# Bridging Kalecki and Kaldor with cost share-induced technological change

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33rd Annual Workshop of the Post-Keynesian Economics Society

SOAS University of London

13 June 2024

# The bigger picture

**The macroeconomics of a sustainable economy**

- The sustainable economy itself
- The transition from where we are to a sustainable long run

**Problems this raises**

- Bridging short-run dynamics to long-run outcomes
- Incorporating technological change

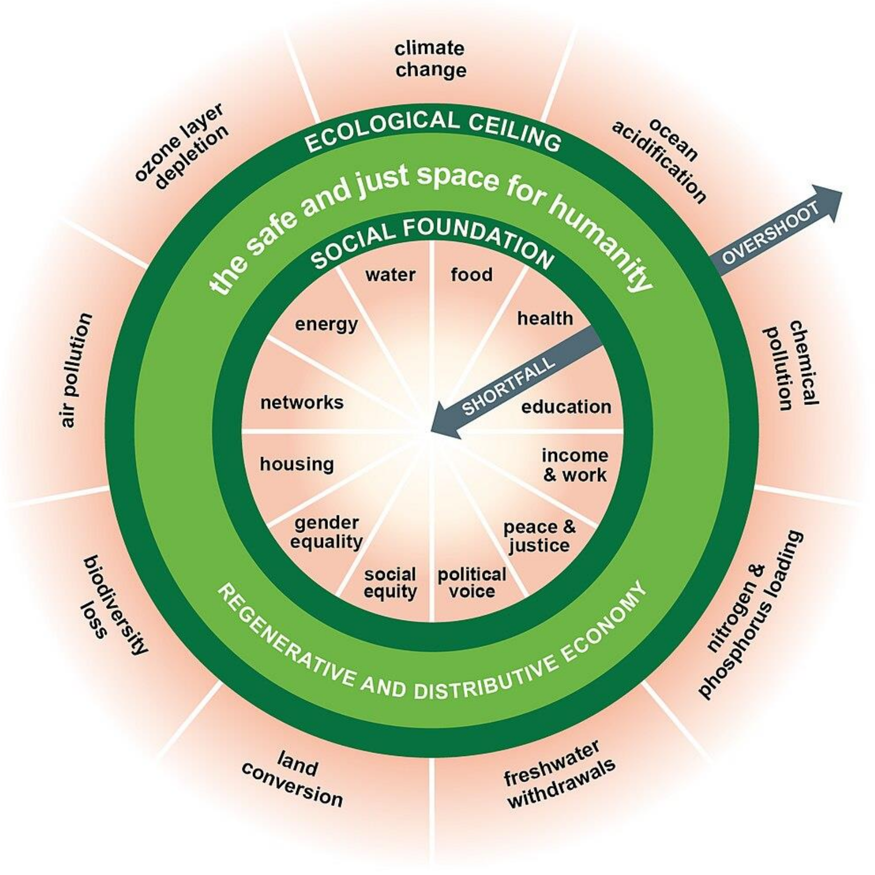
**How it fits into this presentation**

- Reconciling long-period (Kaldorian) and short-run (Kaleckian) analysis
- Adding cost share-induced technological change into the models

This is not a new set of problems, but I believe some of the results are new.

**Not in this presentation, but needed for a sustainability analysis**

- Resource use
- Growth-agnostic ("post-growth") policies



# Notation

**Saving function:** $g^s\ (\pi, \kappa, u)$, where $g^s_\pi, g^s_\kappa,\ g^s_u > 0$,

**Investment function:** $g^i\ (r, u)$, where $r = \pi\kappa$ and $g^i_r, g^i_u > 0$,

In this equations,

- $\pi$ is the profit share
- $\kappa$ is capital productivity (given by the value of output divided by the value of the capital stock as established by firms)
- $u$ is capital utilization
- $r$ is the profit rate at full utilization

Note that

$$\Gamma = g^s - g^i = \frac{\text{change in inventory}}{\text{capital stock}}$$

This *dynamic* Kaleckian model allows for a saving-investment imbalance.

Further notation: a time derivative is given by a “dot”: $\dot{x}$; a growth rate is given by a “hat”: $\hat{x}$

# A dynamic Kaleckian model with a fixed markup

In the simplest model:

- $\pi$ is fixed by an exogenous markup
- $\kappa$ is fixed by assuming Kaldor's stylized fact of constant capital productivity
- Capacity utilization $u$ adjusts in response to perceived build-up or draw-down of inventories as:

$$\dot{u} = -\alpha\left(g^s - g^i\right) = -\alpha\Gamma$$

This dynamic is stable if $\Gamma_u > 0$, which is the Keynesian stability condition. Equilibrium is obtained at a utilization $u^*$ that satisfies

$$\Gamma(\pi, \kappa, u^*) = 0 \;\; \Rightarrow g^s(\pi, \kappa, u^*) = g^i(\pi\kappa, u^*)$$

**Note:** It is quite possible that the Keynesian stability condition does *not* hold, leading to a Kaleckian-Harrodian model. However, in this presentation the Keynesian stability condition is assumed to hold.

# Adding a conflict wage-setting model

The model in words:

- When growth in the amount of labour needed by firms, $\hat{L}$, is faster than the growth in the working-age population $n$:
  - Existing workers with experience and skills see an increase in bargaining power and the real wage $w$ rises faster than labour productivity $\lambda$;
  - People of working age are drawn to the labour force by higher wages and prospects of stable employment;
  - They are driven into the labour force by rising prices.
- When growth in the amount of labour needed by firms is slower than the growth in the working-age population:
  - Workers are laid off and may become discouraged, exiting the labour force;
  - Existing workers are at higher risk of layoffs, reducing their bargaining power and the real wage rises more slowly than labour productivity.

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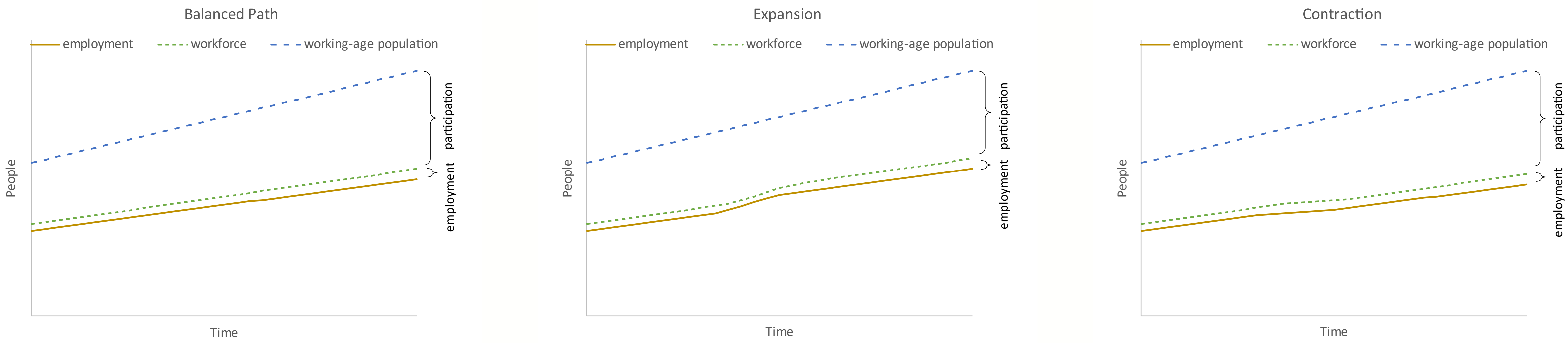
# Adding a conflict wage-setting model

The model in pictures:




Adjustment happens through the participation rate.

This is only partly a “reserve army” story: many people are satisfied being outside the workforce and skills development takes time.

# Adding a conflict wage-setting model

The model in mathematics:

Because the wage share $\omega = 1 - \pi$ is equal to the real wage divided by labour productivity,

$$\hat{\omega} = -\frac{\dot{\pi}}{1-\pi} = \hat{w} - \hat{\lambda}$$

But that difference is an increasing function $f$ of $\hat{L} - n$, so

$$\dot{\pi} = -(1-\pi)f\left(\hat{L} - n\right)$$

where $f' > 0$ and $f(0) = 0$.

The response is based on the difference in growth rates, not levels, because of (implicit) adjustment of the participation rate.

# Implementing the conflict wage-setting model

Note that the growth in the demand for labour is:

$$\hat{L} = \text{growth in potential output} + \text{growth in capacity utilization} - \text{growth rate of labour productivity}$$

or

$$\hat{L} = g^i(r,u) - \delta + \hat{\kappa} + \hat{u} - \hat{\lambda}$$

Substituting into the equation of motion for $\pi$,

$$\dot{\pi} = -(1-\pi)f\left(g^i(r,u) - \delta + \hat{\kappa} + \hat{u} - \hat{\lambda} - n\right)$$

Also, the growth rate of capacity utilization is given by the equation of motion for $u$:

$$\hat{u} = \frac{\dot{u}}{u} = -\frac{\alpha\Gamma}{u}$$

(A further twist is to use a Kaldor-Verdoorn expression for $\hat{\lambda}$, but that will be done later…)

# The equilibrium conditions for the full system

The equations of motion are

$$\dot{u} = -\alpha\Gamma(\pi, \kappa, u)$$

$$\dot{\pi} = -(1-\pi)f\left(g^i(r,u) - \delta + \hat{\kappa} - \frac{\alpha\Gamma}{u} - \hat{\lambda} - n\right)$$

Assuming again that $\kappa$ is constant, so that $\hat{\kappa} = 0$, and recalling that $f' > 0$ and $f(0) = 0$, the equilibrium conditions are

$$\Gamma(\pi^*, \kappa, u^*) = 0 \quad \Rightarrow g^s(\pi^*, \kappa, u^*) = g^i\ (\pi^*\kappa, u^*) \equiv g^*$$

$$g^* = \hat{\lambda} + \delta + n$$

But this is just Harrod's natural rate of growth: $g^* = g_n$. And if $g^s(\pi^*, \kappa, u^*) = s_p\pi^*\kappa u^* = s_p r u^*$, then we get the Cambridge equation,

$$ru^* = \frac{g_n}{s_p}$$

# The equilibrium conditions

The equations of motion are

$$\dot{u} = -\alpha\Gamma(\pi, \kappa, u)$$

The equilibrium for this dynamic Kaleckian model:

1. Clears the goods market
2. Features growth at Harrod's natural rate
3. Returns the Cambridge equation when saving is entirely out of profits

Assuming again that $\kappa$ is

But this is just Harrod's n e equation,

$$ru^* = \frac{g_n}{s_p}$$

# But…

Because the profit share and capacity utilization are entirely determined, there is no $\pi - u$ schedule.

In other words:

- We have reconciled short-run demand-led disequilibrium with a long-period equilibrium at Harrod's natural rate 🙂
- But it removes the basis for a standard Kaleckian comparative statics exercise 😳

Instead, carry out a *non-standard* comparative statics exercise…

# Comparing pricing regimes: Fixed markup

Suppose an economy starts in a fixed-markup (FM) pricing regime, with $\pi$ and $\kappa$ exogenous.

Then at the equilibrium capacity utilization $u^*_{FM}$, the growth rate is not equal to the natural rate. Suppose that it is greater:

$$g^*_{FM} = g^s(\pi, \kappa, u^*_{FM}) = g^i(\pi\kappa, u^*_{FM}) > g_n$$

Then eventually this economy will experience a crisis. Increasing demand for labour will lead to efforts to expand the working-age population:

- Immigration (very much in the news in reference to inflation)
- Extending working lives (an increasingly common phenomenon in the US)
- Relaxing child labour laws (being pursued by state legislatures in the US)

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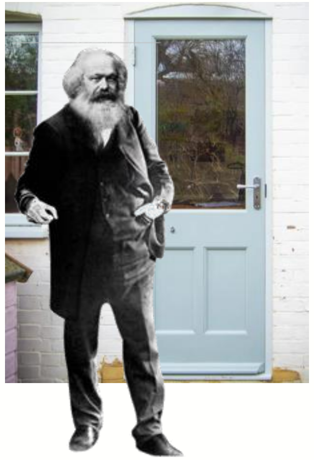
We have a Marxian crisis coming in the back door: The potentially stronger position for labour and popular responses to efforts to extend the working-age population can create the conditions for a conflict wage-determined distribution (*possibly* being seen in the US with a resurgence of labour organizing and union membership).



# Comparing pricing regimes: Conflict wage-setting

The conflict wage-setting regime equilibrium has profit share $\pi_{CW}^*$ and capacity utilization $u_{CW}^*$ and features growth at the natural rate:

$$g_{CW}^* = g^s(\pi_{CW}^*, \kappa, u_{CW}^*) = g^i(\pi_{CW}^* \kappa, u_{FM}^*) = g_n$$

If the following condition holds:*

$$\frac{\Delta g^*}{\Delta \pi} = \frac{g_u^s g_\pi^i - g_\pi^s g_u^i}{g_u^s - g_u^i} > 0$$

then the drop from $g_{FM}^* > g_n$ to $g_{CW}^* = g_n$ means a drop in the profit share as well, and therefore a decline in the profit rate at $u = 1$. But:

- If the economy is profit-led, then $u_{FM}^* > u_{CW}^*$ and the *conflict-wage regime* features underproduction
- If the economy is wage-led, then $u_{FM}^* < u_{CW}^*$ and the *fixed-markup regime* features underproduction

The rate of profit at the equilibrium capacity utilization, $\pi^* \kappa u^*$, can therefore either rise or fall.

Regardless, strong labour and lower profits are likely to provoke their own reaction over time, returning to a higher profit share.

* This condition guarantees stability of the dynamic system.

# Comparing pricing regimes: Conflict wage-setting

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The contradictions in either a fixed-markup or conflict-wage pricing regime will eventually be resolved by exiting the regime.

Increasing contradictions can be seen in responses such as efforts to expand the working-age population or undermining labour.

The economy transitions from one regime to the other over (long) times.

* This condition guarantees stability of the dynamic system.

# Cost share-induced technological change

# About cost share-induced technological change

- A long-standing classical/Marxian mechanism
- Also studied by Hicks, Samuelson, and others, but is problematic in a neoclassical context
- With labour and capital as inputs, can be expressed as

$$\hat{\kappa} = k(\pi), \qquad k' > 0$$
$$\hat{\lambda} = l(\pi), \qquad l' \leq 0$$

- Different theories have different implications. Some imply that if $k' \neq 0$ then $l' \neq 0$ as well. Others do not have that implication. For this presentation, only $k' > 0$ is needed.
- A Kaldor-Verdoorn term can also be added, so that

$$\hat{\lambda} = l(\pi) + (1 - a)g^i, \qquad l' \leq 0$$

# Target-return pricing

Under a target-return pricing regime, the realised profit rate must equal a target rate $\bar{r}$:

$$\pi \kappa u = \bar{r}$$

If the target rate is not changing over time, then

$$\hat{\pi} = \frac{\dot{\pi}}{\pi} = -\hat{\kappa} - \hat{u}$$

But there are equations of motion for $\kappa$ and $u$, so

$$\dot{\pi} = -\pi k(\pi) + \alpha \Gamma(\pi, \kappa, u)$$

# Equilibrium under target-return pricing

An equilibrium is characterised by $\pi^*$, $u^*$, and $\kappa^*$, which satisfy

$$\Gamma(\pi^*, u^*, \kappa^*) = 0$$

$$k(\pi^*) = 0$$

$$\kappa^* = \frac{\bar{r}}{\pi^* u^*}$$

Kaldor's stylized facts hold at equilibrium

Then the growth rate can be calculated from either the investment or saving function, e.g.,

$$g^* = g^i(\bar{r}, u^*)$$

# Conflict wage-setting with cost share-induced technological change

Under conflict wage-setting, the equation of motion for the profit share is again

$$\dot{\pi} = -(1-\pi)f\left(g^i(r,u) - \delta + \hat{\kappa} - \frac{\alpha\Gamma}{u} - \hat{\lambda} - n\right)$$

But now the expressions for productivity growth rates can be written as functions of the profit share, together with the Kaldor-Verdoorn term,

$$\dot{\pi} = -(1-\pi)f\left(ag^i(r,u) - \delta + k(\pi) - \frac{\alpha\Gamma}{u} - l(\pi) - n\right)$$

The equilibrium conditions are:

$$\Gamma(\pi^*, u^*, \kappa^*) = 0 \;\Rightarrow\; g^s(\pi^*, \kappa^* u^*) = g^i\,(\pi^* \kappa^*, u^*) \equiv g^*$$

$$k(\pi^*) = 0$$

The same condition as for target-return pricing

$$ag^* = l(\pi^*) + \delta + n = g_n$$

Harrod’s natural rate of growth

# Comparing pricing regimes

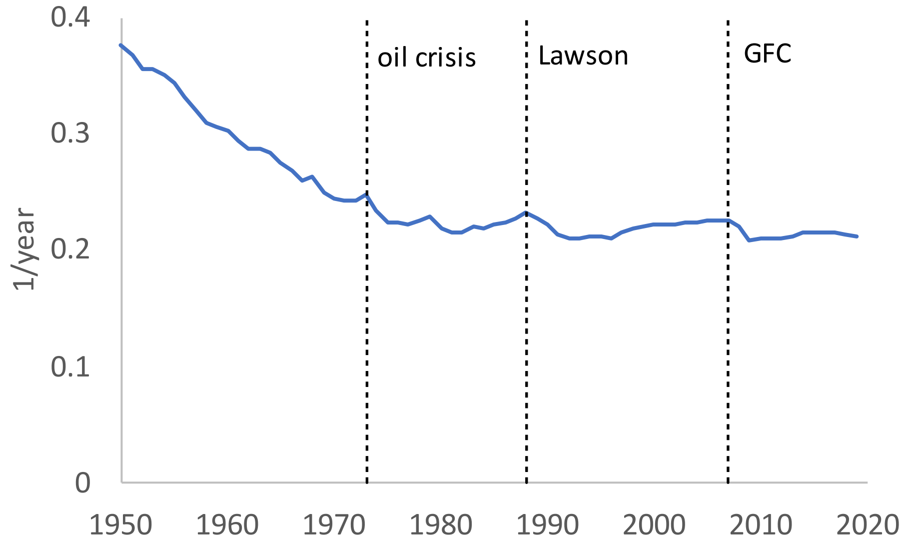
The target-return and conflict wage-setting regimes can be compared as before. The results:

- If the desired target is higher than that compatible with growth at the natural rate, there will be increasing pressure on the labour force
- That pressure could trigger a reaction that leads to a conflict wage-setting regime

However:

- Without cost share-induced technological change, between the fixed markup and conflict-wage regimes, the profit share $\pi$ adjusts
- With cost share-induced technological change, the profit share is the same and capital productivity $\kappa$ adjusts

Capital Productivity in the UK




From Penn World Table 10.01

# Final remarks

- Sustainability studies need to bridge short-run and long-run and require an analysis of technological change.
- Dynamic Kaleckian models can be adapted to the purpose.
- A conflict wage adjustment mechanism that depends on rates rather than levels reproduces Harrod's natural rate of growth at equilibrium.
- With cost share-induced technological change, Kaldor's stylized facts hold at equilibrium as well.
- The standard Kaleckian comparative-statics exercise that is applied to a fixed markup pricing regime cannot be applied, however:
- A comparative statics analysis of pricing regimes *can* be applied.
- Transitions between pricing regimes are triggered by crises arising from accumulating imbalances inherent in the operation of the regime.