Hochschule für
Wirtschaft und Recht Berlin
Berlin School of Economics and Law

Eckhard Hein

MACROECONOMICS AFTER KALECKI AND KEYNES

Post-Keynesian Foundations

(Edward Elgar 2023)

Chapter 9
'FACING ECOLOGICAL CONSTRAINTS: IMPLICATIONS AND CHALLENGES FOR SHORT- AND LONG-RUN MACROECONOMIC STABILITY AND MACROECONOMIC POLICIES'

Content

9.1 Introduction

9.2 Post-Keynesian economics and Ecological economics

9.3 Green growth, zero growth or de-growth to fight climate change?

9.4 Can zero growth be stable in a monetary production economy?

9.1 INTRODUCTION

- Daly (1973, 1974), Meadows et al. (1972) and Georgescu-Roegen (1971): degradation of the earth's carrying capacity

- Ecological economics (Costanza 1989, Gowdy and Erickson 2005): economic activities are embedded in nature, or in the bio-physical system, and are constrained by the first and second law of thermodynamics (the conservation of energy and the law of entropy), the complexity of intertwined natural processes, and the exhaustibility of natural resources

- Consistencies and complementarities of Ecological economics with post-Keynesian economics

- Integration of the implications of environmental constraints into post-Keynesian demand driven macroeconomic models has only recently been attempted (Rezai and Stagl 2016)

9.2 POST-KEYNESIAN ECONOMICS AND ECOLOGICAL ECONOMICS

Early post-Keynesian perspectives

- Bird (1982): fundamental uncertainty undermines neoclassical environment and resource economics with its concept of inter-temporal optimisation in perfect future markets and efficient allocation of resources inter and intra-generationally in the face of scarce and depleting resources.

- Berr (2009): Keynes's work is consistent with sustainable development and a strong sustainability approach

- Substitution of scarce resources and reversibility of damages cannot be generally expected due to hysteresis and path dependencies

- Bird (1982) and Berr (2009, 2015): role of economic and political power, distributional issues and the role of policies when it comes to dealing with ecological constraints, with Berr (2009, 2015) pointing out the relevance of Kalecki's contributions

Ecological economics views:

Gowdy (1991): 'Bioeconomics' and post-Keynesian economics have much in common regarding underlying methodological framework

- the emphasis on the role of production rather than exchange
- the indeterminacy of the social rate of discount, which plays a major role for inter-temporal equilibria in Neoclassical environmental and resource economics.
- However, different and potentially conflicting attitudes towards growth in these two heterodox schools.

Kronenberg (2010): complementarities between PK and EE

- EE has pointed out that growth of the global economy may be incompatible with improving welfare given the environmental constraints,
- PKs have analysed the determination and the dynamics of growth in a capitalist, monetary production economy.

Kronenberg (2010):

- Production: PK and EE reject the aggregate neoclassical production function and rely on fixed coefficient/Leontief-type production functions with constant input-output ratios for a given technology in the short run.
- Consumption: PK and EE reject the hyper-rational utility maximising homo oeconomicus from Neoclassical economics and argue that, under the conditions of fundamental uncertainty, individuals apply procedural rationality and show satisficing behaviour.
- Dynamics: PK and EE are inherently dynamic, fundamental uncertainty, irreversibility and path dependence matter
- Economic policies: government intervention is required to stabilise the long-run growth rate, in EE consistent with ecological constraints, in PK consistent with full employment.

➢ PKs have to take ecological issues when designing full employment policies, EEs have to take into account the macroeconomic and employment implications of environmentally consistent GDP growth, which in their view may mean zero growth or even de-growth

Current PK perspective:

Fontana and Sawyer (2013, 2014, 2016) provide important conceptual attempts for integrating environmental constraints into PK macro, making use of Monetary Circuit and post-Keynesian growth theory, present a simple post-Kaleckian demand-led growth model and distinguish:

- the warranted growth rate, i.e. the growth rate which keeps the goods market equilibrium output and capacity utilisation at the firms' targets,
- the full employment growth rate
- the growth rate allowed by a sustainable ‘ecological footprint’

➢ growth rates are independent of each other and there are no automatic adjustments that align them
➢ economic policy interventions will be crucial for the transition towards ecological sustainability

9.3 GREEN GROWTH, ZERO GROWTH OR DE-GROWTH TO FIGHT CLIMATE CHANGE?

- Paris Agreement 2015: limit global warming to well below 2° C, preferably to 1.5° C compared to pre-industrial levels (UN 2015).
- IPCC (2018): global net carbon dioxide (CO2) emissions will have to fall by about 45 per cent by 2030 and to zero by 2050 in order to reach a maximum global mean temperature increase of 1.5° C by 2100.
- Possibility of decoupling economic growth from negative environmental impact by stimulating green investments and green growth: European Green Deal (European Commission 2019b) or the OECD Green Growth Strategy (OECD 2015)
- Non-growing or even a de-growing economy is necessary if we are to achieve ecological sustainability (Jackson 2017, Victor 2008).
- Daly (1973, 1996): stationary state economy is required
- Zero-growth and de-growth proponents, Hickel (2019), Hickel and Kallis (2020), Kallis (2011), Kallis et al. (2012) and Mastini et al. (2021): to meet ambitious ecological targets, de-growth is required
- Downscaling of material throughput, will most likely lead to stagnant or shrinking real GDP, which is not a good welfare indicator

➢ But lack of macroanalysis in much of the de-growth work

- GDP may not be a good welfare indicator, but is still a good indicator for the level of economic activity and employment in a monetary production economy, as are wage and profit shares in GDP for income distribution.
- Relationship between greenhouse gas emissions and real GDP and macroeconomic effects of de-growth are important

Relationship of the CO2 emissions and real GDP: Kaya identity (Kaya and Yokoburi 1997).

(9.1) $$E = \frac{E}{J}\frac{J}{Y}Y = qjY ,$$

with Y for real GDP, J for the use of energy and E for the related CO2 and other greenhouse gas emissions, q for the CO2-energy ratio, the carbon footprint of the use of energy, and j for the energy-real GDP ratio, the energy intensity of real GDP.

For the respective growth rates, we have:

(9.2) $\hat{E} = \hat{q} + \hat{j} + \hat{Y}$.

The reduction in CO2 emissions can thus be achieved:

- by a reduction in the carbon footprint of energy and
- in the energy intensity of real GDP, i.e. by green technological change,
- and/or by a reduction in real GDP.

Technology optimists (green growth and absolute decoupling) vs. pessimists (no absolute decoupling, but de-growth)

The relationship between real GDP, population (P), labour force (L), employment (N), and hours worked (H) is given in the following way:

(9.3) $$Y = \frac{Y}{H}\frac{H}{N}\frac{N}{L}\frac{L}{P}P = ynelP\,,$$

with y as labour productivity per hour worked, n hours worked per person, e the employment rate and l the labour force participation rate. For the respective growth rates we have:

(9.4) $$\hat{Y} = \hat{y} + \hat{n} + \hat{e} + \hat{l} + \hat{P}\,.$$

By definition, therefore, real GDP can thus fall

- through a decline in productivity, i.e. through sectoral change towards more labour intensive sectors of production with lower labour productivity, usual towards green industries and service sectors,
- through a decline in hours worked per person, i.e. through shortening daily, weekly, monthly or annual working time,
- through a decline in the employment rate, i.e. an increase in the unemployment rate,
- through a decline in the labour force participation rate, i.e. through longer periods of education and earlier retirements, or through the exclusions of certain groups from the labour market,
- through a fall in population.

Substituting equation (9.4) into equation (9.2) shows all the logical possibilities by means of which CO2 emissions can be reduced:

(9.5) $$\hat{E} = \hat{q} + \hat{j} + \hat{y} + \hat{n} + \hat{e} + \hat{l} + \hat{P}\,.$$

Macroeconomic de-growth or zero-growth scenarios have been modelled by Victor (2012) and Jackson and Victor (2020) for the Canadian economy

Victor (2012): a stable de-growth scenario in a demand-driven model with a neoclassical aggregate production function.

- Over a 30-years period from 2005 to 2035, GHG emissions fall by 80 per cent and GDP per capita falls by 40 per cent to the level of 1976.
- This is mainly achieved through a cut of working time by 70 per cent, which allows unemployment to stay roughly stable.
- Population grow this assumed to be zero, government expenditures fall by 50 per cent, significant rise in carbon taxes, which lowers the emission intensity of real GDP through incentives for technical change towards green technologies

Jackson and Victor (2020): stock-flow consistent (SFC) macroeconomic simulation model for Canada

- Higher labour productivity increases real wages, which then increase consumption leading to a kind of growth imperative.
- Working time reduction per person is used to reduce GDP growth and to maintain employment.
- Carbon reduction scenario in which green investments (in renewable energies and the electrification of transport) are introduced to reduce Canada's carbon emissions.
- Sustainable prosperity scenario: assumes a constant population, a decline of working hours per person and significant transfer payments to mitigate inequality, on top of green investment.
- Sustainable stability scenario generates constant real GDP for a 50 years period, from 2017 to 2067, and achieves zero net carbon emission by 2040. Government debt-GDP ratios slightly rise but then stabilise.

Pollin (2018) Green growth, at least during a long transition period growth in energy efficiency and clean renewable energy investments

- between 2000 and 2014, 21 countries, including the US, Germany, the UK, Spain and Sweden, managed to absolutely decouple GDP growth from CO2 emissions
- Green New Deal: worldwide programme to invest between 1.5 and 2 per cent of global GDP every year in energy efficiency (in the stock of buildings, automobiles and public transportation systems) and clean renewable energy supplies (solar, wind, biomass), within 40 to 50 years, CO2 emissions could be eliminated altogether

- Pollin (2021): active industrial policies investment in energy efficiency and renewable energies of 2.5 per cent of global GDP per year between 2024 and 2050 would bring down CO2 emissions to zero at the end of this 25 years period.

- Pollin (2020) argues that the European Green Deal (European Commission 2019b) is basically in line with such a strategy, but needs to be scaled up massively.

Priewe (2022): critical of zero-growth or de-growth strategies to achieve the Paris goals.

- Since 1990 emerging economies (including China and India, of course) have been the key contributors to greenhouse gas emissions.
- Scenarios of a global transition towards zero CO2 emissions show that the reduction of the emission-GDP ratio is far more important than reducing real GDP growth.
- Low green growth, and in the long run even zero growth, for the global North and moderate green growth for the global South as an economic policy orientation.

- Dafermos et al. (2017): stock-flow-fund ecological macroeconomic model, which combines the SFC approach of Godley and Lavoie (2007) with the flow-fund model of Georgescu-Roegen (1971).

- Dafermos and Nikolaidi (2019): different green fiscal policy options for the ecological transition: carbon taxes, green subsidies and green public investment;
- Recommend a green fiscal policy mix of carbon taxes and green investments.

- Dafermos et al. (2018): effects of climate change on financial stability
- By destroying firms' capital and reducing their profitability, climate change reduces the liquidity position of firms, increases the rates of default, lowers the prices of corporate bonds and thus raises interest rates.
- Green corporate QE policies of central banks can help to reduce climate change induced financial instability, stimulate green investment and contribute to restricting CO2 emissions and global warming

Distributional issues

Chancel and Piketty (2015) and Ivanova and Wood (2020): CO2 and other greenhouse gas emissions are concentrated at the top end of personal or household income distribution

- Chancel and Piketty (2015): global analysis: top 1% richest Americans, Luxemburgers, Singaporeans, and Saudi Arabians are the highest individual CO2 emitters in the world

- Ivanova and Wood (2020): study on the EU: top 1% of EU households have the highest per capita carbon footprint. The top 10% of the population account for 27% of the EU carbon footprint, which is much higher than that of the bottom 50% of the population.

9.4 CAN ZERO GROWTH BE STABLE IN A MONETARY PRODUCTION ECONOMY?

9.4.1 SOME VIEWS ON THE FEASIBILITY OF ZERO GROWTH

- In the long run environmental constraints will require lower and maybe even zero growth of real GDP.
- If climate change can be stopped by a timely and successful reduction of CO2 emission to zero, other ecological constraints, like the depletion of exhaustible resources, the limits of sinks etc., may then become binding.

Fontana and Sawyer (2022): a zero-growth economy would have to address the following issues:

- bringing net investment down to zero
- zero growth and positive profits
- zero growth, endogenous credit and positive interest rates, and the stability of the financial system.
- full employment in a stationary economy with productivity growth

- De-growth proponents are rather sceptical whether de-growth or a stationary economy are possible within a capitalist system (Berend Blauwhof 2012, Kallis 2011, Kallis et al. 2012).

- Growth is a systemic requirement of capitalism, because of an inherent pressure on capitalists to accumulate, as claimed in Marxian theory (Harvey 2007)

- Growth imperative is exerted by endogenous credit and a positive interest rate, as derived in some Keynesian inspired theory (Binswanger 2009).

- Richters and Siemoneit (2019): systematic and instructive discussion about growth imperatives and growth drivers, which goes beyond our macroeconomic discussion

Macroeconomic conditions for a stationary economy

Lange (2018): post-Keynesian theory can be compatible with zero growth.

- With technological change, reductions in working hours and compensatory wage increases are necessary to avoid rising unemployment.
- Positive profits must be matched with a sufficiently high level of consumption out of profits, saving must be equal to zero.
- No analysis of the conditions under which such a stationary economy is dynamically stable.

Rosenbaum (2015): stable zero growth and technological progress in a Kaleckian model with fixed capital costs, but several flaws as shown by Monserrand (2020)

Monserand (2019): zero or de-growth in a basic neo-Kaleckian distribution and growth model

- autonomous consumption and/or government deficits allows for a stable goods market equilibrium with zero investment but positive profits
- no financial flows and stability analysis

Berg et al. (2015): SFC model plus input-output approach.

- Equilibrium, i.e. constant stock-flow ratios, is possible, depending on the parameters regarding the propensity to consume out of wealth and the rate of interest on deposits

Cahen-Fourot and Lavoie (2016): SFC model for a stationary economy and an endogenous determination of debt in the stationary state

- credit-money and positive interest rates are compatible with a stationary economy.
- saving out of income has to be compensated with consumption out of wealth

Jackson and Victor (2015): SFC model with a more differentiated banking sector, including a central bank and commercial banks.

- for a stationary state minimum consumption out of wealth is required

➢ No general stability analysis

Richters and Siemoneit (2017): review of several models

- a stationary state with positive profits and interest rates is only possible under the condition that each sector is running neither financial deficits nor surpluses
- ratios of financial assets or liabilities to income (or the capital stock) remain constant, hence no systemic instability
- ➢ no general stability analysis

Hein and Jimenez (2022): stepwise process

- national income accounting and a monetary circuit approach for a closed economy without technical change: a stationary state is compatible with positive profits, endogenous credit and a positive interest rate
- Kaleckian distribution and growth model driven by autonomous government demand: conditions under which a stationary equilibrium is dynamically stable.

9.4.2 AN ACCOUNTING PERSPECTIVE ON ZERO GROWTH

For a stationary goods market equilibrium, effective demand must be sufficient to generate and reproduce stationary output over time.
From national income accounting, output (Y_P), here net of depreciation, is given as the sum of private consumption out of rentiers' income (C_R) and out of wages (C_W), government consumption expenditures (G), net investment (I), revenues from exports of goods and services (Ex), and expenditures on imports of goods and services (Im), all variables in real terms:

(9.6) $$Y_P = C_R + C_W + G + I + Ex - Im.$$

It is assumed that depreciations are re-invested, so that the focus can be on output and income net of depreciations.

- For total income (Y), government interest payments to rentiers ($R_{GR} = iB_{GR}$) are included, with B_{GR} for the stock of government debt and i for the rate of interest on that debt.
- This income has to be added to the income generated in production, which is equal to the sum of total wages (W) and total profits ($\Pi = \Pi_F + R_{FR}$).
- Profits from production is the sum of retained profits (Π_F) and distributed profits (including interest and dividends) equal to rentiers' income from firms (R_{FR}).
- Assuming that both wages and profits are taxed, wages can be split into net wages and taxes on wages ($W = W^{net} + T_W$), retained profits into net retained profits and taxes on retained profits ($\Pi_F^T = \Pi_F^{net} + T_F$), rentiers' income from firms into their net income from firms and taxes on that income ($R_{FR} = R_{FR}^{net} + T_{FR}$), and rentiers' income from the government into net interest revenues from the government and taxes on these revenues ($R_{GR} = R_{GR}^{net} + T_{GR}$).
- Rentiers' total net income is $R^{net} = R_{FR}^{net} + R_{GR}^{net} = R_{FR} - T_{FR} + R_{GR} - T_{GR}$, and rentiers' total tax payments are $T_R = T_{FR} + T_{GR}$.

For total income it thus obtained:

(9.7)
$$Y = Y_P + iB_{GR} = I + C_R + C_W + G + iB_{GR} + Ex - Im = \Pi_F + R_{FR} + R_{GR} + W$$
$$= \Pi_F^{net} + T_F + R_{FR}^{net} + T_{FR} + R_{GR}^{net} + T_{GR} + W^{net} + T_W = \Pi_F^{net} + R^{net} + W^{net} + T$$

From this, it follows for the sectoral financial balances:

$$
\begin{aligned}
& \Pi_F^{net} - I + R^{net} - C_R + W^{net} - C_W + T_W + T_F + T_R - G - iB_{GR} + Im - Ex \\
(9.8) \quad & = FB_F + FB_R + FB_W + FB_G + FB_E \\
& = 0
\end{aligned}
$$

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

- Stationary economy at some target level of output ($Y^T_{P,I=0}$) zero net investment is required, i.e. $I = 0$.

- For such an economy to be financially stable, the financial balances of the different macroeconomic sectors, should each be balanced at the stationary target level of output to avoid ever-rising debt-income ratios of any sector.

- For equation (9.8), this implies that saving out of net rentiers' income and out of net wages have each to be zero ($S_R = S_W = 0$), governments will have to run a balanced budget ($T\text{-}G\text{-}iB_{GR} = 0$), and net exports and hence the current account have to be equal to zero, too ($Ex\text{-}Im = 0$). This implies that equation (9.7) turns to:

(9.9)
$$\begin{aligned} Y &= Y^T_{P,I=0} + iB_{GR} = C_R + C_W + G + iB_{GR} = R_{FR} + R_{GR} + W \\ &= R^{net}_{FR} + T_{FR} + R^{net}_{GR} + T_{GR} + W^{net} + T_W = R^{net} + W^{net} + T \end{aligned}$$

- Since retained profits are zero: ($T = T_R + T_W$). The condition of zero financial balances of each financial sector also implies:

(9.10) $$C_R = R^{net} = R_{FR}^{net} + R_{GR}^{net} = \Pi^{net} + \left(iB_{GR}\right)^{net}.$$

- positive profits and a positive rate of interest do not require a growing economy from this accounting perspective.

9.4.3 ZERO GROWTH IN A MONETARY CIRCUIT MODEL

- The commercial banking sector is able to generate short-term credit (B^S), as well as to grant long-term credit (B).The interest rate on short-term credit and deposits is zero and that any interest on long-term credit received by banks is immediately transferred to the rentiers as the owners of the banks.
- A firm sector whose capital stock (K) is long-term financed by equity held by shareholders/rentiers (E_R) and by the firms themselves as accumulated retained earnings (E_F).
- The government sector is the indebted sector and has issued long-term bonds in the past, which are held by rentiers (B_{GR}) and by banks (B_{GB}).
- The rentiers' households hold equity issued by the firms, long-term bonds issued by the government and may also hold deposits with the banks (D_R).
- The workers' households do not hold any assets nor issue liabilities. The stock accounting consistency requires:

(9.11) $$K = E_F + E_R .$$

Table 9.1: Balance sheet matrix for a zero-growth closed economy without a central bank

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

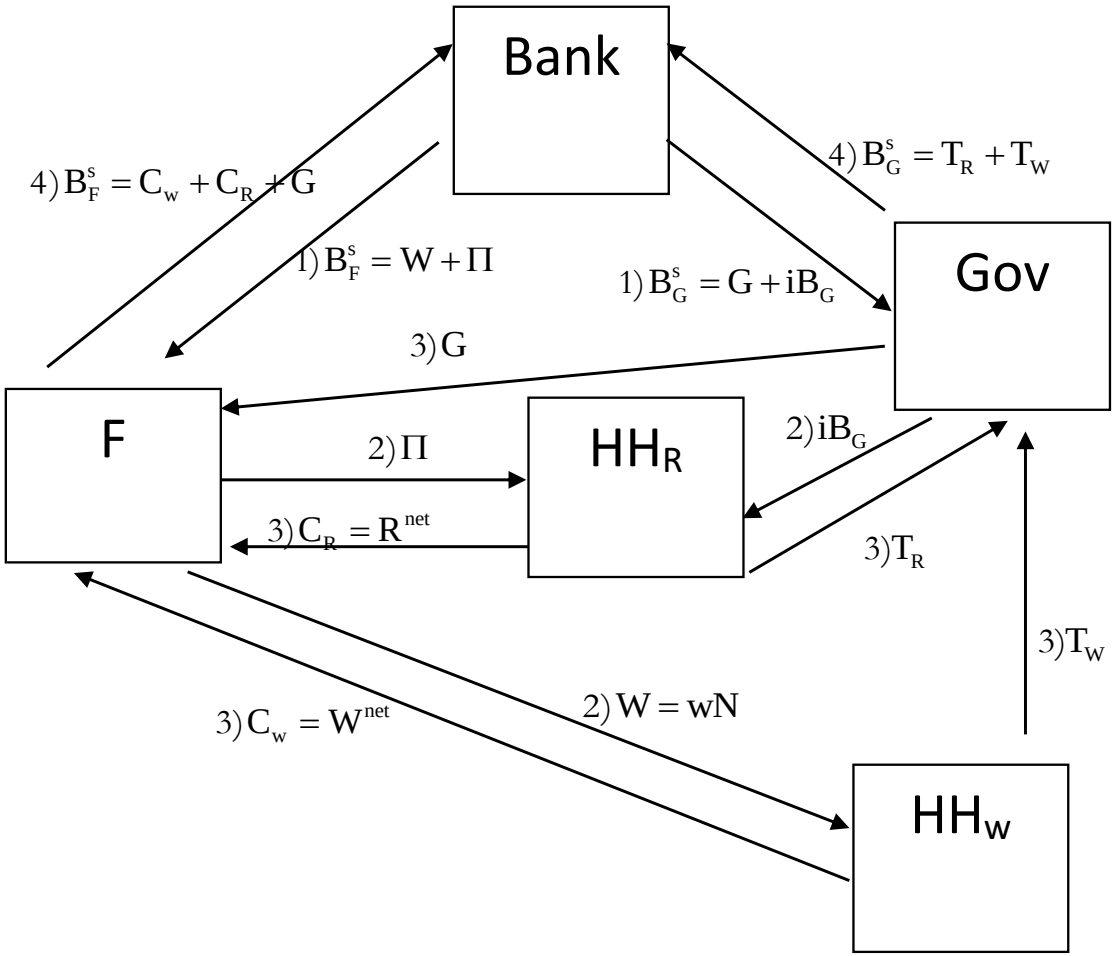
For a zero-growth equilibrium economy, with zero net investment ($I = 0$) and with initial government debt, inherited from past positive growth periods, and thus interest payments of the government to the rentiers ($iB_G = iB_{GR} + iB_{GB}$), the accounting equation (9.9) for income and expenditures holds again.

(9.9)
$$\begin{aligned} Y &= Y^T_{P,I=0} + iB_{GR} = C_R + C_W + G + iB_{GR} = R_{FR} + R_{GR} + W \\ &= R^{net}_{FR} + T_{FR} + R^{net}_{GR} + T_{GR} + W^{net} + T_W = R^{net} + W^{net} + T \end{aligned}$$

Furthermore, the prevention of systemic financial stability requires that the financial balances of each sector have to be equal to zero.

- Retained profits of the firm sector are zero and the rentiers receive all the profits as dividends.
- Saving out of workers' and out of rentiers' income need to be zero, too. This means that workers and rentiers have to spend their net income after taxes for consumption goods.
- Government will have to run a balanced budget.

Figure 9.1: A monetary circuit for a zero-growth closed economy with a government, without a central bank and without interest on initial finance



Phases of the monetary circuit

1. In the first phase of the circuit, short-term initial finance is provided by the banks to the firms (B_F^S) and to the government (B_G^S). The initial finance for firms consists of wages (W) and profits/dividends (Π) to be paid in advance to workers' and rentiers' households ($B_F^S = W+\Pi$). The initial finance for the governments consists of planned government consumption expenditures (G) plus government interest payments on the stock of debt to the rentiers ($B_G^S = G+iB_G$).
2. Income payments to be made in advance to the rentiers' and workers' households in the second phase. These include the interest payments from the government to the rentiers (iB_G), the profits/dividends from the firms to the rentiers (Π), and wages paid by firms, which are equal to the nominal wage rate multiplied by the number of employees ($W = wN$).
3. Income received then allows for expenditures in the third phase (i.e. the reflux phase). Rentiers and workers pay taxes (T_R, T_W) to the government and spend their net incomes on consumption goods ($C_R = R^{net}$, $C_w = W^{net}$). The government now also spends its initial finance on government consumption (G).
4. The expenditures in the third phase make sure that the firms and the government receive the funds which enable them in the fourth phase to repay initial finance and hence short-term credit to the banks and thus to close the circuit.

- In the course of the monetary circuit, profits of firms are realised and a positive interest rate on government debt is also consistent with a stable stationary economy.

- Endogenous credit creation (and destruction) with positive interest rates and profits is thus possible in a stationary economy and, as such, does not impose a growth bias on the economy.

Table 9.2: Transaction flow matrix for a zero-growth closed economy without a central bank

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

9.4.4 AN AUTONOMOUS DEMAND-LED GROWTH MODEL WITH ZERO GROWTH

Hein and Jimenez (2022): Kaleckian distribution and growth model driven by autonomous government expenditure growth, as initially developed by Hein (2018c) and then modified by Hein and Woodgate (2021)

- Built on the closed economy model structure presented in the previous sections, but only taxes on capital income are considered.
- In the short run, defined by given government expenditures- and government debt-capital ratios, the model may generate a goods market equilibrium with positive capital accumulation and saving-capital ratios.
- In the long run, however, when government expenditures- and government debt-capital ratios become endogenous, the model converges towards the autonomous growth rate of government expenditures, which is set equal to zero.

- Pre-tax profit share in production ($h = \Pi/Y_P$) is determined by mark-up pricing of firms in an oligopolistic goods market.

- With given institutional conditions in the goods market, prices are constant, and the price level can be set at $p = 1$, such that nominal and real variables coincide.

- Rentiers receive all the profits from production (hY_P) as dividends and the interest paid by the government on the stock of debt, either directly or indirectly via the banks they own ($iB_G = iB_{GR} + iB_{GB}$).

- Workers do not save.

- Only rentiers save a fraction of their net income after taxes $[(1-t_R)(hY_P+iB_G)]$, with a given tax rate (t_R), according to their propensity to save (s_R). Furthermore, they consume a fraction of their wealth (B_G+K) according to their propensity to consume out of wealth (c_{RW}).

- Normalising all variables by the firms' capital stock, such that we have a rate of capacity utilisation ($u = Y_P/K$), a government debt-capital ratio ($\lambda = B_G/K$), a profit rate in production ($r = \Pi/K = hu$), the saving-capital ratio and hence the saving rate ($\sigma = S/K$) is given as:

$$\begin{aligned} \sigma &= s_R\left(1-t_R\right)\left(hu+i\lambda\right)-c_{RW}\left(1+\lambda\right) \\ &= s_R\left(1-t_R\right)hu+\lambda\left[is_R\left(1-t_r\right)-c_{RW}\right]-c_{WR}, \\ & 1 \geq s_R > 0,\ c_{RW} \geq 0 \end{aligned} \tag{9.12}$$

Firms adjust the capital stock via net investment (I) according to the expected trend rate of growth of output and sales (α). They will slow down (accelerate) the rate of capital accumulation ($g = I/K$) whenever the actual rate of capacity utilisation falls short of (exceeds) the normal or the target rate of utilisation (u_n):

(9.13) $$g = \alpha + \beta\left(u - u_n\right), \quad \beta > 0 .$$

Government expenditures (G) for goods and services, i.e. government consumption, grow at a constant rate γ and drive the model. The government expenditures-capital ratio ($\delta = G/K$), is given as:

(9.14) $$\delta = \frac{G_0 e^{\gamma t}}{K} .$$

The tax-capital ratio ($\tau = T/K$) is given by:

(9.15) $$\tau = t_R\left(hu + i\lambda\right), \quad 1 > t_R \geq 0 .$$

The balanced budget condition:

(9.16) $$\tau = t_R\left(hu + i\lambda\right) = \delta + i\lambda .$$

Short-run equilibrium

With a balanced government budget, the goods market equilibrium is given by:

(9.17) $$\sigma + \tau = g + \delta + i\lambda \qquad \Rightarrow \qquad \sigma = g\,.$$

The Keynesian/Kaleckian stability condition:

(9.18) $$\frac{\partial \sigma}{\partial u} - \frac{\partial g}{\partial u} > 0 \qquad \Rightarrow \qquad s_R\left(1 - t_R\right)h - \beta > 0\,.$$

From equations (9.12), (9.13), (9.14), (9.16) and (9.17):

$$(9.19)\quad u^* = \frac{\alpha - \beta u_n + c_{RW} + \left[c_{RW} - s_R\left(1 - t_R\right)i\right]\lambda}{s_R\left(1 - t_R\right)h - \beta}.$$

$$(9.20)\quad r^* = hu^* = \frac{h\left\{\alpha - \beta u_n + c_{RW} + \left[c_{RW} - s_R\left(1 - t_R\right)i\right]\lambda\right\}}{s_R\left(1 - t_R\right)h - \beta},$$

$$(9.21)\quad g^* = \frac{\left(\alpha - \beta u_n\right)s_R\left(1 - t_R\right)h + \beta\left\{c_{RW} + \left[c_{RW} - s_R\left(1 - t_R\right)i\right]\lambda\right\}}{s_R\left(1 - t_R\right)h - \beta},$$

From the balanced budget condition in equation (9.16):

$$(9.22) \quad u = \frac{\delta + (1 - t_R) i\lambda}{t_R h}.$$

From equations (9.19) and (9.22):

$$(9.23) \quad t_R^* = \frac{(s_R h - \beta)(\delta + i\lambda)}{h(\alpha - \beta u_n + c_{RW} + s_R \delta) + \left[c_{RW} h + (s_R h - \beta) i\right]\lambda}.$$

Using this equilibrium tax rate:

(9.24) $$u^* = \frac{\alpha - \beta u_n + c_{RW}(1+\lambda) + s_R \delta}{s_R h - \beta},$$

(9.25) $$r^* = \frac{h\left[\alpha - \beta u_n + c_{RW}(1+\lambda) + s_R \delta\right]}{s_R h - \beta},$$

(9.26) $$g^* = \frac{(\alpha - \beta u_n) s_R h + \beta\left[c_{RW}(1+\lambda) + s_R \delta\right]}{s_R h - \beta}.$$

Figure 9.2: Short-run equilibrium

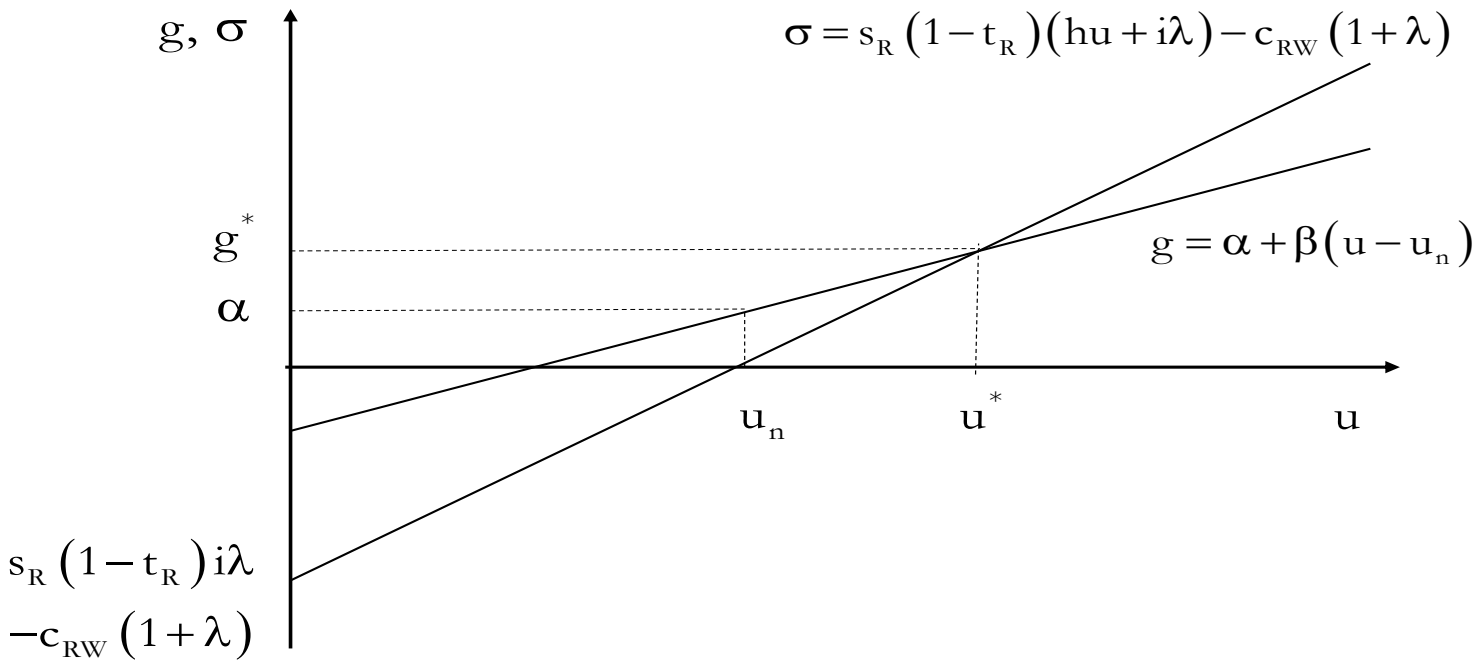


Table 9.3: Response of stable zero growth equilibrium towards changes in exogenous variables in the short run and in the long run

	short run			***long run***				
	u^*	r^*	g^*	u^{**}	r^{**}	g^{**}	$\delta^{**} > 0$	$\lambda^{**} > 0$
s_R	–	–	–	0	0	0	–	+
c_{RW}	+	+	+	0	0	0	+	–
h	–	–	–	0	+	0	+/–	+
u_n	–	–	–	+	+	0	+/–	+
i	–/0	–/0	–/0	0	0	0	–	+
t_R	+	+	+	0	0	0	+	–
δ	+	+	+					
λ	+/–	+/–	+/–					

Note: In the short-run, there are two possible cases regarding t_R and δ: In case 1, t_R is exogenous while δ is endogenous, while in case 2, δ is exogenous and t_R endogenous.

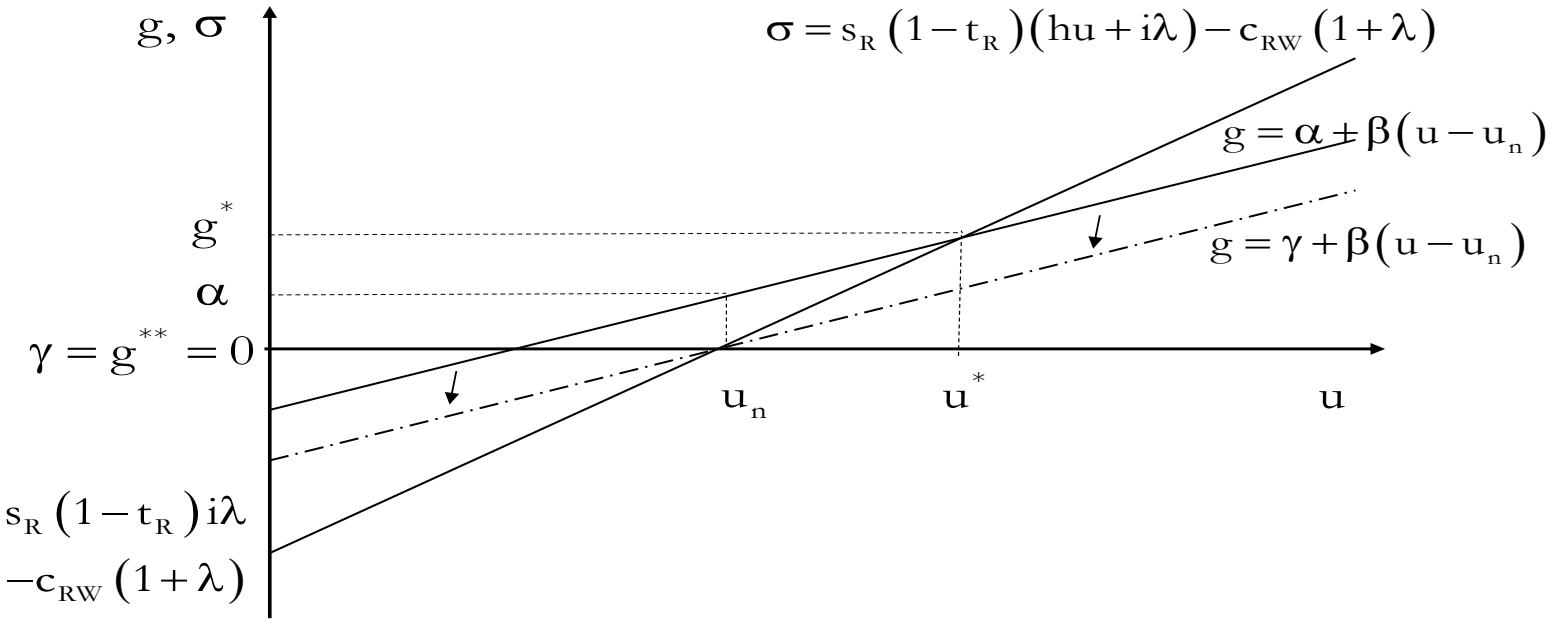
Long-run equilibrium

Dutt (2019, 2020): firms' expectations about the trend rate of growth of the economy adjust towards the autonomous growth rate of government expenditures, equal to zero in the model economy:

(9.27) $\alpha = \gamma = 0$.

The goods market equilibrium will thus adjust towards the normal rate of capacity utilisation and the autonomous growth rate of government expenditures, as shown in Figure 9.3.

Figure 9.3: Long-run equilibrium



Government expenditure- and debt-capital ratios are endogenous in the long run, and it has to be examined whether these ratios will converge towards some stable long-run equilibrium. The time rates of change $\dot{x} = \partial x/\partial t$:

(9.28) $$\dot{\delta} = \delta(\gamma - g) = \delta\left[\gamma - \alpha - \beta\left(u^* - u_n\right)\right],$$

(9.29) $$\dot{\lambda} = \delta + i\lambda - \tau - \lambda g\,.$$

A balanced budget ($\delta + i\lambda - \tau = 0$) turns equation (9.29) to:

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

For the long-run equilibrium, the endogenous government expenditures- and debt-capital ratios have to be constant, and hence $\dot{\delta} = 0$ and $\dot{\lambda} = 0$ in equations (9.28) and (9.30) is needed.

Trivial long-run equilibrium, with r_n as the normal rate of profit, i.e. the rate of profit at normal capacity utilisation:

(9.31) $u^{**} = u_n$,

(9.32) $r^{**} = hu_n = r_n$,

(9.33) $g^{**} = \gamma = 0$,

(9.34) $\delta^{**} = 0$,

(9.35) $\lambda^{**} = 0$.

Plugging the long-run equilibrium rate of capacity utilisation from equation (9.31) into the short-run goods market equilibrium rate of capacity utilisation from equation (9.19) gives:

$$(9.36) \qquad u_n = \frac{\alpha + c_{RW} + \left[c_{RW} - s_R\left(1 - t_R\right)i\right]\lambda}{s_R\left(1 - t_R\right)h}.$$

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

$$(9.37) \quad \lambda^{**} = \frac{s_R\left(1 - t_R\right)hu_n - c_{RW}}{c_{RW} - s_R\left(1 - t_R\right)i}.$$

Furthermore, from the balanced budget condition in equation (9.16), using equations (9.31) and (9.37), the related long-run equilibrium government expenditures-capital ratio is obtained:

$$(9.38)\quad \delta^{**} = t_R h u_n - (1-t_R) i \lambda^{**} = t_R h u_n - \frac{(1-t_R) i \left[s_R (1-t_R) h u_n - c_{RW} \right]}{c_{RW} - s_R (1-t_R) i}.$$

The dynamic stability of the non-zero equilibria in equations (9.37) and (9.38) can be examined making use of the dynamic equations (9.28) and (9.30) together with the short-run goods market equilibrium in equation (9.24). The corresponding Jacobian matrix is given by:

$$(9.39) \quad J = \begin{pmatrix} \frac{\partial \dot{\delta}}{\partial \delta} & \frac{\partial \dot{\delta}}{\partial \lambda} \\ \frac{\partial \dot{\lambda}}{\partial \delta} & \frac{\partial \dot{\lambda}}{\partial \lambda} \end{pmatrix}.$$

Evaluated at the long-run equilibrium values δ^{**} and λ^{**}:

(9.28a) $$\frac{\partial\dot{\delta}}{\partial\delta} = \frac{-\beta s_R \delta^{**}}{s_R h - \beta},$$

(9.28b) $$\frac{\partial\dot{\delta}}{\partial\lambda} = \frac{-\beta c_{RW} \delta^{**}}{s_R h - \beta},$$

(9.30a) $$\frac{\partial\dot{\lambda}}{\partial\delta} = \frac{-\beta s_R \lambda^{**}}{s_R h - \beta},$$

(9.30b) $$\frac{\partial\dot{\lambda}}{\partial\lambda} = \frac{-\beta c_{RW} \lambda^{**}}{s_R h - \beta}.$$

For the local stability in this 2x2 dynamic system, the trace of the Jacobian in (9.39) has to be negative and the determinant needs to be non-negative:

(9.40) $$\mathrm{TrJ}^{**} = \frac{\partial\dot{\delta}}{\partial\delta} + \frac{\partial\dot{\lambda}}{\partial\lambda} = \frac{-\beta s_R \delta^{**}}{s_R h - \beta} + \frac{-\beta c_{RW} \lambda^{**}}{s_R h - \beta} = \frac{-\beta\left(s_R \delta^{**} + c_{RW} \lambda^{**}\right)}{s_R h - \beta},$$

(9.41) $$\mathrm{DetJ}^{**} = \frac{\partial\dot{\delta}}{\partial\delta}\frac{\partial\dot{\lambda}}{\partial\lambda} - \frac{\partial\dot{\delta}}{\partial\lambda}\frac{\partial\dot{\lambda}}{\partial\delta} = 0.$$

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

For $\lambda^{**} > 0$ in equation (9.37), it is required that

(9.37a) $$s_R\left(1-t_R\right)hu_n > c_{RW} > s_R\left(1-t_R\right)i \quad \Rightarrow \quad r_n > \frac{c_{RW}}{s_R\left(1-t_R\right)} > i\,,$$

or that

(9.37b) $$s_R\left(1-t_R\right)hu_n < c_{RW} < s_R\left(1-t_R\right)i \quad \Rightarrow \quad r_n < \frac{c_{RW}}{s_R\left(1-t_R\right)} < i\,.$$

Since condition (9.37b) implies that the rate of interest on safe government bonds exceeds the rate of profit in production, which will make production difficult to sustain, given the 'risks and troubles' involved here, the condition (9.37a) is economically more meaningful and is used in the further considerations.

If λ^{**} is positive, for δ^{**} in equation (9.38) to assume positive values, too, it is necessary that $\frac{t_R hu_n\left[c_{RW}-s_R\left(1-t_R\right)i\right]-\left(1-t_R\right)i\left[s_R\left(1-t_R\right)hu_n-c_{RW}\right]}{c_{RW}-s_R\left(1-t_R\right)i}>0$, which implies:

(9.38a) $$\frac{c_{RW}t_R hu_n}{\left(1-t_R\right)\left(s_R hu_n-c_{RW}\right)}>i \quad\Rightarrow\quad \frac{c_{RW}}{s_R\left(1-t_R\right)}>\frac{ir_n}{t_R r_n+\left(1-t_R\right)i}=\frac{i}{t_R+\left(1-t_R\right)i/r_n}$$

Since $r_n>i$ implies that $\frac{i}{t_R+\left(1-t_R\right)i/r_n}>i$, for positive and stable long-run equilibria for both δ^{**} and λ^{**} in a stationary economy, it is required that:

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

which is equivalent to

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

Table 9.3: Response of stable zero growth equilibrium towards changes in exogenous variables in the short run and in the long run

	short run			***long run***				
	u^*	r^*	g^*	u^{**}	r^{**}	g^{**}	$\delta^{**} > 0$	$\lambda^{**} > 0$
s_R	–	–	–	0	0	0	–	+
c_{RW}	+	+	+	0	0	0	+	–
h	–	–	–	0	+	0	+/–	+
u_n	–	–	–	+	+	0	+/–	+
i	–/0	–/0	–/0	0	0	0	–	+
t_R	+	+	+	0	0	0	+	–
δ	+	+	+					
λ	+/–	+/–	+/–					

Note: In the short-run, there are two possible cases regarding t_R and δ: In case 1, t_R is exogenous while δ is endogenous, while in case 2, δ is exogenous and t_R endogenous.

Under some specific conditions regarding the values of the rate of profit, the rate of interest and the propensities to consume out of wealth and to save out of income, stable zero growth with endogenous credit, positive real interest rates and positive profit rates is possible.

- no growth imperative in a monetary production economy

Restrictive assumptions:

- Firms' investment is only determined by the autonomous growth rate of the system, the zero growth rate of government expenditures. This rules out long-run effects of animal spirits, competitive pressures, financial factors, etc. on investment in the aggregate.
- Firm sector only re-invests depreciations and does not retain any profits net of depreciations,
- Government balances its budget, at least in the long run.
- Regarding distribution, the model only considers functional income distribution, but it does not address personal income or wealth inequality (Jackson and Victor 2016, Janischewski 2022).
- The model is only for a closed economy. However, the basic principles could also be applied to an open economy. In particular, this would then also require balanced current accounts, at least in the long run.
- The model has assumed constant technical conditions of production in a one-good economy and has only addressed goods market and systemic financial market stability.
- The model has not tackled the issue of stable employment and hence unemployment in a zero-growth economy under the conditions of technical progress, productivity growth and structural change.

9.4.5 SOME THOUGHTS ON STABLE EMPLOYMENT AND ZERO GROWTH

Rearranging equation (9.3), which then shows the principle statistical determinants of the employment rate – and thus the rate of unemployment:

(9.44) $$\frac{N}{L} = \frac{Y}{\frac{Y}{H}\frac{H}{N}\frac{L}{P}p} \Rightarrow \qquad e = \frac{Y}{ynlP}.$$

From this it follows:

(9.45) $$\hat{e} = \hat{Y} - \hat{P} - \hat{l} - \hat{n} - \hat{y}.$$

With zero growth – and thus constant real GDP – the employment rate will fall, according to population growth, growth in the labour force participation rate, growth of working time per person employed and productivity growth.

To maintain a high rate of employment, and thus a low rate of unemployment, in a zero-growth economy with productivity growth, the following options or combinations of them are available:

- a slowdown in productivity growth through structural change towards green industries and services with higher labour intensity and lower labour productivity,
- a reduction of hours worked per person, i.e. through shortening daily, weekly, monthly or annual working time,
- a decline in the labour force participation rate, i.e. through longer periods of education and earlier retirements, or a politically and socially unacceptable exclusion of certain groups from the labour market,
- through a fall in population via birth and immigration controls.

- Major role to prevent rising unemployment will have to be played by reducing productivity growth, by all types of cutting working time and by reducing the effective labour force participation rate through longer education periods and earlier retirements.
- The increase in labour intensity and the slowdown in labour productivity growth can be expected to occur with structural change towards a green economy with more labour intensive and less capital and nature intensive method of production (Jackson and Victor 2011, 2020, Victor 2012, Pollin 2018, 2020, 2021)
- Cutting weekly, annual (more holidays) and life-long (longer periods of education, sabbaticals, early retirement) working time (Fontana and Sawyer 2022, Jackson and Victor 2011, 2020, Lange 2018, Rezai et al. 2013), also: Keynes's (1930b) long-run vision in his 'Economic possibilities of our grandchildren'

- To make this affordable and socially acceptable for the majority of employees, it will have to be associated with income redistribution, in particular towards low wage earners.
- Secondary redistribution by the state, via progressive taxation and improved social transfers, different sorts of basic income schemes, etc., which each lead to a decoupling of work and income (Strunk et al. 2022).
- Improving primary distribution of market incomes via higher wage shares and a more compressed wage structure.
- Several feedbacks on the macroeconomy (Rezai et al. 2013, Taylor et al. 2016)
  - Aggregate demand effects, which may be wage-led or profit-led, which requires demand management of the government
  - Raising the wage share, will stimulate the efforts of firms to introduce even more labour saving technical progress. This will further raise labour productivity and potential output and thus require stabilising government intervention, too

Summing up

- Socio-economic and -ecological transformation requires a significant transformation of capitalism as we know it.
- Green New Deal concepts, would have to be more closely linked with the post-Keynesian macroeconomic policy mix.
- Fiscal policy has a major role to play, not only stabilising aggregate demand. Public investments have to be targeted towards the required socio-ecological transformation and they have to be linked with industrial and regional policies.
- Central banks can support such policies by targeting low long-term interest rates and by stabilising the financial system, making use of other instruments, like ecologically targeted quantitative easing and credit controls.

- Incomes policies will have a major role to play, in order to support stable inflation, on the one hand, but also to contribute to a more egalitarian distribution of income in a low or even zero-growth environment, on the other hand.

- Furthermore, consumption patterns would have to change and shift away from energy- and emission-intense individual consumption towards more labour-intense forms of collective consumption.

- Finally, international coordination of such a policy approach is most important, respecting the need of emerging economies to develop, on the one hand, and the planetary boundaries, on the other hand.