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Pseudo, or not? Neo-Goodwinian growth cycles with financial linkages

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Abstract

Barbosa-Filho and Taylor (2006) propose a theoretical model with the *Goodwin mechanism* (profit-led economic activity and profit-squeeze distribution of income) that generates the *Goodwin pattern* (a counter-clockwise cycle in activity-labor share space), which fits data well. Stockhammer and Michell (2017) investigate a three-dimensional model in output, labor share and firms' debt, and demonstrate that the inclusion of the financial linkage produces the Goodwin pattern in simulations even if demand is not profit-led (or weakly wage-led). This paper extends neo-Goodwinian theory to include the valuation ratio q. In two different models, we corroborate that the Goodwin pattern can indeed arise in simulations without profit-led demand when a financial linkage is present. Further, the Keynesian distributive cycle theory we build on clearly distinguishes between short run (usually profit-led) cycles, and a long run (potentially wage-led) steady state. In the two models discussed here, redistribution has no steady state effects.

Keywords: Goodwinian theory; cyclical growth, growth and distribution.
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1 Introduction

Lance Taylor made numerous seminal contributions to structuralist development economics and post-Keynesian macroeconomics. His research was rooted in empirical observation, moved the theoretical research frontier, and significantly deepened our understanding of real world phenomena. Lance's many books synthesize the many more papers, and throughout his writing emphasizes the intellectual foundations of his work in Marx, Keynes, Kalecki and Minsky (Taylor, 1979, 1983, 1991, 2004, 2011).

Essential to these intellectual foundations is the notion that macroeconomic performance and monetary conditions are inextricably intertwined. Further, conflict over the functional distribution of income matters, and therefore macroeconomic activity and distribution are also strongly interdependent. Barbosa-Filho and Taylor (2006) is a much-cited and well-known contribution along these lines: extending Goodwin (1967) to include Kaleckian demand dynamics, this paper advanced a vision of cyclical growth rooted in the interactions between growth and distribution.

In a nutshell, the underlying Goodwinian idea is that accumulation is driven by profitability, but also requires employment, which in turn reduces profitability. In line with Keynesians and Kaleckians, Barbosa-Filho and Taylor (2006) emphasize that expansion is driven by demand, too (since the profit rate can be decomposed into income-capital ratio and profit share), which opens the possibility of not only profit-led but also wage-led demand regimes (Bhaduri and Marglin, 1990). The paper spurred and deepened rich empirical and theoretical literatures.

The recent empirical literature finds consensus that the *Goodwin pattern* persists, and needs to be explained. The term refers to the empirical stylized fact in the US post-war macroeconomy of regular counter-clockwise movements at business cycle frequency in activity-labor share space, measured and replicated in myriad ways (see Section 2). The theoretical debate has therefore moved on to consider different mechanisms that might explain this observed pattern.

Candidate 1 is the standard *Goodwin mechanism*, which refers to the combination of profit-led activity and profit-squeeze distribution. Candidate 2 is centered on the hypothesis that the Goodwin pattern is an artefact of the interaction between Keynesian demand dynamics and pro-cyclical labor productivity (Lavoie, 2017; Cauvel, 2023). However, Rada et al. (2024) show that this is theoretically impossible, and we will not pursue the idea further.[1]

Candidate 3 is a *pseudo-Goodwin* mechanism: Stockhammer and Michell (2017) (henceforth, SM17) present a three-dimensional model in output, labor share and the corporate debt-to-income ratio, and demonstrate that the inclusion of the financial linkage

[1] The authors also summarize current research on the fundamentally *acyclical* nature of labor productivity in recent decades. Hence, even if it were feasible to generate the Goodwin pattern as an artefact of pro-cyclical labor productivity, it would not be a viable explanation for the US Goodwin pattern of, roughly, the post-1980 era.

produces the Goodwin pattern in simulations not only if demand is unaffected by the distribution of income, but even if demand is (weakly) wage-led.[2] This research raises a series of questions.

First, the models discussed in SM17 are highly stylized. How do key results hold up in a more standard and comprehensive framework? Second, the models draw on the debt-to-income ratio as a Minskyan financial linkage. How do key results hold up with an alternative financial specification? Third, simulations illustrate the theoretical possibility of the Goodwin pattern arising with a wage-led demand regime, but for none of the models do the authors investigate steady state impacts (around warranted or natural rates of growth). What are the long run effects of redistribution in models with a pseudo-Goodwin mechanism?

Our research here offers some answers. This paper extends recent theoretical literature on a Keynesian distributive cycle (KDC) with the inclusion of the valuation ratio. KDC state variables are income-capital ratio, employment rate and labor share, and causal linkages rely on neo-Goodwinian theory (Rada et al., 2021, 2022, 2024). Crucially, the framework is built around Harrod's three growth rates, conforms to Kaldor's stylized facts and generates key *cyclical* stylized facts (of the US post-war period). Further, it clearly distinguishes between short run profit-led cycles and long run wage-led natural growth, and therewith allows for a nuanced discussion of relevant policy objectives and trade-offs. A core result is that an increase in the profit share boosts activity in the short run, but triggers stagnation in the long run, due to an effect akin to induced technical change (Rada et al., 2023). Including the valuation ratio q, i.e., the ratio of the market value of outstanding equity to the nominal value of the existing capital stock, facilitates a comparison to SM17's focus on 'financial fragility,' and we draw here extensively on Taylor (2012).

Our contribution can be summarized as follows: First, our findings support SM17's key result: simulations of three -and four-dimensional KDC models *cum* q generate the Goodwin pattern even if the income-capital ratio is not profit-led (or weakly wage-led). However, and second, in the models discussed here, redistribution towards labor has no effect on growth in the long run even if the natural rate of growth is endogenous, i.e. responds positively to the labor share. Further research needs to investigate steady state effects, and their sensitivity to specific modeling decisions about finance.

The remainder of the paper is organized as follows. Section 2 discusses related literature, weighs key empirical results, and introduces notation. Section 3 presents a three-dimensional model in income-capital ratio, labor share and valuation ratio, establishes steady state effects of redistribution, and puts forward simulation results. Section 4 proceeds in the same fashion for a four-dimensional model that adds the employment rate as state variable. Section 5 concludes.

[2] A recent paper offers a potential candidate 4: Setterfield and Wheaton (2024) show that an agent-based simulation with profit-squeeze distribution and an expectational feedback mechanism can create an aggregate Goodwin pattern, even with wage-led demand.

2 Theoretical background and stylized facts

Here we lay foundations for model development in subsequent sections. We review recent literature on the real-side Keynesian distributive cycle (KDC) and summarize empirical evidence before moving on to discussions of financial linkages.

2.1 Keynesian distributive cycle: Theory and empirics

The three-dimensional KDC model in income-capital ratio, employment rate and labor share has previously been presented in Rada et al. (2021). Rada et al. (2022) apply a similar model in the context of structural change. Rada et al. (2023) present a detailed comparison to a classical distributive cycle, as well as numerical simulations. Rada et al. (2024) demonstrate the model's ability to incorporate pro-cyclical labor productivity, and survey current debates.[3]

KDC theory has several desirable properties. Importantly, the model's steady state satisfies Kaldor's key stylized facts, and equalizes realized, warranted and natural rates of growth, without sacrificing a long run role for Keynesian aggregate demand. Further, under plausible assumptions, the model implies (dampened) cycles consistent with empirical facts, including the Goodwin pattern. Additionally, the model defines differential effects of redistribution in the short and long run. The importance of doing so emerged with empirical results presented in Kiefer and Rada (2015) and theory discussed in Blecker (2016).

There is no reason in general to assume that the impact of redistribution should be uniform over time. Moreover, the stylized facts of the neoliberal era appear to bear this out, with the persistence of the Goodwin pattern, even as the labor share and economic growth have fallen in tandem across business cycles. In the short run, economic activity is profit-led so that a redistribution towards profits has an expansionary effect. In the long run, redistribution towards profits *reduces* realized, warranted and natural rates of growth, since the labor share positively affects the rate of labor productivity growth through the induced technical change channel.

To begin, we define Harrod's growth rates *in steady state*:

$$g^* = s_\pi(1 - \psi^*)u^* = a^* + n = h^*, \tag{2.1}$$

where $g^* \equiv I^*/K^*$ is the steady state rate of accumulation and $h^* \equiv \hat{Y}^*$ is the steady

[3] This subsection draws heavily on research referenced in this paragraph. We refrain from summarizing well-known origin narratives. Goodwin (1967) proposed the growth cycle, built around Say's Law. Theory discussed here draws on Barbosa-Filho and Taylor (2006); Flaschel (2009). Blecker and Setterfield (2019) offer a textbook treatment. Barrales et al. (2022, Sec. 2) provide an overview of theoretical motivations and further references. Three-dimensional models similar in spirit to the one presented here appear in Flaschel (2015), von Arnim and Barrales (2015, Sec. 3.2) and Araujo et al. (2019, Sec. 4). In comparison to these efforts, the KDC model explicitly includes warranted and natural rates of growth, and otherwise simplifies to emphasize the key steady state linkages via the productivity growth rule.

state rate of real output.[4] The second term in (2.1) is the warranted rate of growth g^w and the third is the natural rate of growth g^n. In steady state, i.e., when all state variables are at rest and expectations are satisfied, $g^* = g^w = g^n = h^*$, and in all subsequent discussion, we will denote this rate of growth only as g^*.

Further, notation: s_π is the savings propensity of capitalists. $\pi = 1-\psi = 1-wL/PY = 1-\Omega/A$ is the profit share, and ψ the labor share. The growth rate of the labor share is equal to the difference between the growth rates of real wages $\hat{\Omega} = \omega$ and labor productivity $\hat{A} = \hat{Y} - \hat{L} = a$. $u = \sigma U = (Y^*/K)(Y/Y^*) = Y/K$ is the income-capital ratio, given by the product of the full capacity output to capital ratio σ and the utilization rate U. The growth rate of the labor force is constant, $\hat{N} = n$.

Empirical evidence on this type of framework can be categorized along three dimensions. First, cycles matter: classical-Keynesian theory is deeply rooted in the notions of gravitation and endogenous fluctuations. Though Stockhammer (2017, Sec. 3), who coined the term "neo-Goodwinian," emphasizes that neo-Kaleckians (in contrast to neo-Goodwinians) do *not* attempt to provide a theory of cyclical growth, SM17 accept the occurrence and importance of the *Goodwin pattern* (see also Lavoie, 2017).

The literature contains numerous depictions of this pattern (for the US post-war macroeconomy), i.e. descriptive evidence for quite regular and easily discernable periodic movements at business cycle frequency that imply economic activity to lead the labor share (or, equivalently, a counter-clockwise movement in activity-labor share space). For examples, see Mohun and Veneziani (2006, Fig. 3, p. 15), Barbosa-Filho and Taylor (2006, Fig. 1, p. 390); Zipperer and Skott (2011); Tavani and Zamparelli (2015, Fig. 1, p. 208); Barrales and von Arnim (2017, Fig. 4, p. 208) and, for a recent update, Rada et al. (2023, Fig. 2, p. 444).[5]

Second, econometric estimations of these (real side) short run cycles provide evidence that the *Goodwin mechanism* is the propagating cause. Specifically, VAR exercises in Barrales et al. (2024) across a multitude of specifications find a positively sloped (i.e., profit squeeze) distributive schedule, a negatively sloped (i.e., profit-led) activity schedule, and the counter-clockwise impulse response functions (IRFs) in the activity-labor share planes these generate. These results are not new: see Goldstein (1999); Barbosa-Filho and Taylor (2006); Proaño et al. (2006); Basu et al. (2013); Kiefer and Rada (2015); Carvalho and Rezai (2016); Rada and Kiefer (2016); Basu and Gautham (2020); Barrales et al. (2022); Mendieta-Muñoz et al. (2022); Barrales et al. (2023); Stamegna (2024); Santetti (2023); Santetti et al. (2024), among others, who provide econometric evidence in favor of either short run profit-led activity, or a cyclical profit-

[4]Behavioral functions are defined in Section 3, and notation related to the financial linkage just below. K is non-depreciating capital stock, $I = \dot{K}$ and Y the level of real GDP. As is standard, $\dot{x} = \partial x/\partial t$ and $\hat{x} = \dot{x}/x$ for any variable x. Starred variables (x^*) indicate a steady state value.

[5]Much of the empirical literature in this area focuses on the post-war US, and we will do the same, though other advanced countries have been found to exhibit similar dynamics (Kiefer and Rada, 2015; Rada and Kiefer, 2016; Grasseli and Maheshwari, 2018).

squeeze, or both.[6]

Third, despite the evidence for short run profit-led activity regimes, the association between growth and the labor share is positive in the long run. Post-war trends of the labor share are sensitive to measurement of the distribution of income (see footnote 6), but the strong and positive correlation between macroeconomic performance—growth rates of real GDP and labor productivity—and the labor share during the neoliberal era (or the great moderation) is uncontroversial, and has only strengthened since the start of the new millenium. The KDC model asserts a causal link, from a high labor share via its positive effect on labor productivity growth on steady state (and therewith average) growth. A growing literature analyzes this relationship, and finds some evidence in favor (Kiefer and Rada, 2015; Barrales and von Arnim, 2017; Charpe et al., 2020; Santos and Araujo, 2020; Kiefer et al., 2020; Stamegna, 2024).[7]

2.2 Minsky, debt & pseudo-Goodwin

The literature on financial cycles is vast, and our discussion must be selective. Here, we briefly introduce Minsky's hypothesis of financial fragility, and pivot to focus on how such debt dynamics can lead to "pseudo-Goodwin" cycles.

SM17 provide a convenient entry point. The focus lies on the interaction between economic activity and firms' debt: a booming economy leads to a relaxation of lending practices, and leverage increases. As leverage rises, capital accumulation slows, and ultimately the cycle turns. In this narrative, activity (on the horizontal axis) leads corporate debt or "fragility" in a counter-clockwise cycle (see SM17 Fig. 2, for their real-financial predator-prey model). In other words, the cross-feedbacks are oppositely signed—economic activity fosters debt build-up, but high debt reduces economic activity—and hence facilitate cyclical propagation.

The authors note that "no canonical version of the Minsky cycle" exists, and that therefore "several different models purporting to summarize his argument have been proposed" (SM17, p. 110). Taylor and O'Connell (1985) is an important early paper that develops Minskyan theory in a portfolio balance framework. In the basic model, the profit rate (given the mark-up rate) assumes the role of goods market closure,

[6] In this literature, economic activity has been proxied by the employment rate, the real GDP growth rate, the income-capital ratio, or proxies for the rate of utilization, such as the ratio of real GDP to the CBO's estimate of potential output. Similarly, estimates of the labor share (and in particular its trend) depend on which sectors are included, whether flows are gross or net, and how intellectual property products are accounted for. Many questions of measurement are warranted, but results summarized in this and the previous paragraph are robust to choice of variables and sample selections. Therefore, and for brevity's sake, we do not review these issues; for details and references, see Barrales et al. (2022, Sec. 3).

[7] A related literature considers the question whether either the Goodwin pattern or the Goodwin mechanism have changed over time (Setterfield, 2021; Mendieta-Muñoz et al., 2022; Carillo-Maldonado and Nikiforos, 2024). Moreover, the slowdown in long run growth could be related to this evolution of the characteristics of the growth cycle. For further evidence, discussion and references, see Barrales et al. (2024).

and interacts with the interest rate in an IS/LM-type setup. The dynamic version is framed in the (expected) profit rate and the ratio of money to fiscal debt (see their Fig. 2, p. 881), and implies, with a constant ratio of fiscal debt to the capital stock, a clockwise cycle in economic activity (on the horizontal axis) and money.

More recently, Sordi and Vercelli (2006) model financial fragility as the dynamic interplay between the ratio of current financial outflows to inflows and the 'intertemporal ratio' of the sum of discounted expected financial outflows to the sum of discounted expected inflows. Fazzari et al. (2008) simulate a dynamic macroeconomic model that emphasizes firms' cash flow and central bank interest rate setting, and "generate[s] endogenous cycles with characteristics described in Hyman Minsky's research" (p. 555). Ryoo (2013), in contrast, develops a theoretical model that generates a limit cycle between firm indebtedness and bank capital, and merges this with a Kaldorian real-side model to overlay high frequency activity-distribution cycles on top of a lower frequency leverage cycle.

For our purposes, the key is to consider syntheses of the Minskyan hypothesis with Goodwinian ideas. Keen (1995, 2013) has proposed such a framework, in which the classical growth cycle of Goodwin (1967) is extended to allow capitalists to borrow in order to accumulate. Sordi and Vercelli (2014) advance this line of research with the inclusion of Keynesian aggregate demand dynamics. These papers do not question the profit-led nature of the activity regime, so that the Goodwin pattern between the employment rate (or income-capital ratio) and the labor share arises from the Goodwin mechanism.

SM17 break that very linkage. The authors first restate the classical growth cycle (p. 107), then suggest an analog predator-prey real-financial Minsky cycle (p. 110, and the aforementioned Fig. 2), and subsequently outline three model variants that merge key features of these two frameworks. The first (their Sec. 4, eqs. 3-5) adds a profit-squeeze equation to the basic Minsky framework; we'll label it SM4. The second (their Sec. 5) makes the demand regime wage-led; we'll label it SM5. The third (their Sec. 6) generalizes SM5 by allowing further cross-feedbacks, and, importantly, negative own-feedbacks for all state variables, but does not alter the nature of the demand regime as wage-led. Analogously, we'll label this SM6.

In short: simulations of all three models generate the Goodwin pattern, either without profit-led demand (SM4) or even with wage-led demand (SM5 and SM6). The mechanism, however, is Minsky rather than Goodwin, and therefore labeled by SM17 as "pseudo-Goodwin:" in the trough of the recession, both debt and the labor share are falling, but only the decline of the former causes the turning point in economic activity. The labor share is merely along for the ride. Further, it should be emphasized that in SM4 and SM5, redistribution has no steady state effects.[8] SM6 relaxes these

[8]In SM17, redistribution could be implemented as a change in the constant term of the differential equation for the labor share, eq. 5. The steady state for output, however, is independent of this or other labor share equation parameters, for both SM4 and SM5. SM17's results here reflect the structure of

constraints, and redistribution (towards the labor share) now has a positive effect on output, as long as the wage-ledness of the economy is not "too strong."[9]

2.3 Valuation ratio and financial cycles

The two models presented in this paper extend the KDC framework with an alternative financial variable: the valuation ratio q. In this subsection, we briefly (and selectively) review theoretical literature, and motivate a law of motion for the valuation ratio.

q-theory posits that firms compare the value of capital goods with their valuation in the stock market. Hence:

$$q \equiv \frac{P_e E}{P_k K}, \tag{2.2}$$

where E represents equities, P_e the price of equity, K the capital stock, and P_k the price of capital goods. The origins of q-theory can be traced back to Keynes (1936). Keynes argued that when $q < 1$, firms find it more cost-effective to acquire existing capital assets rather than invest in new capital goods, leading to lower investment levels. Conversely, when $q > 1$, firms have an incentive to acquire new capital goods, stimulating investment.[10]

Heterodox approaches focus on average rather than marginal q, and, in line with Kaldor (1966), do not require the valuation ratio to converge to unity in steady state. This

predator-prey models: deer steady state depends only on wolf parameters; in Goodwin (1967), the labor share steady state depends only on the (technological) parameters of the employment rate equation. Specifically, redistribution in SM4 affects only the labor share, and in SM5 the labor share and debt (in the same direction).

[9] The key parameter is $s > 0$ in their eq. 8, p. 117. If s is too large, the effect of a higher labor share on steady state output could be negative (*ceteris paribus*). However, if s is too large, the economy also becomes unstable, as wage-led *cum* profit-squeeze economies tend to. Additionally, we note that the two dimensionsal subsystem that describes output-labor share interaction can be expressed in a phase diagram, taking the financial state variable as given. Two options exist: (i) the respective minor is positive, and, with two positively signed off-diagional entries, exhibits monotonic convergence; or (ii) the respective minor is negative, and therefore exhibits saddle path dynamics. In the latter case, instability can be globally bounded by the inclusion of the third state variable: the three-dimensional Routh-Hurwitz conditions require only the sum of the three minors to be positive, not each minor independently; see discussion further below.

[10] These ideas were later formalized by Brainard and Tobin (1968) and Tobin (1969), forming the foundation of the neoclassical theory of investment. In this framework, Tobin's marginal q emerges as a central explanatory variable in investment functions (Hayashi, 1982). Importantly, $q = 1$ in the long run, since arbitrage opportunities deter the production of capital goods when q is below one and encourage it when q is above one. Tobin's marginal q has been interpreted as the ratio of the marginal efficiency of investment, in turn equal to the difference between the marginal product of capital and (convex) marginal adjustment costs, to the interest rate (for an important example, see Foley and Sidrauski, 1971). This perspective highlights the inverse relationship between q and the interest rate, and present a link to a large literature on the cyclical interaction between demand and monetary policy. For relevant examples in our context, see Franke and Asada (1994); Asada et al. (2006) and Flaschel (2009, Ch. 9).

reflects an emphasis on the separation of ownership and control, i.e. shareholders and managers (Crotty, 1990).

Foley et al. (2019, Ch. 14) usefully contrast different regimes governing the interaction between q and accumulation: in a "rentier capitalist" regime, managers' investment plans are infinitely sensitive to stock market valuations, and $q = 1$ in steady state. In a "managerial capitalist" regime, accumulation is predominantly driven by animal spirits, and $q \neq 1$, except by fluke. In a "hybrid capitalist" regime, q and g interact systematically, but the steady state valuation ratio does not need to be unity.

Most post-Keynesian approaches as well as theory formalized in this paper are firmly rooted in a hybrid regime. Indeed, the stock-flow consistent (SFC) macroeconomic literature demonstrates that q can persist at multiple values in steady state, depending on financial structure, corporate behavior, and macroeconomic conditions (Godley and Lavoie, 2007; Le Heron and Mouakil, 2008; Dos Santos and Zezza, 2008; Nikiforos and Zezza, 2017).

Foley and Taylor (2006) present an influential and detailed SFC model with a hybrid regime, which the authors aggregate into a two-dimensional model in the rate of capacity utilization and q. The short-run model features upward sloping equilibrium schedules in goods and financial market. More recently, Michl (2017) develops an SFC model in accumulation rate and q that features a positively sloped growth schedule and a negatively sloped q-schedule. However, neither of these efforts focus on cycles *per se*.

As a matter of fact, cyclical models indicate that monetary expansion leads macroeconomic activity. Monetary expansion can occur with a decline in the policy rate, or endogenously through an increase of expected profitability and, concomitantly, decline in bank rate, inflation of balance sheets, or increase in asset prices.

Taylor and O'Connell (1985), already referenced above, propose such a mechanism based on Minskyan ideas. Similarly, Foley (1987, Sec. 4) models an aggregate economy where the profit rate (as in Taylor's model, and taking the distribution of income as given) serves as proxy for macroeconomic activity, and interacts with firms' balance sheets. This model also implies a clockwise cycle in economic activity (on the horizontal axis) and a monetary aggregate, or, equivalently, that money leads activity.[11] Taylor (2012, Sec. 6), in turn, outlines a model in accumulation rate g and valuation ratio q, that features positively sloped growth and finance schedules, and predicts a clockwise cycle (or, equivalently, that q leads g; see Fig. 7, p. 56).

For our purposes, the critical question is how this activity-q cycle relates to Goodwin mechanism and pattern. To investigate, we need to develop a law of motion for the valuation ratio. We follow the approach taken in Taylor and Rada (2008, p. 233ff). Definitionally, the equity yield ρ must equal the sum of capital gains and dividends D,

[11] See the top right panel of Fig. 1, p. 373. Simulation trajectories indicate counter-clockwise movement in m, r, i.e. money-activity: in the depth of the recession—the low point for r—money is growing, triggering the turnaround.

i.e. $\rho P_e E = \dot{P}_e E + D$ (see Gordon, 1962). If dividends are proportional to the capital stock, i.e. $D = \phi P_k K$, and ρ is an exogenous and "required" rate of return,

$$\hat{P}_e = \rho - \phi/q. \tag{2.3}$$

We proceed with differentation of the definition of q, and assume (as do Taylor and Rada, 2008) that $\hat{P}_k = 0$ and new equity issuance is proportional to investment demand, i.e. $P_e\dot{E} = \chi\dot{K}$, so that $\hat{E} = \chi g/q$.

$$\dot{q} = q(\hat{P}_e + \hat{E} - g) = q(\rho - g) + \chi g - \phi, \tag{2.4}$$

where eq. (2.3) is substituted after the second equal sign. Taylor (2012, Sec. 6) also draws on this line of argument to motivate the financial dimension of his (g, q)-cycle.

The upshot of all this is to link economic activity to the evolution of q, through the inclusion of eq. (2.4), and a positive effect from q on investment expenditure. The models presented below do just this, and simulations demonstrate that a profit-led demand regime is not necessary to generate the Goodwin pattern. As in SM17, though there based on Minskyan debt, the *mechanism* generating the Goodwin pattern could be labeled as *pseudo*: in the trough of the cycle, q is rising, and therefore triggers a turnaround in activity. The labor share—falling at this point in the cycle—is just along for the ride.[12]

3 A Keynesian distributive cycle *cum* valuation ratio

Here we present a three-dimensional model in income-capital ratio u, the labor share ψ, and the valuation ratio q. The next subsection outlines the system and its stability and the dynamic patterns it generates. Further below, we discuss steady state effects of labor suppression, and ultimately show illustrative simulations.

3.1 The three-dimensional model

The distributive cycle model of this section features three laws of motion:

$$\dot{u} = u(h - g^w) \tag{3.1}$$
$$\dot{\psi} = \psi(\omega - a) \tag{3.2}$$
$$\dot{q} = q(\rho - g^w) + \chi g - \phi, \tag{3.3}$$

where $h = \hat{Y}$ represents the independent expenditure function that determines output growth. The state variables are income-capital ratio u, the labor share ψ, and the valuation ratio q. The differential equation for q reproduces (2.4). The social accounting

[12] Barrales et al. (2022, Sec. 5.1) discusses related issues, and presents empirical evidence based on a VAR exercise suggesting that demand is statistically significantly profit-led even when q is included in the model. Hence, the *theoretical possibility* of a pseudo-Goodwin pattern is, as of now, just that: theoretical. We return to this theme in concluding discussion.

matrix underlying this system is similar to Foley et al. (2019, Ch. 14), and implies that new investment is financed exclusively by firms' retained earnings or new equity issuance. (Details are available upon request.)

These laws of motion become fully specified with the warranted rate of growth g^w, and two behavioral functions that describe the growth rates of output h and real wages ω:

$$g^w = s_\pi(1-\psi)u \tag{3.4}$$

$$h = h(u,\psi,q),\ h_\psi < 0,\ h_u > 0,\ h_q > 0 \tag{3.5}$$

$$\omega = \omega(u,\psi),\ \omega_u > 0,\ \omega_\psi < 0 \tag{3.6}$$

The baseline KDC model further includes endogenous labor productivity growth, with a positive effect from the labor share, akin to "induced technical change." We abstract from that here, but reintroduce it in the four-dimensional model of Section 4.

Further, in this closed economy without a public sector, h is the growth rate of the sum of consumption and investment. Hence, equation (3.1) equalizes growth rates of output and capital, while (only implicitly) assuming an inventory process to equalize flows of investment and saving. Crucially, this is a disequilibrium model: goods and labor markets clear only in steady state with fully satisfied expectations. Therefore, the growth rate of the capital stock is equal to the warranted growth rate only when all variables are at rest, i.e. in steady state.

The partials in the expressions above can be motivated as follows: First, $h_u > 0$ indicates that higher demand, as reflected in a rising income-capital ratio, leads to increased output growth, as in Skott (1989). This contrasts with the assumption that $h_u < 0$, which ensures dynamic stability of the income-capital ratio, as in Barbosa-Filho and Taylor (2006). In fact, and as will be seen below, the positive partial h_u is necessary in the four dimensional model to impart a positive effect of higher demand on employment.

Second, $h_\psi < 0$ represents a Kaleckian link from functional distribution of income to economic activity, although here driving investment as expenditure first. (Note that $h_\psi + s_\pi u$ determines the slope of the nullcline for the income-capital ratio and therewith the demand regime.) Further, $h_q > 0$ captures the idea anticipated by Keynes (1936) that a higher valuation ratio stimulates investment demand. This is consistent with a hybrid regime in which investment decisions are responsive to q, but not infinitely so, emphasizing the separation between capitalists and managers. Together, these relationships establish h as an independent expenditure function with Keynesian-Kaleckian characteristics.

In this model, the profit squeeze mechanism operates through u, with the labor market only implicit and relegated to the background, as in Barbosa-Filho and Taylor (2006). This profit squeeze mechanism vis-a-vis u reflects the Keynesian view that employment levels primarily depend on output, meaning that rising u increases employment, which in turn leads to higher wages.

In addition, we assume $\omega_\psi < 0$, reflecting the diminishing scope for real wage growth at higher levels of the labor share. This negative own-feedback ensures the self-stabilizing behavior of the distribution variable, and reinforces the dynamic stability of the system.

Substitution of the behavioral equations into the laws of motion results in a three-dimensional system of differential equations. The Jacobian matrix at the non-trivial steady state is given by:

$$J^* = \begin{bmatrix} u(h_u - s_\pi(1-\psi)) & u(h_\psi + s_\pi u) & uh_q \\ \psi\omega_u & \psi\omega_\psi & 0 \\ -s_\pi(1-\psi) & s_\pi u & \rho - s_\pi(1-\psi)u \end{bmatrix}, \tag{3.7}$$

where we refrain from starring steady-state variables for brevity.

We assume, in steady state: (i) own-stability of income-capital ratio ($h_u < s_\pi \pi$), (ii) equality of equity yield and warranted rate ($\rho = g^w$) and (iii) profit-led income-capital ratio ($|h_\psi| > s_\pi u$). Assumption (iii) will be relaxed further below—but relying on (i)–(iii) for the moment, the Jacobian's sign pattern becomes:

$$J^* = \begin{bmatrix} - & - & + \\ + & - & 0 \\ - & + & 0 \end{bmatrix} \tag{3.8}$$

The linearized model is asymptotically stable if the following Routh-Hurwitz conditions hold:

$$Tr(J) < 0 \tag{3.9}$$
$$|J_{11}| + |J_{22}| + |J_{33}| > 0 \tag{3.10}$$
$$|J| < 0 \tag{3.11}$$
$$-Tr(J)(|J_{11}| + |J_{22}| + |J_{33}|) + |J| > 0 \tag{3.12}$$

The first two conditions are easily verified. A sufficient condition to satisfy condition (3.11) is

$$(1-\psi)|\omega_\psi| > u\omega_u, \tag{3.13}$$

which tends to be satisfied if the self-stabilizing effect of ψ is stronger than the profit-squeeze effect. Moreover, if (3.13) holds, condition (3.12) does, too, and the three-dimensional model converges. (See Appendix A.1 for details.) We note that the baseline KDC model does not include negative own-feedback of the labor share, i.e. $\omega_\psi = 0$ in Rada et al. (2021). This partial becomes essential here, presumably due to the additional expansionary impact of finance on activity.

3.2 Labor Suppression

Now we consider a shift in labor market institutions that reduces the bargaining power of labor. In this model, bargaining is represented by the real wage Phillips curve, which is influenced by changes in the income-capital ratio. To capture shifts, we introduce the parameter α, so that $\omega(u;\alpha)$ and $\omega_\alpha > 0$. (See Appendix A.2 for further details.)

Key results regarding the state variables are:

$$\frac{\partial \psi^*}{\partial \alpha} = \frac{-s_\pi(1-\psi)\psi\omega_\alpha u h_q}{|J^*|} > 0 \tag{3.14}$$

$$\frac{\partial u^*}{\partial \alpha} = \frac{-u h_q \psi \omega_\alpha s_\pi u}{|J^*|} > 0 \tag{3.15}$$

$$\frac{\partial q^*}{\partial \alpha} = \frac{u\psi\omega_\alpha s_\pi[(h_\psi + s_\pi u)(1-\psi) + u(h_u - s_\pi(1-\psi)]}{|J^*|} > 0 \tag{3.16}$$

It follows that:

$$\frac{\partial g^w}{\partial \alpha} = s_\pi(1-\psi)\frac{\partial u}{\partial \alpha} - s_\pi u \frac{\partial \psi}{\partial \alpha} \tag{3.17}$$

$$\frac{\partial g^*}{\partial \alpha} = a_\psi \frac{\partial \psi}{\partial \alpha} = 0 \tag{3.18}$$

These results show that a shock to labor market institutions impacts the labor share, the income-capital ratio, and the valuation ratio in the same direction. Specifically, a reduction in α results in lower steady state values for the labor share, the income-capital ratio, and the valuation ratio.

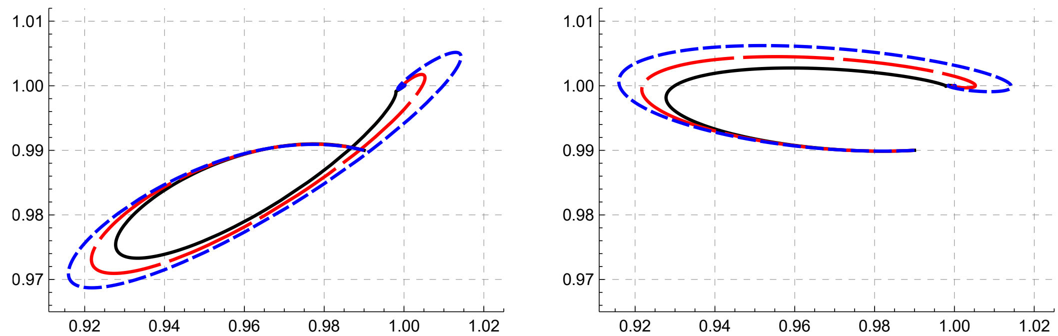
Importantly, the growth rate of labor productivity and therewith the natural rate of growth can not change, given the absence of an induced technical change channel. In contrast, equation (3.17) suggests that the warranted rate of growth might rise or fall, which would imply $g^* \neq g^w$, as in Rada et al. (2021, Sec. 3) and due to the employment rate not being modeled. However, in steady state $g^w = \rho$, so that in fact all three of Harrod's growth rates converge (in response to any shock other than to ρ or a). Simulations in the next subsection illustrate this further.

3.3 Three-dimensional simulations

The three-dimensional model contains two-dimensional subsystems that imply cyclical propagation. Indeed, based on the signs of the Jacobian in equation (3.8) the model generates relevant cyclical stylized facts, i.e., the (u, ψ) and (u, q) cycles. These match the cyclical patterns described in Barbosa-Filho and Taylor (2006) for the former and Taylor (2012) for the latter, respectively, and are empirically validated in Barrales et al. (2022, 2024) and other research referenced above (p. 6).

This section puts forth illustrative simulations that are consistent with theoretical formulations and empirical evidence.[13] We present short run results in Figure 1. These

[13] We emphasize that these simulations are merely illustrative: parameter values and resulting cyclical or long run trajectories do not match the characteristics of macroeconomic time series. They do, however, give an indication of the dynamic properties of the theory outlined above.



(a) u, ψ

(b) u, q

Figure 1: Three-dimensional model, cycles. Trajectories are shown relative to baseline steady state and converge from initial disequilibrium conditions. Panels (a) and (b) show u, ψ and u, q, respectively, with u on the horizontal axis. Three calibrations are shown: solid black is profit-led, long-dashed red features no distributive effect, and short-dashed blue is wage-led.

are reported relative to baseline steady state, with trajectories beginning at an assumed initial disequilibrium. Further, we present long run results in Figures 2 and 3. Here, trajectories are reported in levels or growth rates. Long run simulations begin at baseline steady state, and evolve in response to an adverse bargaining shock, analog to the exercise in Section 3.2.

To calibrate the model, we set $a = 0.02$, $n = 0.01$, and therefore $\rho = 0.03$. Baseline steady states are $u^* = 0.4$, $\psi^* = 2/3$ and $q^* = 1$. Further, $\phi = 0.005$ and $\chi = 0.17$, so that $\dot{q} = 0$ in the initial steady state. To satisfy $g^w = 0.03$, $s_\pi = 0.225$.[14] Lastly, we assume simple linear behavioral functions for h and ω, with the following parameters:

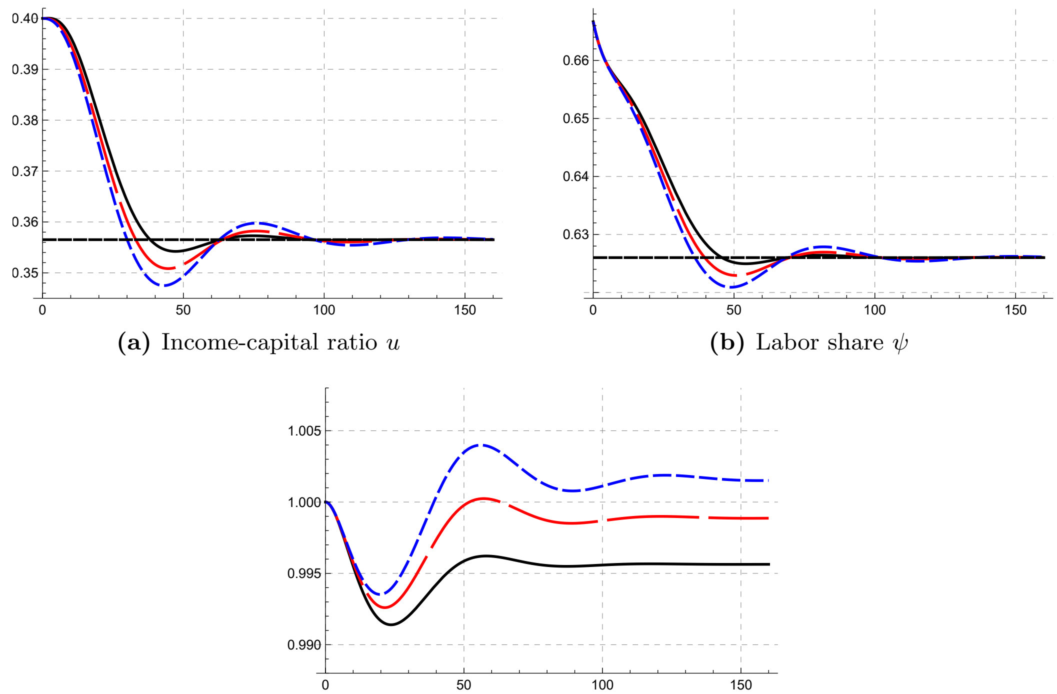
$$h = -0.65 + 0.065u - 0.15\psi + 0.75q \tag{3.19}$$

$$\omega = 0.14 + 0.2u - 0.3\psi, \tag{3.20}$$

which produce $h^* = 0.03 = g^*$ and $\omega^* = 0.02 = a^*$ in the baseline steady state. Note that these parameters satisfy assumptions (i)–(iii) (just after equation 3.7).

Importantly, the simulations vary demand regimes, and achieve that by changing the magnitude of h_ψ (and adjusting h_0, accordingly). The previous paragraph sets $h_\psi = -0.15$, which renders $|h_\psi| > s_\pi u$ and demand therefore profit-led. The second simulation sets $h_\psi = -0.09$, which renders $|h_\psi| = s_\pi u$ and therefore implies no distributive effect on the income-capital ratio. The third simulation sets $h_\psi = -0.04$,

[14]Firms distribute a portion of profits to capitalists ($\phi > 0$), who utilize this income to consume and purchase newly issued equity ($\chi > 0$). $0 < s_\pi < 1$ reflects aggregate behavior, i.e. the savings behavior of firms and capitalists in combination. Taylor (2012) suggests that $\chi < 0$ in the US in recent decades. Further, Taylor and Rada (2008) and Taylor (2012) assume $\partial\dot{q}/\partial q > 0$, but this destabilizing effect creates many questions for comparative dynamics, and we therefore stick to $\partial\dot{q}/\partial q = 0$. The latter, in turn, requires $\chi > 0$. Additionally, we recognize that ϕ, χ and ρ are all endogenous—and likely cyclical—in the real world. These are held constant here merely for tractability.



(a) Income-capital ratio u

(b) Labor share ψ

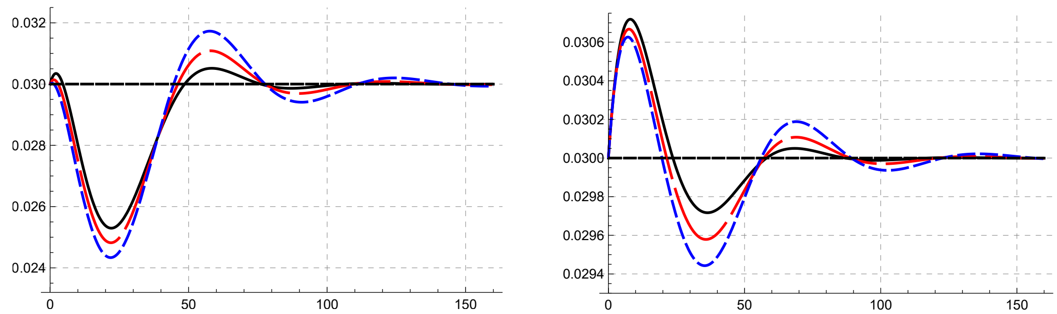
(c) Tobin's q

Figure 2: Three-dimensional model, state variables. At $t = 0$, an adverse shock to labor's bargaining power is imposed. Trajectories evolve from baseline to post-shock steady states. Three calibrations are shown: solid black is profit-led, long-dashed red features no distributive effect, and short-dashed blue is wage-led. The dashed black line is the post-shock steady state (not shown for q).

which renders $|h_\psi| < s_\pi u$ and demand therefore wage-led.

Figure 1 shows that the model converges to the baseline steady state from an initial disequilibrium in a cyclical manner. The left panel shows the counter-clockwise Goodwin pattern, the right panel the clockwise (u, q)-pattern. Crucially, these patterns do not change qualitatively with the varying demand regimes, but merely differ in amplitude. Specifically, the profit-led (wage-led) calibration shows the smallest (largest) amplitude, which is consistent with our understanding that wage-led demand in combination with a profit-squeeze is destabilizing.

Figures 2 and 3 report trajectories for the three state variables and growth rates, respectively, in response to an adverse shock to labor's bargaining power, from the baseline steady state. The black lines in Figure 2 panels (a)-(c) are in line with the results of Section 3.2. The growth rate of labor productivity a is exogenous and not reported. h and g in Figure 3, however, deviate from their steady state values before converging back to these.



(a) Growth rate of real GDP h **(b)** Growth rate of capital stock g

Figure 3: Three-dimensional model, growth rates. At $t = 0$, an adverse shock to labor's bargaining power is imposed. Trajectories evolve from baseline to post-shock steady states. Three calibrations are shown: solid black is profit-led, long-dashed red features no distributive effect, and short-dashed blue is wage-led. The dashed black line is the post-shock steady state.

In summary, the addition of q to an otherwise standard neo-Goodwinian model in (u, ψ) has important consequences. First, the Goodwin pattern can be generated without profit-led demand, or even with weakly wage-led demand. As in SM17, the financial variable assumes the burden of providing incentives for an upswing, instead of declining real unit labor costs in a real-side Goodwin mechanism. Second, model closures and long run impacts critically depend on modeling choices regarding financial institutions and behaviors: in our three-dimensional KDC *cum* q model, ρ tightly anchors the system, since g^w must converge in steady state.

4 Balanced growth and the valuation ratio

This section extends the model to include labor constraints. The employment rate becomes the fourth state variable, placing the burden of the profit squeeze into the labor market. The employment rate's law of motion ensures that the output growth rate converges to the natural growth rate in steady state. We first introduce the model, subsequently consider labor suppression and lastly present simulations.

4.1 The four-dimensional model

The extended model adds the employment rate $e = L/N = Y/(AN)$ as fourth state variable. The system of nonlinear differential equations is:

$$\dot{u} = u(h - g^w) \tag{4.1}$$
$$\dot{e} = e(h - (a + n)) \tag{4.2}$$
$$\dot{\psi} = \psi(\omega - a) \tag{4.3}$$
$$\dot{q} = q(\rho - g^w) + \chi g - \phi, \tag{4.4}$$

where the employment rate's law of motion forces convergence of the realized output growth rate $\hat{Y} = h$ and the growth rate of the effective labor force, $g^* = a + n$. The laws of motion for income-capital ratio, labor share, and valuation ratio are as in the previous section. As in the previous section, the social accounting matrix underlying this system is similar to Foley et al. (2019, Ch. 14), and implies that new investment is financed exclusively by firms' retained earnings or new equity issuance.

The inclusion of the employment rate introduces a new partial, $h_e < 0$. As noted by Skott (1989, p. 236), this negative sign reflects the impact of adjustment and turnover costs that arise at higher employment rates, which reduce the desired rate of expansion. This mechanism also finds support in Kalecki's (1943) essay on the "political aspects of full employment," where high employment levels diminish the power of capital, thus curbing growth plans.

Additionally, we now include an induced technical change effect:

$$a = a(\psi), a_\psi > 0, \tag{4.5}$$

so that rising real wages relative to labor productivity drive efforts to economize on labor costs. Such a functional relationship can be motivated in classical, optimizing frameworks (Shah and Desai, 1981; Foley et al., 2019). Here we model aggregate productivity directly, based on the assumption that labor-saving innovation is encouraged by real higher unit labor costs (Barbosa-Filho and Taylor, 2006; Storm and Naastepad, 2012).

Further, the real wage Phillips curve depends directly on the employment rate:

$$\omega = \omega(e), \omega_e > 0 \tag{4.6}$$

Substituting these equations into the four laws of motion results in the following Jacobian matrix, evaluated at the non-trivial steady state:

$$J^* = \begin{bmatrix} u(h_u - s_\pi(1-\psi)) & uh_e & u(h_\psi + s_\pi u) & uh_q \\ eh_u & eh_e & e(h_\psi - a_\psi) & eh_q \\ 0 & \psi\omega_e & \psi(\omega_\psi - a_\psi) & 0 \\ -s_\pi(1-\psi) & 0 & s_\pi u & \rho - s_\pi(1-\psi)u \end{bmatrix} \tag{4.7}$$

To unambiguously sign this matrix, we restate assumptions on key parameters in steady state: (i) own-stability of income-capital ratio ($h_u < s_\pi \pi$), (ii) equality of equity yield and warranted rate ($\rho = g^w$) and (iii) profit-led income-capital ratio ($|h_\psi| > s_\pi u$). Again, assumption (iii) will be relaxed below. With (i)–(iii), the sign pattern is:

$$J^* = \begin{bmatrix} - & - & - & + \\ + & - & - & + \\ 0 & + & - & 0 \\ - & 0 & + & 0 \end{bmatrix} \tag{4.8}$$

It is clear from inspection that the trace is negative. Appendix A.3 shows that the determinant is positive. Both of these are necessary (though not sufficient) conditions for all four roots to have negative real parts. A full investigation of the four-dimensional Routh-Hurwitz conditions might provide a route forward, but in the interest of space we do not pursue it here. Simulations further below indicate that stability is indeed attainable across a number of parameterizations.

4.2 Labor suppression in the four-dimensional model

The four-dimensional model retains important causal mechanisms present in the simpler model of Section 3. The key distinction lies in the growth rate of output now converging not only to the warranted growth rate but also to the natural growth rate. In consequence, $h^* = g^w = g^n = g^*$ under any circumstance.

To investigate long run distributive impacts, we introduce the parameter α, so that $\omega(e;\alpha)$ and $\omega_\alpha > 0$. (See Appendix A.4 for further details.) Results differ from the three-dimensional model:

$$\frac{\partial \psi^*}{\partial \alpha} = 0 \tag{4.9}$$

$$\frac{\partial u^*}{\partial \alpha} = 0 \tag{4.10}$$

$$\frac{\partial e^*}{\partial \alpha} = \frac{-a_\psi e h_q s_\pi u(1-\psi)}{|J^*|} < 0 \tag{4.11}$$

$$\frac{\partial q^*}{\partial \alpha} = \frac{\psi \omega_\alpha a_\psi e h_e s_\pi u(1-\psi)}{|J^*|} < 0 \tag{4.12}$$

A reduction in α, i.e. a downward shift in the intercept of the real wage Phillips curve, leads to an increase in e^* and q^*. However, labor suppression in the four-dimensional model does *not* impact the steady-state values of u^* and ψ^*. Consequently, changes in the parameter α leave the steady-state values of the natural and warranted growth rates unchanged, despite the fact that the natural rate of growth is responsive in principle to redistribution:

$$\frac{\partial g^w}{\partial \alpha} = s_\pi(1-\psi)\frac{\partial u}{\partial \alpha} - s_\pi u \frac{\partial \psi}{\partial \alpha} = 0 \tag{4.13}$$

$$\frac{\partial g^*}{\partial \alpha} = a_\psi \frac{\partial \psi}{\partial \alpha} = 0. \tag{4.14}$$

4.3 Four-dimensional simulations

The four-dimensional model contains two-dimensional subsystems that imply cyclical propagation. Based on the signs of the Jacobian in equation (4.8), the two-dimensional subsystems produce counter-clockwise cycles in (e,ψ), (u,e) as well as clockwise cycles in (u,q). These match the cyclical patterns described in the literature (Barrales et al., 2022, 2024).

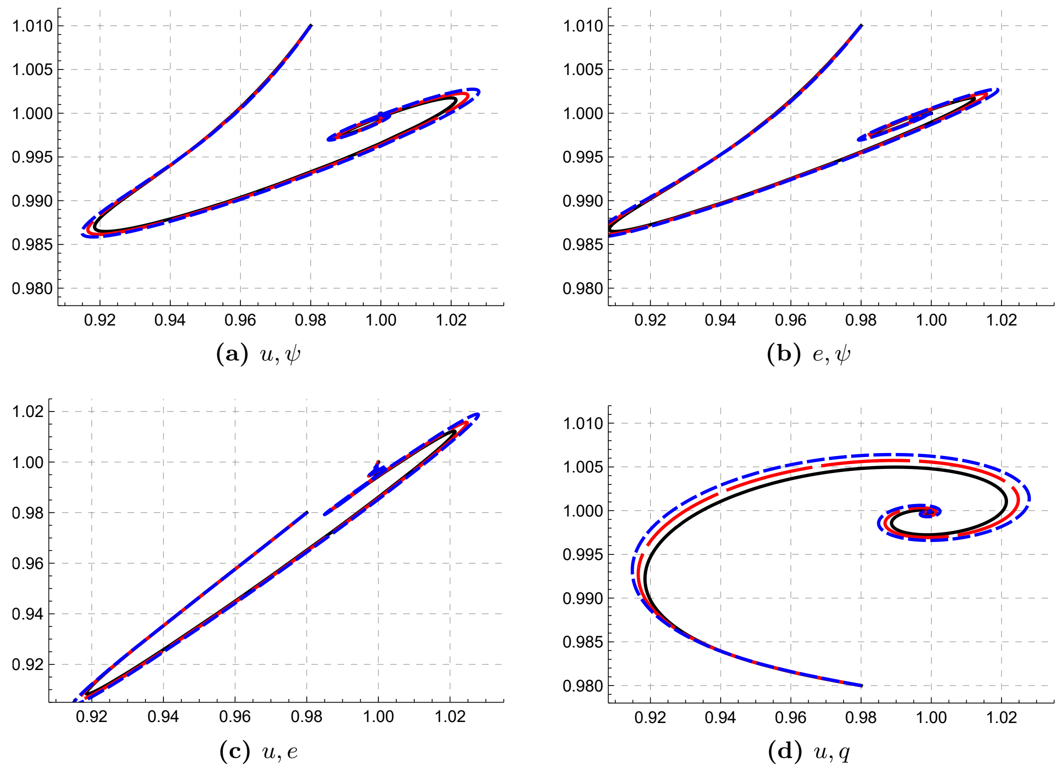


Figure 4: Four-dimensional model, cycles. Trajectories are shown relative to baseline steady state and converge from initial disequilibrium conditions. Panels (a)-(d) show variable pairs as noted, with the first variable on the horizontal axis. Three calibrations are shown: solid black is profit-led, long-dashed red features no distributive effect, and short-dashed blue is wage-led.

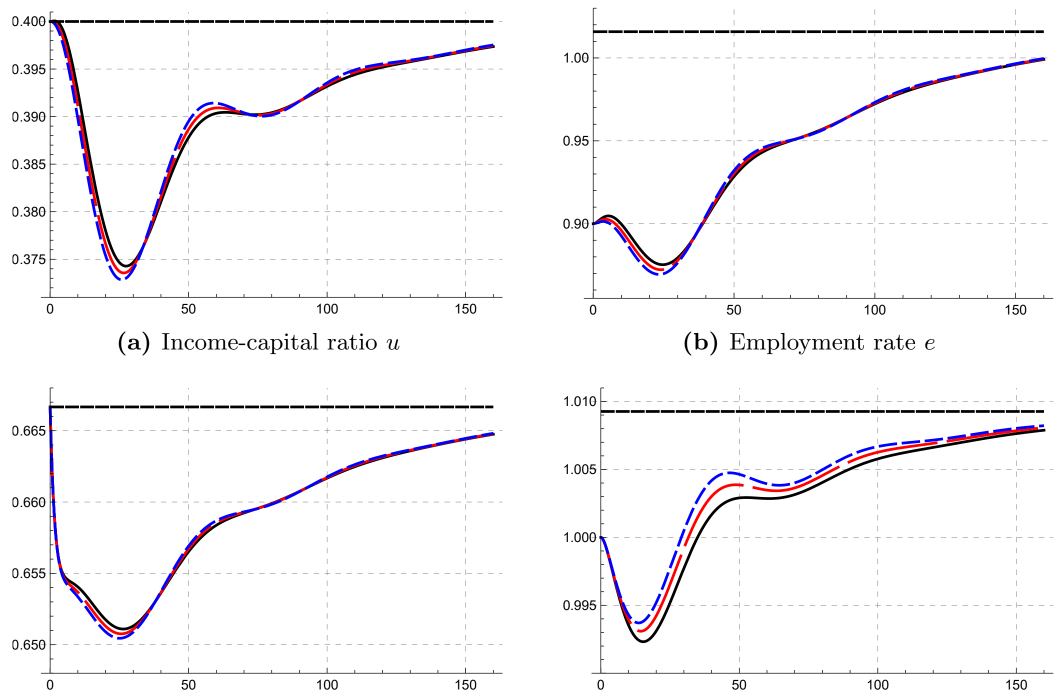
We now present illustrative simulations. Short run results are shown in Figure 4. As before, these are reported relative to baseline steady state, with trajectories beginning at an assumed initial disequilibrium. We present long run results in Figures 5 and 6, with trajectories reported in levels or growth rates. Long run simulations begin at baseline steady state, and evolve in response to an adverse bargaining shock, analog to the exercise in Section 4.2.

To calibrate the model, we follow the same appraoch as above: $n = 0.01$ and $\rho = 0.03$. Baseline steady states are $u^* = 0.4$, $\psi^* = 2/3$, $q^* = 1$, and now additionally $e^* = 0.9$. We again set $\phi = 0.005$, $\chi = 0.17$ and $s_\pi = 0.225$. (See p. 15 and footnotes 13 and 14.) Lastly, the linear behavioral functions for h, ω and a are:

$$h = -0.59 + 0.065u - 0.06e - 0.15\psi + 0.75q \tag{4.15}$$

$$\omega = 0.46 + 0.1e - 0.8\psi \tag{4.16}$$

$$a = -0.047 + 0.1\psi, \tag{4.17}$$



(a) Income-capital ratio u **(b)** Employment rate e

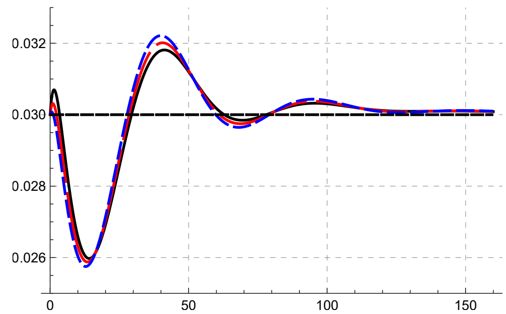
(c) Labor share ψ **(d)** Tobin's q

Figure 5: Four-dimensional model, state variables. At $t = 0$, an adverse shock to labor's bargaining power is imposed. Trajectories evolve from baseline to post-shock steady states. Three calibrations are shown: solid black is profit-led, long-dashed red features no distributive effect, and short-dashed blue is wage-led. The dashed black line is the post-shock steady state.

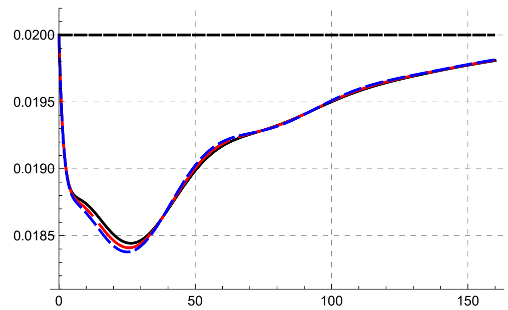
which produce $h^* = 0.03 = g^*$ and $\omega^* = 0.02 = a^*$ in initial steady state. Note that these parameters satisfy assumptions (i)–(iii) (just after equation 4.7).

As in Section 3.3, the simulations vary demand regimes, and achieve that by changing the magnitude of h_ψ, from -0.15 for a profit-led income-capital ratio, to -0.09 and -0.04 for no distributive effect and a wage-led regime, respectively. Note that for all three calibrations, the employment regime remains profit-led, since $h_\psi - a_\psi < 0$ even as the income-capital ratio has become wage-led (which is consistent with Lavoie, 2017, p. 216, and the literature cited there).

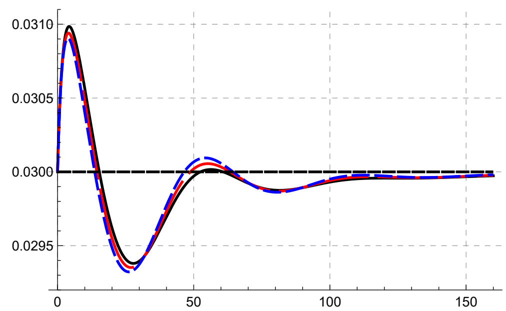
Figure 4 demonstrates that the model converges cyclically to the baseline steady state. The top two panels exhibit the Goodwin pattern in e and u vis-à-vis ψ. As discussed in Rada et al. (2021, p. 11), the Goodwin pattern in u arises via the interaction of the effect of demand on employment and the profit-squeeze. Panel (c) shows that demand leads employment in a counter-clockwise pattern, and panel (d) reports the clockwise (u, q)-cycle. As in Figure 1, the amplitude of the profit-led calibration is smallest. These cycles reflect available empirical evidence (Zipperer and Skott, 2011;



(a) Growth rate of real GDP h



(b) Growth rate of labor productivity a



(c) Growth rate of capital stock g

Figure 6: Four-dimensional model, growth rates. At $t = 0$, an adverse shock to labor's bargaining power is imposed. Trajectories evolve from baseline to post-shock steady states. Three calibrations are shown: solid black is profit-led, long-dashed red features no distributive effect, and short-dashed blue is wage-led.The dashed black line is the post-shock steady state.

Taylor, 2012; Barrales et al., 2024).

Figures 5 and 6 show trajectories for the four state variables and three growth rates, respectively, in response to an adverse shock to labor's bargaining power. These are consistent with the results of Section 4.2: employment rate and q rise, whereas income-capital ratio and labor share do not change. The transition paths suggest the possibility of a negative level effect on u, which is smaller if the demand regime is profit-led. Given that the key state variables do not change in the long run, growth rates converge back to the baseline natural rate of growth, too.

5 Conclusions

The Goodwin pattern is the recurring counter-clockwise cycle between an activity variable—employment rate, or an appropriate proxy for aggregate demand—and the labor share (on the vertical axis), or, equivalently, that activity leads the labor share at business cycle frequency. A consensus on the persistence and empirical relevance of this pattern exists.

Current post-Keynesian macroeconomic research focuses on identification of the mechanism that drives this cycle. The Goodwin mechanism, i.e., the combination of profit-led activity and profit-squeeze distribution, is the only feasible candidate in small-scale real-side models. Stockhammer and Michell (2017) offer a theoretical, alternative mechanism: a highly stylized Minskyan predator-prey cycle in demand and firms' debt, *cum* profit-squeeze distribution, and *sine* profit-led demand. The authors label this as a pseudo-Goodwin mechanism.

In this paper, we confirm that a more detailed model of a Keynesian distributive cycle, extended to include the valuation ratio, can also generate the Goodwin pattern even when demand is wage-led. In conclusion, the finding is intuitive: a pseudo-Goodwin mechanism sets the lower turning point—decreasing leverage in Minsky, increasing q in Tobin—when the labor share does not assume that burden.

To weigh the import of these insights requires further research. First, of the three models presented in Stockhammer and Michell (2017), two feature no steady state effects of redistribution on economic activity. The third is wage-led. Further, these models are highly stylized, and do not specify natural or warranted rates of growth.

However, the two models discussed here also show no steady state effects of redistribution, even if the natural rate of growth is responsive to labor share changes. In our context, these results arise due to the specific modeling choices on financial structure, in particular the exogenous equity yield, and convergence of the warranted rate thereto. Future research could elucidate robustness of results in the context of different assumptions about financial market behaviors and institutions.

Second, empirical evidence on neo-Goodwinian models with financial linkages is limited. Barrales et al. (2022, Sec. 5.1) presents an exception. The authors estimate a model in demand, labor share and q (i.e., as in our three-dimensional model) and find evidence in support of profit-led activity even in the presence of the valuation ratio. If the true data-generating mechanism is indeed pseudo-Goodwin, one ought to be able to find support for wage-led demand.

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A Appendix

A.1 3D model stability

The Routh-Hurwitz stability conditions for a three-dimensional system of (linearized) differential equations are listed in Section 2, equations (3.9)-(3.12). The first condition requires a negative trace, which is always satisfied. The second condition is also satisfied, since $|J_{11}| = 0, |J_{22}| > 0, |J_{33}| > 0$.

Next, the full determinant needs to be negative. The steady state Jacobian yields the following determinant:

$$det(J^*) = uh_q s_\pi \psi((1-\psi)\omega_\psi + u\omega_u) \tag{A.1}$$

Therefore, a sufficient condition for a negative determinant is:

$$(1-\psi)|\omega_\psi| > u\omega_u \tag{A.2}$$

Finally, the fourth condition (eq. 3.12) can be restated as:

$$\underbrace{-Tr(J)|J_{22}|}_{I:+}\underbrace{-Tr(J)|J_{33}|}_{II:+} + \underbrace{|J|}_{III:-} > 0 \tag{A.3}$$

We can show that $I + III > 0$:

$$u^2 h_q \psi \omega_u + uh_q s_\pi \psi(1-\psi)\omega_\psi - Tr(J)s_\pi(1-\psi)uh_q \tag{A.4}$$

$$u^2 h_q \psi \omega_u + uh_q s_\pi (1-\psi)[\psi\omega_\psi - Tr(J)] \tag{A.5}$$

$$\underbrace{u^2 h_q \psi \omega_u}_{+} + \underbrace{uh_q s_\pi (1-\psi)}_{+}\underbrace{[-u(h_u - s_\pi(1-\psi))]}_{+} \tag{A.6}$$

which is sufficient to satisfy the fourth condition. In summary, the profit-led Jacobian is asymptotically stable under the assumed sign pattern, and satisfaction of inequality (A.2).

A.2 3D model comparative dynamics

We employ Cramer's rule to calculate the partial derivatives of state variables $u^*, \psi^*, q^*$with respect to α. Given the sign pattern of the Jacobian in equation (3.8) and the assumption of satisfaction of the Routh-Hurwitz conditions (see above), each of these can be unambiguously signed:

$$\frac{\partial \psi^*}{\partial \alpha} = \frac{\begin{vmatrix} u(h_u - s_\pi(1-\psi)) & 0 & uh_q \\ \psi\omega_u & -\psi\omega_\alpha & 0 \\ -s_\pi(1-\psi) & 0 & 0 \end{vmatrix}}{|J^*|} = \frac{-s_\pi(1-\psi)\psi\omega_\alpha uh_q}{|J^*|} > 0 \tag{A.7}$$

$$\frac{\partial u^*}{\partial \alpha} = \frac{\begin{vmatrix} 0 & u(h_\psi + s_\pi u) & uh_q \\ -\psi\omega_\alpha & \psi\omega_\psi & 0 \\ 0 & s_\pi u & 0 \end{vmatrix}}{|J^*|} = \frac{-uh_q\psi\omega_\alpha s_\pi u}{|J^*|} > 0 \tag{A.8}$$

$$\frac{\partial q^*}{\partial \alpha} = \frac{\begin{vmatrix} u(h_u - s_\pi(1-\psi)) & u(h_\psi + s_\pi u) & 0 \\ \psi\omega_u & \psi\omega_\psi & -\psi\omega_\alpha \\ -s_\pi(1-\psi) & s_\pi u & 0 \end{vmatrix}}{|J^*|} \tag{A.9}$$

$$= \frac{u\psi\omega_\alpha s_\pi[(h_\psi + s_\pi u)(1-\psi) + u(h_u - s_\pi(1-\psi)]}{|J^*|} > 0 \tag{A.10}$$

A.3 4D model determinant

We show here that $|J^*| > 0$. We compute the determinant using cofactor expansion along the first column:

$$J^* = j_{11}\det(J_{11}) - j_{21}\det(J_{21}) + j_{31}\det(J_{31}) - j_{41}\det(J_{41}). \tag{A.11}$$

Further expansion yields the following results:

$$|J_{11}| = eh_q\psi\omega_e s_\pi u > 0 \tag{A.12}$$

$$|J_{21}| = u^2 h_q\psi\omega_e s_\pi > 0 \tag{A.13}$$

$$|J_{41}| = uh_q e\psi\omega_e(s_\pi u + a_\psi) > 0 \tag{A.14}$$

The determinant of J^* is given by:

$$|J^*| = u(h_u - s_\pi(1-\psi))|J_{11}| - eh_u|J_{21}| + 0\cdot|J_{31}| + s_\pi(1-\psi)|J_{41}|, \tag{A.15}$$

and it follows that

$$|J^*| = a_\psi eh_q\omega_e\psi s_\pi u(1-\psi) > 0. \tag{A.16}$$

A.4 4D model comparative dynamics

We employ Cramer's rule to calculate the partial derivatives of state variables u^*, ψ^*, e^*, q^* with respect to α. Under the sign pattern of the model's Jacobian (4.7), each of these can be unambiguously signed:

$$\frac{\partial \psi^*}{\partial \alpha} = \frac{\begin{vmatrix} u(h_u - s_\pi(1-\psi)) & uh_e & 0 & uh_q \\ eh_u & eh_e & 0 & eh_q \\ 0 & \psi\omega_e & -\psi\omega_\alpha & 0 \\ -s_\pi(1-\psi) & 0 & 0 & 0 \end{vmatrix}}{|J^*|} = 0 \tag{A.17}$$

$$\frac{\partial u^*}{\partial \alpha} = \frac{\begin{vmatrix} 0 & uh_e & u(h_\psi + s_\pi u) & uh_q \\ 0 & eh_e & e(h_\psi - a_\psi) & eh_q \\ -\psi\omega_\alpha & \psi\omega_e & \psi(\omega_\psi - a_\psi) & 0 \\ 0 & 0 & s_\pi u & 0 \end{vmatrix}}{|J^*|} = 0 \tag{A.18}$$

$$\begin{aligned} \frac{\partial e^*}{\partial \alpha} &= \frac{\begin{vmatrix} u(h_u - s_\pi(1-\psi)) & 0 & u(h_\psi + s_\pi u) & uh_q \\ eh_u & 0 & e(h_\psi - a_\psi) & eh_q \\ 0 & -\psi\omega_\alpha & \psi(\omega_\psi - a_\psi) & 0 \\ -s_\pi(1-\psi) & 0 & s_\pi u & 0 \end{vmatrix}}{|J^*|} = \\ &= \frac{-a_\psi e h_q s_\pi u(1-\psi)}{|J^*|} < 0 \end{aligned} \tag{A.19}$$

$$\begin{aligned} \frac{\partial q^*}{\partial \alpha} &= \frac{\begin{vmatrix} u(h_u - s_\pi(1-\psi)) & uh_e & u(h_\psi + s_\pi u) & 0 \\ eh_u & eh_e & e(h_\psi - a_\psi) & 0 \\ 0 & \psi\omega_e & \psi(\omega_\psi - a_\psi) & -\psi\omega_\alpha \\ -s_\pi(1-\psi) & 0 & s_\pi u & 0 \end{vmatrix}}{|J^*|} \\ &= \frac{\psi\omega_\alpha a_\psi e h_e s_\pi u(1-\psi)}{|J^*|} < 0 \end{aligned} \tag{A.20}$$