the present contribution calls for a closer connection between the neo-Kaleckian model of growth and distribution and Kalecki's original business cycle theory. As the neo-Kaleckian model appears to be moving between steady-state positions at business cycle frequencies (Angeletos, Collard, and Dellas. 2020), the former is consistent with Kalecki's idea that the short run is characterized by damped oscillations perturbed continuously by stochastic shocks that generate semi-regular cyclical movements (Kalecki 1971, pp. 134-135).

On a more general level, the analysis conducted in the paper points to the importance of explicitly taking into account the time scale of steady-state growth models when describing their comparative dynamic effects and policy implications, thus coherently combine logical-time analysis and real-world historical time, as advocated by Joan Robinson (1980). In this respect, the paper has analytically showed the validity of the line of argument put forward by Henry (1987), Park (1995) and Lavoie (2016, p.183-184) on the importance of paying more attention to the values that the relevant variables of a system take *during the traverse* rather than to their *potential* steady-state values. Whilst the ultimate assessment of the validity of the neo-Kaleckian model for policy analysis ought to rest on rigorous empirical investigation, this contribution wishes to set the ground for a new agenda for Kaleckian authors and demand-led growth theorists, suggesting to move away from the comfortable but limited realm of comparative dynamics and think more carefully about the properties exhibited by economic models *during the traverse*. The comparison between steady-state positions is undoubtedly useful to grasp the logic of a model as it moves from one equilibrium to another, but it needs to be coupled with a precise description of the model's out-of-equilibrium trajectory if we want to provide a valid representation of a real-world economy operating in historical time on human time scales.

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References

Amadeo, E. 1986. 'The Role of Capacity Utilization in the Long Period Analysis.' *Political Economy Studies in the Surplus Approach* 2 (2): 147–160.

Angeletos, G., F. Collard, and H. Dellas. 2020. 'Business-Cycle Anatomy.' *American Economic Review* 110 (10): 3030–3070.

Barbieri-Góes, M. 2020. 'Personal Income Distribution and Progressive Taxation in a Neo-Kaleckian Model: Insights From the Italian Case.' *Review of Political Economy* 32 (4): 615–639.

Blecker, R., M. Cauvel, and Y. Kim. 2022. 'Systems Estimation of a Structural Model of Distribution and Demand in the US Economy.' *Cambridge Journal of Economics* 46 (2): 391–420. doi:10.1093/cje/beab052

Blecker, R., and M. Setterfield. 2019. *Heterodox Macroeconomics: Models of Demand, Distribution and Growth*. Edward Elgar Publishing. Q7

Dávila-Fernández, M., J. Oreiro, and L. Punzo. 2019. 'Inconsistency and Over-Determination in Neo-Kaleckian Growth Models: A Note.' *Metroeconomica* 70 (2): 313–319.

Del Monte, A. 1975. 'Grado Di Monopolio E Sviluppo Economico.' *Rivista Internazionale di Scienze Sociali* 46 (Fasc. 3): 231–263.

Dutt, A. 1984. 'Stagnation, Income Distribution and Monopoly Power.' *Cambridge Journal of Economics*8 (1): 25–40. doi:10.1093/oxfordjournals.cje.a035533

Fazzari, S., P. Ferri, and A. Variato. 2020. 'Demand-Led Growth and Accommodating Supply.' *Cambridge Journal of Economics* 44 (3): 583–605.

Franke, R. 2017. 'A Simple Approach to Overcome the Problems Arising From the Keynesian Stability Condition.' *European Journal of Economics and Economic Policies: Intervention* 14 (1): 48–69.

Gahn, S., and A. González. 2020. 'On the 'Utilisation Controversy': A Comment.' *Cambridge Journal of Economics* 44 (3): 703–707.

Gallo, E. 2022. 'When is the Long Run? Historical Time and Adjustment Periods in Demand-Led Growth Models.' *Metroeconomica* 1–24. doi:10.1111/meca.12400 Q8

Gandolfo, G. 2012. *Continuous-Time Econometrics: Theory and Applications*. Springer Science & Business Media. Q9

Girardi, D., and R Pariboni. 2019. 'Normal Utilization As the Adjusting Variable in Neo-Kaleckian Growth Models: A Critique.' *Metroeconomica* 70 (2): 341–358.

Hein, E. 2014. *Distribution and Growth After Keynes: A post-Keynesian Guide*. Cheltenam: Edward Elgar.

Henry, J. 1987. 'Equilibrium As a Process.' *Économie Appliquée* 40 (3): 463–482.

Kalecki, M. 1954. *Theory of Economic Dynamics: An Essay on Cyclical and Long-Run Changes in Capitalist Economy*. Rinehart & Company. Q10

Kalecki, M. 1971. *Selected Essays on the Dynamics of the Capitalist Economy 1933–1970*. Cambridge University Press. Q11

Lavoie, M. 2010. Surveying Short-Run and Long-Run Stability Issues with the Kaleckian Model of Growth. In *Handbook of Alternative Theories of Economic Growth*, edited by M. Setterfield, Edward Elgar Publishing. Q12

Q13 Lavoie, M. 2014. *Post-Keynesian Economics: New Foundations*. Edward Elgar.

Lavoie, M. 2016. 'Convergence Towards the Normal Rate of Capacity Utilization in Neo-Kaleckian Models: The Role of Non-Capacity Creating Autonomous Expenditures.' *Metroeconomica* 67 (1): 172–201.

Lavoie, M. 2018. 'Interview with Marc Lavoie: 'The Vigorous Critique of the Neo-Kaleckian Or Post-Kaleckian Growth Model is a Measure of Its Success'.' *interview by Hein, E., European Journal of Economics and Economic Policies* 15 (1): 2–11.

Nikiforos, M. 2016. 'On the 'Utilisation Controversy': A Theoretical and Empirical Discussion of the Kaleckian Model of Growth and Distribution.' *Cambridge Journal of Economics* 40 (2): 437–467.

Park, M. 1995. 'A Note on the "Kalecki–Steindl" Steady-State Approach to Growth and Income Distribution.' *The Manchester School of Economic & Social Studies* 63 (3): 297–310.

Robinson, J. 1980. 'Time in Economic Theory.' *Kyklos* 33 (2): 219–229.

Rowthorn, B. 1981. *Demand, Real Wages and Economic Growth*. Thames Papers in Political Economy. Thames Polytechnics. Q14

Sato, R. 1963. 'Fiscal Policy in a Neo-Classical Growth Model: An Analysis of Time Required for Equilibrating Adjustment.' *The Review of Economic Studies* 30 (1): 16–23.

Sato, R. 1964. 'The Harrod–Domar Model Vs the Neo-Classical Growth Model.' *The Economic Journal*74 (294): 380–387.

Sato, R. 1980. 'Adjustment Time and Economic Growth Revisited.' *Journal of Macroeconomics* 2 (3): 239–246.

Skott, P. 2010. Growth, Instability and Cycles: Harrodian and Kaleckian Models of Accumulation and Income Distribution. In *Handbook of Alternative Theories of Economic Growth*, edited by M. Setterfield, Edward Elgar Publishing. Q15

Skott, P. 2012. 'Theoretical and Empirical Shortcomings of the Kaleckian Investment Function.' *Metroeconomica* 63 (1): 109–138.

Steindl, J. 1952. *Maturity and Stagnation in American Capitalism. Monthly Review Press Classic Titles*. Monthly Review Press.

Taylor, L. 1983. *Structuralist Macroeconomics: Applicable Models for the Third World*. New York: Basic Books.

Appendix 1. Proof of the General Solution in Equation 17

1. In order to prove that equation (17) is the general solution of the ordinary differential equation (16), let us first conveniently simplify the notation. In particular, let us denote with the term K the Keynesian stability condition, i.e., $K = s + m - \beta v > 0$. Therefore, equation (16) becomes:

$$\frac{\mathrm{d}u}{\mathrm{d}t} = (\alpha + z)\mu v - \mu K u_t \tag{A1}$$

2. Rewrite equation (A1) in the form $\mathrm{d}y/\mathrm{d}t + p_t y_t = q$, as follows:

$$\frac{\mathrm{d}u}{\mathrm{d}t} + \mu K u_t = (\alpha + z)\mu v \tag{A2}$$

which implies that $p_t = \mu K$ and $q = (\alpha + z)\mu v$.

3. Let us find the integrating factor (η_t), i.e., the continuous function that satisfies the condition $\eta_t p_t = \eta_t'$, as follows:

$$\eta_t = \mathbf{e}^{\int \mu K \mathrm{d}t} = \mathbf{e}^{\mu K t} \tag{A3}$$

4. Let us now multiply all the terms in the differential equation (A2) by the integrating factor:

$$\mathbf{e}^{\mu K t}\frac{\mathrm{d}u}{\mathrm{d}t} + \mu K\, \mathbf{e}^{\mu K t} u_t = (\alpha + z)\mu v\, \mathbf{e}^{\mu K t} \tag{A4}$$

$$\left(\mathbf{e}^{\mu K t} u_t\right)' = (\alpha + z)\mu v\, \mathbf{e}^{\mu K t} \tag{A5}$$

5. Integrating both sides of equation (A5), it follows that:

$$\int \left(\mathbf{e}^{\mu K t} u_t\right)' \mathrm{d}t = \int (\alpha + z)\mu v\, \mathbf{e}^{\mu K t}\, \mathrm{d}t \tag{A6}$$

$$\mathbf{e}^{\mu K t} u_t + k = \frac{(\alpha + z)\mu v}{\mu K}\, \mathbf{e}^{\mu K t} + c \tag{A7}$$

6. Subtracting k from both sides, we get:

$$\mathbf{e}^{\mu K t} u_t = \frac{(\alpha + z)v}{K}\, \mathbf{e}^{\mu K t} + c - k \tag{A8}$$

7. Both c and k are unknown constants and so the difference is also an unknown constant. Therefore, we can write the difference as $c_1 = c - k$:

$$\mathbf{e}^{\mu K t} u_t = \frac{(\alpha + z)v}{K}\, \mathbf{e}^{\mu K t} + c_1 \tag{A9}$$

8. We now have only one constant of integration c_1. It should be noted that the constant c_1 is negative for economically meaningful initial values of the rate of capacity utilization (if $u_0 > 0$, then $c_1 < 0$). For convenience, let us then define another constant C as $C = -c_1/K$. Therefore, equation (A9) becomes:

$$\mathbf{e}^{\mu K t} u_t = \frac{(\alpha + z)v\, \mathbf{e}^{\mu K t} - C}{K} \tag{A10}$$

9. Multiplying both sides by $\mathbf{e}^{-\mu K t}$, we can obtain the general solution to the ODE that regulates out-of-equilibrium dynamics in the model, as follows:

$$u_t = \frac{(\alpha + z)v - C\, \mathbf{e}^{-\mu K t}}{K} \tag{A11}$$

10. Last, substituting $K = s + m - \beta v$, we can write u_t as follows:

$$u_t = \frac{(\alpha + z)v - C \exp[-t\mu(s + m - \beta v)]}{s + m - \beta v} \tag{A12}$$

Appendix 2. Data Sources

- Capacity Utilization, Rate, All industry, SA, Federal Reserve Board (FRB), https://fred.stlouisfed.org/series/TCU
- Gross Domestic Product, Overall, Total, Constant Prices, SA, USD, 2012 Chained Prices, BEA – Bureau of Economic Analysis, U.S. Department of Commerce, https://www.bea.gov/data/gdp/gross-domestic-product
- Private Fixed Investment, Nonresidential, Total, Constant Prices, SA, USD, 2012 Chained Prices, BEA – Bureau of Economic Analysis, U.S. Department of Commerce, https://www.bea.gov/data/gdp/gross-domestic-product
- Imports, Goods and Services, Total, Constant Prices, SA, USD, 2012 Chained Prices, BEA – Bureau of Economic Analysis, U.S. Department of Commerce, https://www.bea.gov/data/gdp/gross-domestic-product

All weblinks last accessed on September 26, 2021.

Online Appendix 3. Sensitivity Analysis

The interested reader could easily perform a re-parameterization of the neo-Kaleckian model under scrutiny through the following interactive Web App – created with Shiny R: https://ettoregallo.shinyapps.io/Short_run_NKM/.