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Analysis

Stability of Zero-growth Economics Analysed with a Minskyan Model

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A B S T R A C T

As humanity is becoming increasingly confronted by Earth's finite biophysical limits, there is increasing interest in questions about the stability and equitability of a zero-growth capitalist economy, most notably: if one maintains a positive interest rate for loans, can a zero-growth economy be stable? This question has been explored on a few different macroeconomic models, and both 'yes' and 'no' answers have been obtained. However, economies can become unstable whether or not there is ongoing underlying growth in productivity with which to sustain growth in output. Here we attempt, for the first time, to assess via a model the relative stability of growth versus no-growth scenarios. The model employed draws from Keen's model of the Minsky financial instability hypothesis. The analysis focuses on dynamics as opposed to equilibrium, and scenarios of growth and no-growth of output (GDP) are obtained by tweaking a productivity growth input parameter. We confirm that, with or without growth, there can be both stable and unstable scenarios. To maintain stability, firms must not change their debt levels or target debt levels too quickly. Further, according to the model, the wages share is higher for zero-growth scenarios, although there are more frequent substantial drops in employment.

1. Introduction

As humanity is becoming increasingly confronted by Earth's finite biophysical limits, there is an increasing interest in questions about the stability and equitability of a zero-growth economy (Rezai and Stagl, 2016; Hardt and O'Neill, 2017; Richters and Siemoneit, 2017a). In particular, there has been a focus on the sustainability of a zero-growth economy that maintains a positive interest rate for loans. There are now a variety of models on which this question has been posed explicitly, and both 'yes' (Berg et al., 2015; Jackson and Victor, 2015; Rosenbaum, 2015; Cahen-Fourot and Lavoie, 2016) and 'no' (Binswanger, 2009) answers have been obtained as to whether a stable zero-growth state is theoretically possible. Typically, the question is settled by the existence, or not, of a single attractive fixed point (i.e. an equilibrium that is robust at least to small shocks) with economically desirable characteristics, namely positive profit and wage rates, and low unemployment (Richters and Siemoneit, 2017a). That is, the focus has been on demonstrating that there is some local stability within the system. However, real economies do not sit in equilibrium at a locally stable fixed point. They exhibit fluctuations, business cycles and, occasionally, severe crises, whether or not there is ongoing underlying growth in productivity with which to sustain growth in output (Minsky, 1986; Keen, 2011). This paper analyses zero-growth scenarios by focussing on global stability. Thus, a scenario is considered stable if its dynamics are characterised by fluctuations that do not grow in severity; unstable scenarios will be characterised by run-away explosive behaviour (which would correspond to a crisis). The model employed is a non-linear dynamical system that incorporates elements of Minsky's financial instability hypothesis (FIH) (Minsky, 1986, 1992). The analysis involves the tweaking of a productivity growth parameter, set to either 2% or zero to respectively produce growth and no-growth scenarios. In so doing, this paper is the first to attempt to compare the relative stability of a zero-growth economy with that of a growing economy.

Key to the FIH is that serious macroeconomic instability arises as a result of firms desiring to vary their debt burden in response to changes in the profit share, and expectations about the future profit share. This idea was first put into a mathematical model by Keen (1995), and there is now a substantial literature on Minskyan models that capture various dynamics related to the FIH; see Nikolaidi and Stockhammer (2017) for a recent survey. The original Keen (1995) model consisted of three coupled differential equations for the key variables: wage rate, employment rate and firm debt. It is derived from a few simple intuitive assumptions, and is capable of producing both stable and unstable scenarios, depending on firms' behaviour in relation to debt. It thus provides a useful starting point from which to build a simple model to compare the stability of growth and no-growth scenarios. Further, the presence of labour dynamics (*a la* Goodwin) enables comparison of employment and wage rates between growth and no-growth scenarios. However, in the original model, investment is a direct function only of the profit share of output, i.e. investment decisions are based purely on recent profit. Since investment must depend on growth, it is necessary for the present study to extend the model. Further, it is realistic for

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investment decisions to have an additional explicit direct dependence on debt, (i.e. beyond the indirect dependence due merely to profit itself depending on debt). Thus, rather than employing the Keen (1995) model in its original form, the investment dynamics here have terms added from a recent model of Dafermos (in press) to include an explicit direct dependence on growth and debt.[1] With output determined by the investment dynamics, consumption will be the accommodating, or residual, variable in the model.

The outline of the paper is as follows. Section 2 presents the details of the model. The dynamical variables in the model are the wage rate, the employment rate, firm debt and target firm debt. Further equations express GDP, growth rate and profit share in terms of these variables. In Section 2.1, the analysis pipeline is presented. Section 2.2 demonstrates that the modelled dynamics can form part of a stock-flow consistent framework. In Section 2.3, the parameters used in the simulations are written down and explained. Section 3 presents the simulation results. Scenarios of constant positive productivity growth and constant zero productivity growth are shown, demonstrating stable and unstable runs for both cases. Then, more realistic scenarios of fluctuating productivity growth are explored, with comparisons between scenarios in which mean growth is positive and in which mean growth is zero. Further, transitions from a positive to zero productivity growth era are considered. The paper concludes with Discussion 4 and Concluding Remarks 5 sections.

2. The Model

This section describes the model and its assumptions in detail. As mentioned in the Introduction 1, most of the pieces of the model are taken from that of Keen (1995), but the debt dynamics are inspired by the recent model of Dafermos (in press). The notation and presentation are drawn from Grasselli and Costa Lima (2012). Further, the model is an extension of the Goodwin (1967) growth cycle model, which consisted of just two equations for the wage and employment rates, and contained no debt, only reinvestment of profit.

It is assumed that there is full capital utilisation and a constant rate of return ν^{-1} on capital K:

$$Y = K/\nu = aL, \tag{1}$$

where Y is the yearly output, a is productivity and L is labour employed. The yearly wage bill is denoted W, firm debt is denoted D, and the interest rate by r. The yearly profit Π is defined as output minus the yearly wage bill minus the yearly interest payments, that is $\Pi =: Y - W - rD$. Concerning investment, it is assumed that all profits are either reinvested or used to pay down debts. Thus, the rate of investment I is given by[2]

$$I = \dot{D} + \Pi. \tag{2}$$

This is admittedly a simple model of finance, however the concern in this paper is to construct just one possible economic model with interest-bearing debt and no growth imperative; for further discussion of finance see Section 2.2 and the Discussion 4. Given the rate of depreciation of capital δ we have

$$\dot{K} = I - \delta K. \tag{3}$$

From Eqs. (1), (2) and (3) we have

$$\dot{Y} = \frac{1}{\nu}(\dot{D} + \Pi - \delta K), \tag{4}$$

an expression we will use further down to derive the growth rate in terms of profit and debt. Productivity growth is denoted by α, and a constant population size N is assumed. Thus,

$$\dot{a} = \alpha a. \tag{5}$$

Using Eqs. (1) and (5) it can be derived that the employment rate $\lambda =: L/N$ satisfies

$$\dot{\lambda} = \lambda(g - \alpha), \tag{6}$$

where $g =: \dot{Y}/Y$ is growth (of output). The rate of change of wages w per unit of labour is an increasing function of the employment rate λ,

$$\dot{w} = \Phi(\lambda)w, \tag{7}$$

reflecting the assumption that the higher the rate of employment, the greater the bargaining power of workers. We specify the Phillips curve[3] Φ explicitly in Section 2.3 below. Note that in addition to being an increasing function, the Phillips curve should satisfy $\Phi(0) < 0$ to ensure there is an employment rate below which there is downward pressure on wages. Further, the curve should rise steeply as λ approaches 1 from below, as the employment rate cannot rise higher than 1 (given that it starts positive, Eq. (6) ensures that it can't drop below zero). In practice, in the simulations, an exceptional line was included in the code to implement that if λ exceeds 0.99, and Eq. (6) indicates that λ should rise further, then that equation is overridden, and $\dot{\lambda}$ is set to zero for the given integration step. This is just a simple way of imposing that there is a limited labour pool.

The equation for the wages share of output $\omega =: wL/Y$ is derived from Eqs. (1), (5) and (7) as

$$\dot{\omega} = \omega[\Phi(\lambda) - \alpha]. \tag{8}$$

The Eqs. (6) and (8) for the employment rate and wages share are the same as those of the Goodwin (1967) model, except growth g itself satisfies different dynamics in the present model, as will be described below.

Considering now the debt dynamics, following Dafermos (in press), the rate of change of debt is taken to be proportional to the difference between the target debt and the current debt. The equation for this, expressed in terms of normalised debt $d =: D/Y$ is

$$\dot{d} = \theta_1(d_T - d) \tag{9}$$

(henceforth, when the term debt is used, normalised debt is implied).[4] The parameter θ_1 here determines the rate at which debt moves towards the target level; θ_1^{-1} is the length of time it takes for the difference between debt and target debt to drop by a factor of e, all other variables remaining constant. Note that, in practice, target debt may never become close to being realised, as all the variables of the system remain in continuous flux. The target debt has a tendency to move towards a benchmark that depends on the current growth rate and profit share $\pi =: \Pi/Y$:

$$\dot{d}_T = \theta_2(d_0 + \eta_1 g + \eta_2\pi - d_T). \tag{10}$$

The parameter θ_2 determines the timescale on which target debt moves towards the benchmark $d_0 + \eta_1 g + \eta_2\pi$. The parameter d_0 is a constant, and η_1 and η_2 respectively determine how strongly the benchmark debt is affected by changes in growth rate and profit share. As mentioned above, in the original Keen (1995) model, the investment rate was taken as a function only of profit, with the simplifying assumption that

[1] Running the original Keen (1995) model with parameters that produce a stable scenario with 2% productivity growth led to run-away behaviour when productivity growth was switched to zero (simulation not shown). See Appendix C for an explanation of this, and further discussion of the original Keen model.

[2] The dot here denotes derivative with respect to time. Note the continuous time formulation implies that profit and investment here are both rates. The term yearly profit is used in place of profit rate to avoid confusion, as profit rate commonly refers to a rate of return on capital.

[3] Throughout the paper, the term 'Phillips curve' refers to that linking the rate of employment with wage growth, rather than that linking wage growth and inflation.

[4] This equation implies that non-normalised debt D satisfies $\dot{D} = \theta_1(d_T - d)Y + dg$. Thus, it is assumed that the rate of increase of debt depends not just on how far away the current stock of debt is from the current target, but also on the current growth rate of the economy, so as to achieve the desired move of the debt-to-output ratio towards the target.