The Bielefeld School of Macroeconomics

A Disequilibrium Approach to Macroeconomic Modeling

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Outline

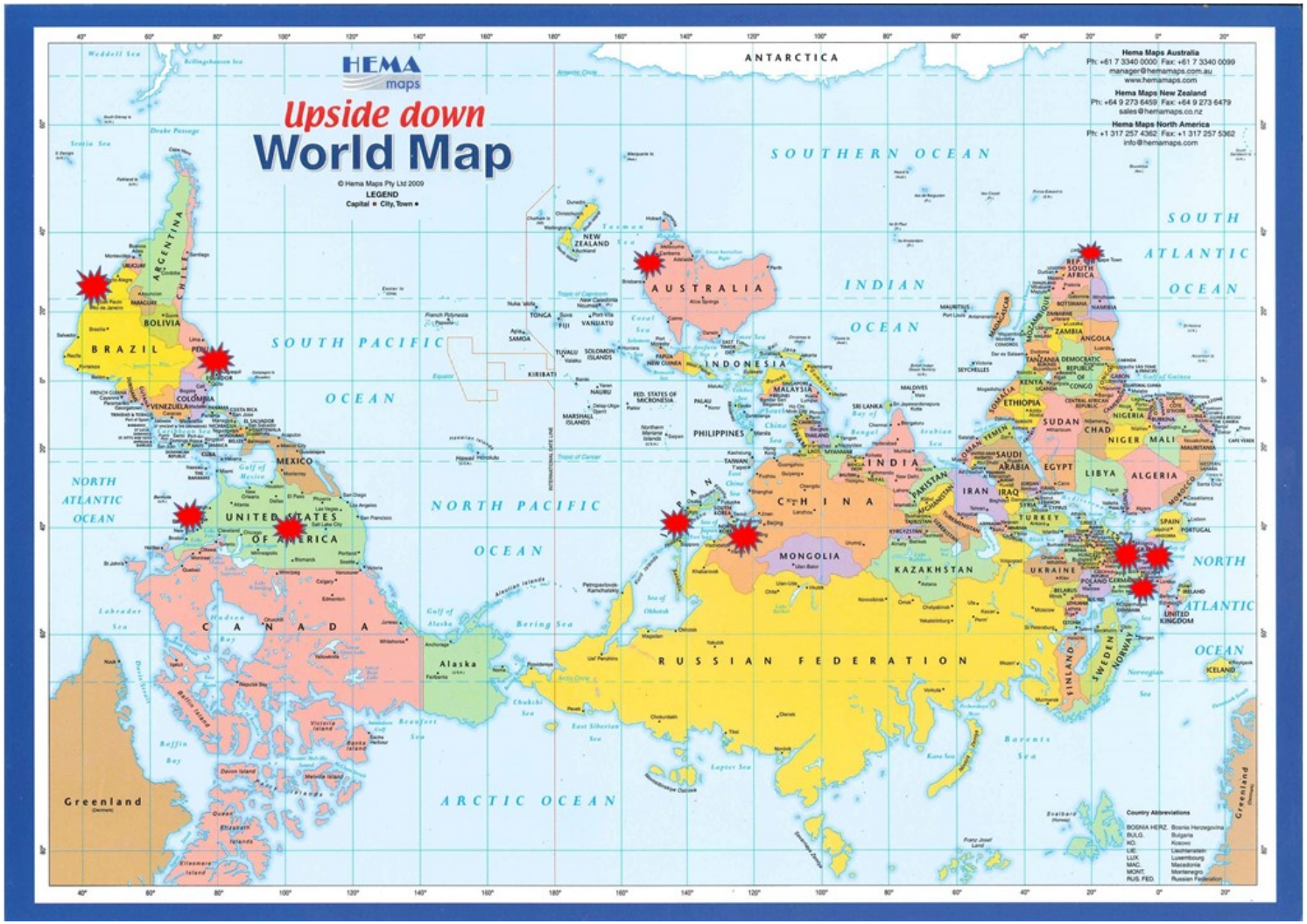
- Introduction
- The New Neoclassical Synthesis
- The Bielefeld Disequilibrium Approach to Macroeconomic Modeling
- Critical Appraisal and the Way Forward

Introduction

Introduction

This group is scattered in various parts of the globe, principally in the cities of Bielefeld, Beijing, New York, Sydney and Tokyo. While the output of this group is the result of visits to each other's institutions (particularly those of Flaschel to the University of Technology, Sydney) [...] the intellectual centre of their enterprise has been the Faculty of Economics at Bielefeld University. [...] Hence I feel it is appropriate to neologize here and dub the results of their collective efforts to constitute an emerging school of macroeconomic thought "the Bielefeld School".

J. Barkley Rosser, Jr. (James Madison University)
Foreword of Chiarella, Flaschel & Franke (2005),
Foundations of a Disequilibrium Theory of the Business Cycle, Cambridge University Press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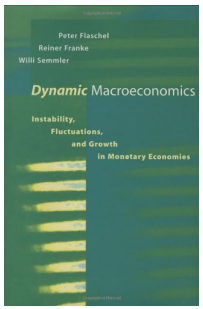
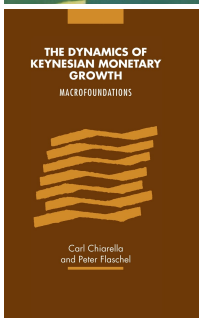
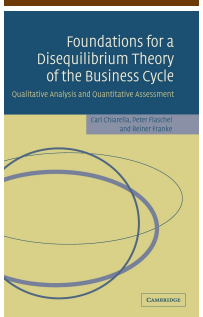
Key Contributions



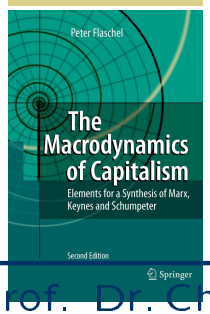
Flaschel, Franke & Semmler (1997) *Dynamic Macroeconomics. Instability, Fluctuations, and Growth in Monetary Economies*



Chiarella & Flaschel (2000) *The Dynamics of Keynesian Monetary Growth. Macrofoundations*



Chiarella, Flaschel & Franke (2005) *Foundations of a Disequilibrium Theory of the Business Cycle*



Flaschel (2009) The Macrodynamics of Capitalism. Elements for a Synthesis of Marx, Keynes & Schumpeter

And Some Others...

The "New Neoclassical Synthesis"

The "New Neoclassical Synthesis" (NNS)

The modeling approach of the "New Neoclassical Synthesis" is based on the following precepts:

1. Neoclassical microfoundations
2. Market-clearing on all markets (general equilibrium)
3. Rational expectations
4. Imperfect competition and nominal rigidities

While (1)-(3) stem from the Real Business Cycle School, (4) results from the intent of "New Keynesians" to introduce a role for monetary policy at least in the short run through the assumption of imperfectly flexible prices and/or wages.

. . . however

- *"Rational Expectations":*
  - Is the assumed level of cognitive power/rationality realistic?
  - How does the coordination of expectations in the real world occur?
- *General Equilibrium (with optimal allocation):*
  - at every moment in time?
  - market coordination?
  - a result of rational, forward looking expectations?

. . . however

- *"Representative Agent" Microfoundations:*
  - since nearly anything can be "microfounded" once enough agent heterogeneity is assumed, what is the value of a "Robinson Crusoe" type of microfoundation?
  - "Two souls, alas, are dwelling in my breast?! (J.W. Goethe, Faust)
  - The inclusion of "habit formation", indexation and the likes improve empirical performance of this class of models

$\Longrightarrow$ "Are we adding epicycles to a dead model? (Fuhrer 2010)

The Bielefeld Disequilibrium Approach to Macroeconomic Modeling

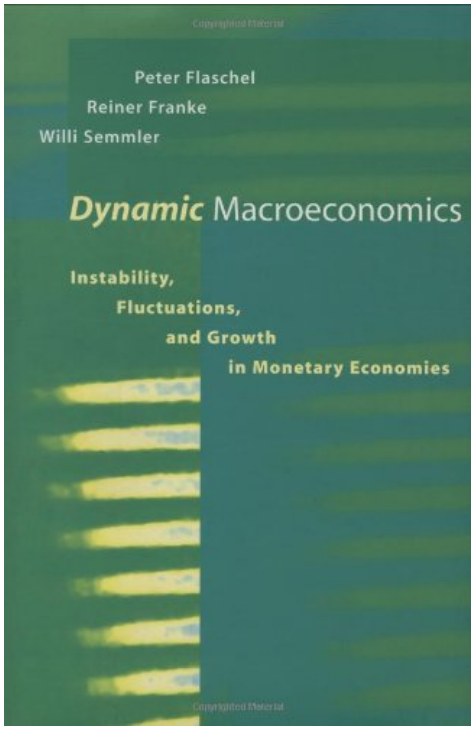
The Bielefeld Disequilibrium Approach to Macroeconomic Modeling

- "Macrofounded" approach: No explicit utility maximization of a "representative agent"
- Behavioral functions of different "sectors" of the economy
- "Disequilibrium" in the real markets is considered the standard situation $\Longrightarrow$ Wage- and price inflation dynamics are driven by disequilibrium situations in the goods and labor markets
- (Implicit) boundedly rationality of agents
- Exploration of nonlinear variations of standard models
- Continuous time framework

"Macrodynamics is a venerable and important tradition, which fifty or sixty years ago engaged the best minds of the economics profession: among them Frisch, Tinbergen, Harrod, Hicks, Samuelson, Goodwin. Recently it has been in danger of being swallowed up by rational expectations, moving equilibrium, and dynamic optimization. We can be grateful to the authors of this book for keeping alive the older tradition, while modernizing it in the light of recent developments in techniques of dynamic modeling."

James Tobin, Nobel Laureate

Appraisal to "Dynamic Macroeconomics (1997)"



However, it can be argued that their approach can be viewed as a sophisticated formulation of certain Post-Keynesian elements or trends. [. . .] Thus, I have no problem describing the Bielefeld School as representing effectively a highly sophisticated Post-Keynesian approach.

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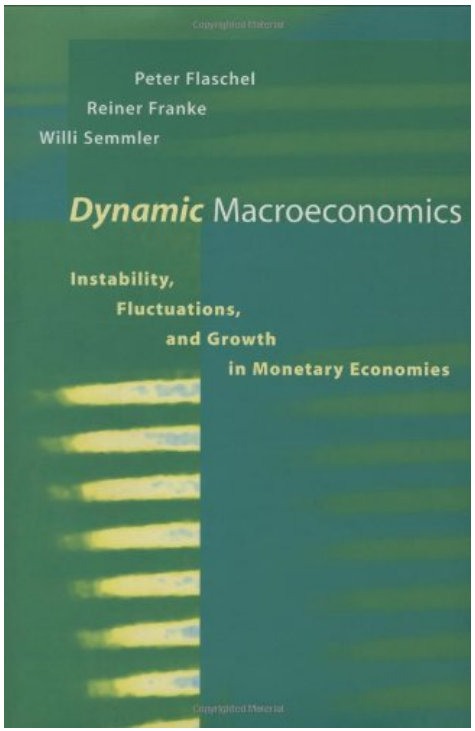
Foreword of Chiarella, Flaschel & Franke (2005), *Foundations of a Disequilibrium Theory of the Business Cycle*, Cambridge University Press

Why Continuous-Time?

- "No substantive prediction or explanation in a well-defined macroeconomic period model should depend on the real time length of the period." (Foley 1975, p.310)
- If "chaos" at the macroeconomic level, then due to intrinsic dynamics of the model and not due to choice of period length (Flaschel & Proaño 2009)
- Analytical solution of continuous-time frameworks is much more tractable than in their discrete-time representation (see e.g. Flaschel, Franke & Proaño, 2008)
- The underlying "period length" of the evolution of the economy at the aggregate level is much shorter than a "quarter", despite of eventual "staggered" behavior at the individual level $\Longrightarrow$ DGP $\neq$ DCP (Data Collection Process)

The Foundations: Dynamic Macroeconomics (1997)

- Analysis of micro- and macroeconomic adjustment mechanism
- Walrasian vs. Keynesian processes
- Neoclassical and non-neoclassical approaches
- Wage- and price flexibility and macroeconomic instability
- Cyclical dynamics and instability are the core of analysis
- Critique of saddle-path stability concept and exploration of alternative expectation formation schemes



The Saddle-Path Stability Concept

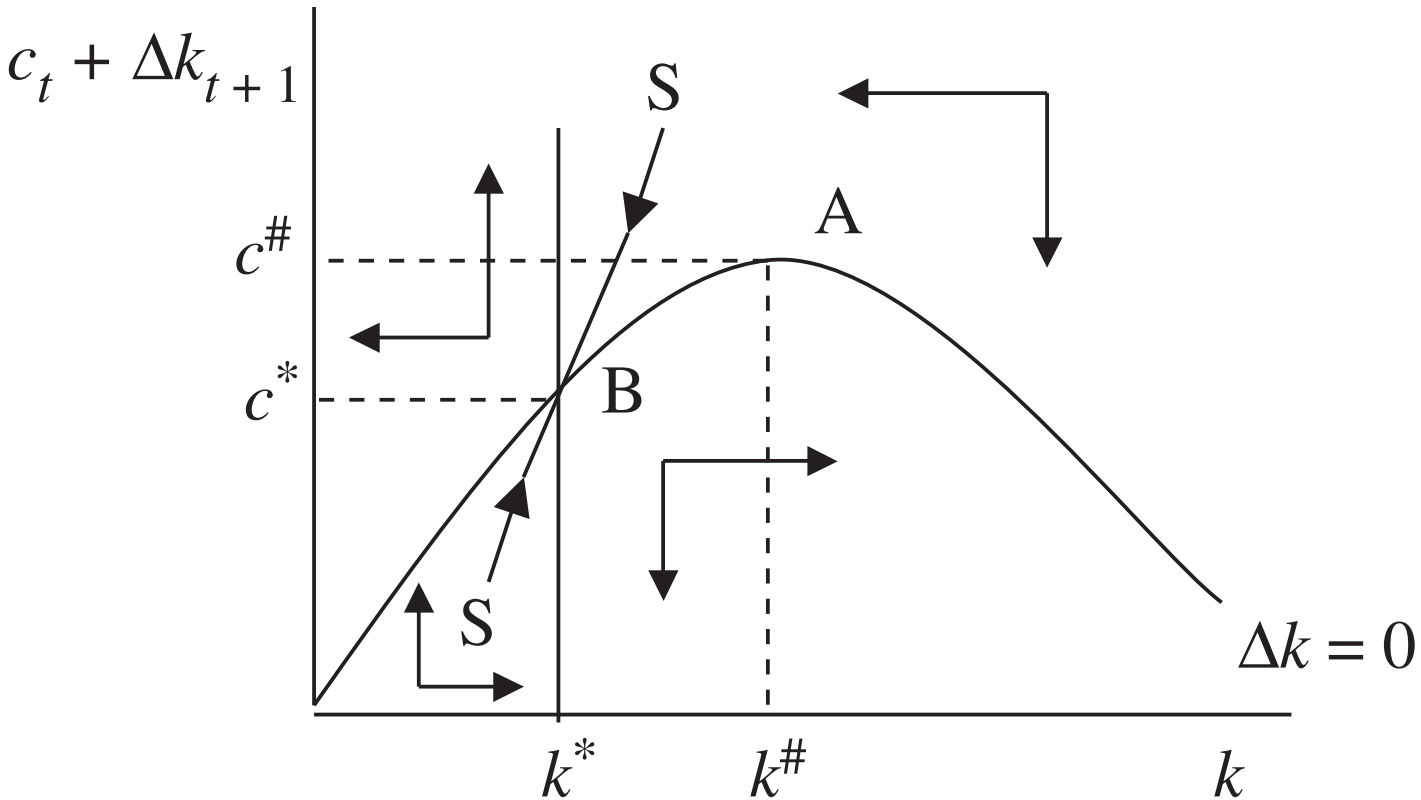


Figure: The phase diagram of the Ramsey model

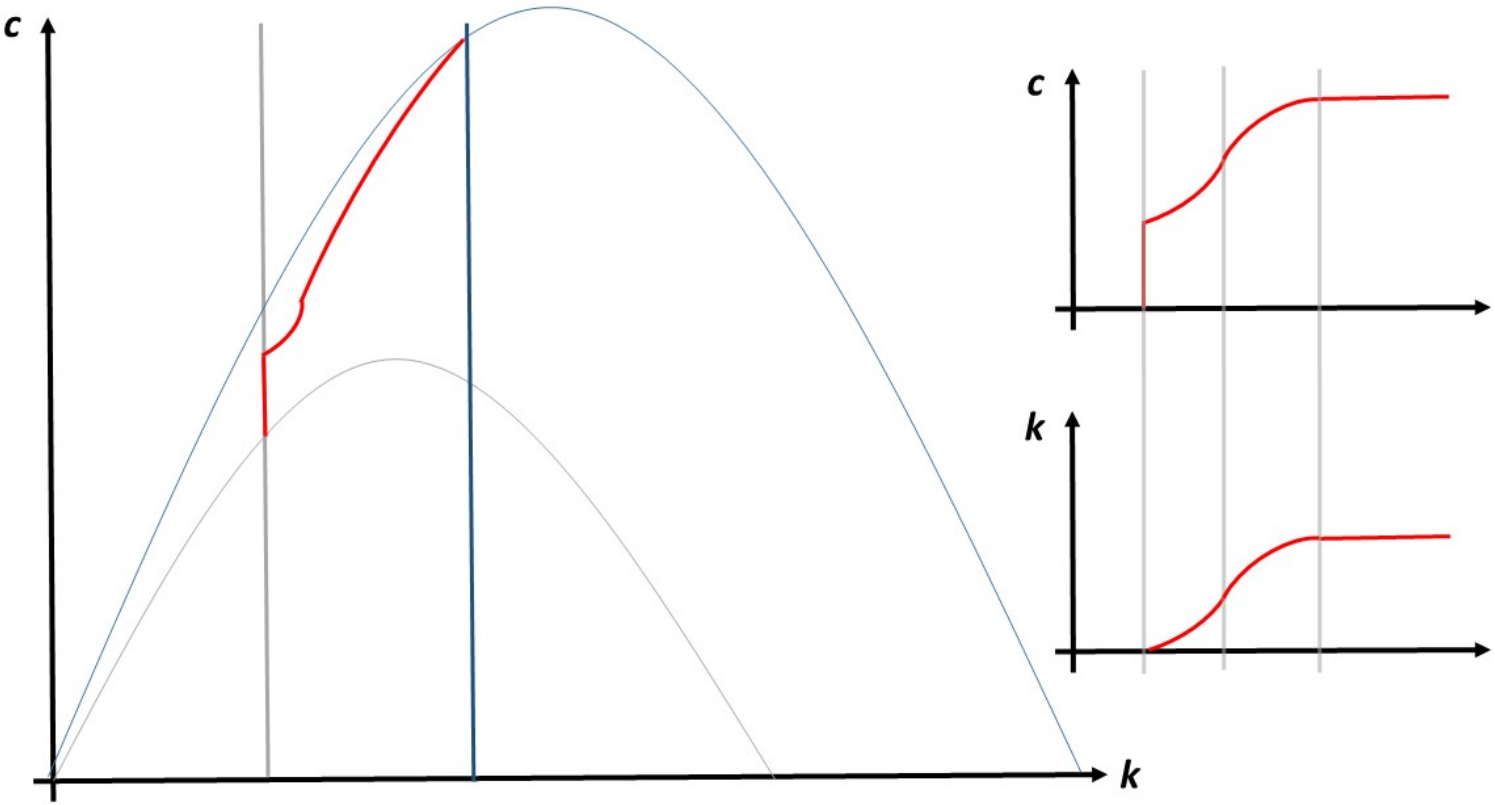


Figure: Dynamics after an anticipated expansionary permanent technology shock in the Ramsey model

Methodological Relevance of the "Bielefeld Approach"

- In current New Neoclassical Synthesis models (so-called Dynamic Stochastic General Equilibrium Models) stability (more correct: determinacy) is ensured by the discrete "jumps" of forward-looking variables

$\Longrightarrow$ Identification of (de-)stabilizing channels is of key importance in a world with "jumping agents"

- Models with limit cycles or periodic orbits are nearly non-existent in current mainstream (Frisch-Slutky paradigm: Shock-dependent business cycle dynamics)

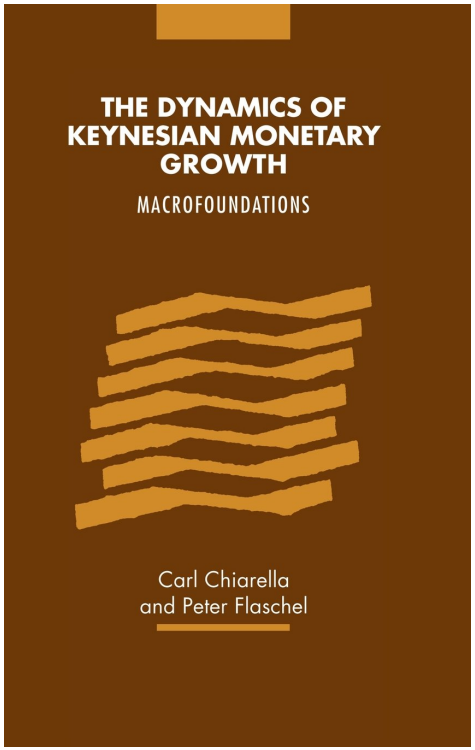
$\Longrightarrow$ Explicit analysis of nonlinearities, cycles and local vs. global (in)stability

The Core: The Dynamics of Keynesian Monetary Growth (2000)

Starting point: Extension of neoclassical Solow growth model à la Tobin with

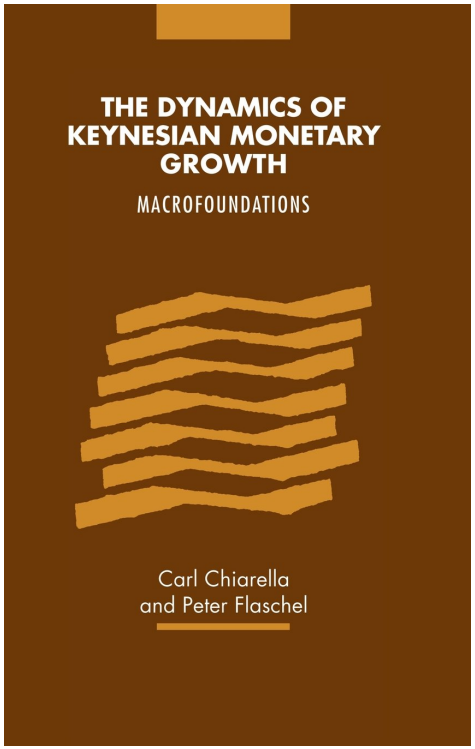
- various types of financial assets
- where money market (dis-)equilibrium drives inflation
- in interaction with inflationary expectations

Then: Analysis of Keynesian-Wicksell alternative



The Keynes-Metzler (KM) monetary growth model:

- Kaldorian consumption function (different consumption propensities for wages and profits)
- Output is determined by effective demand
- Metzler inventory adjustment coupled with (boundedly rational) sales expectations
- Goods market disequilibrium
- Sluggish wage and price adjustments to goods- and labor market disequilibria



Example: General disequilibrium version of the neoclassical monetary growth model (Chiarella & Flaschel, 2000 p.112)

Starting from aggregate behavioral equations and budget constraints, the reduced-form system can be expressed as a 5D dynamical system:

$$
\begin{aligned}
\hat{\omega} &= \kappa[(1-\kappa_p)\beta_w X^w + (\kappa_w - 1)\beta_p X^p] \\
\hat{l} &= n - s(\cdot) \\
\hat{m} &= \mu_o - n - \pi - \kappa[\beta_p X^p + \kappa_p \beta_w X^w] + \hat{l} \\
\dot{\pi} &= \beta_{\pi_1}\kappa(\beta X^p + \kappa_p \beta_w X^w) + \beta_{\pi_2}(\mu_o - n - \pi) \\
\dot{b} &= (\mu_2 - \mu_o)m - (\pi + n)b - [\kappa(\beta_p X^p + \kappa_p \beta_w X^w) - \hat{l}]b
\end{aligned}
$$

with $\omega = w/p$, $l = L/K$, $m =$real balances per capita, π inflation expectations and $b =$ bond holdings per capita.

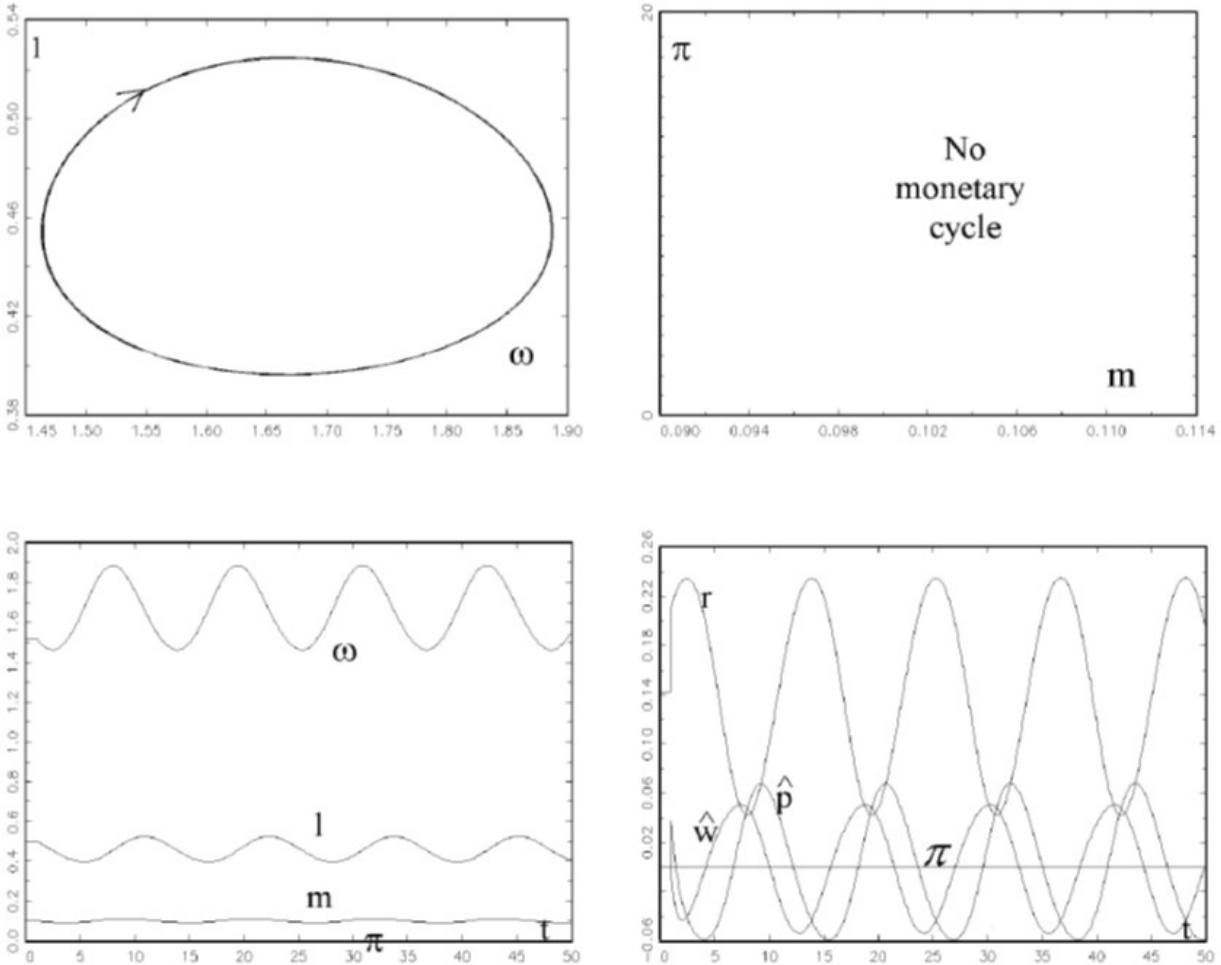


Figure: The real (Goodwin) growth cycle ($\kappa_w = 1$, $\mu_2 = 0$, $\pi = \pi_o = 0$, $\beta_{\pi_1} = \beta_{\pi_2} = 0$). Source: Chiarella & Flaschel (2000)

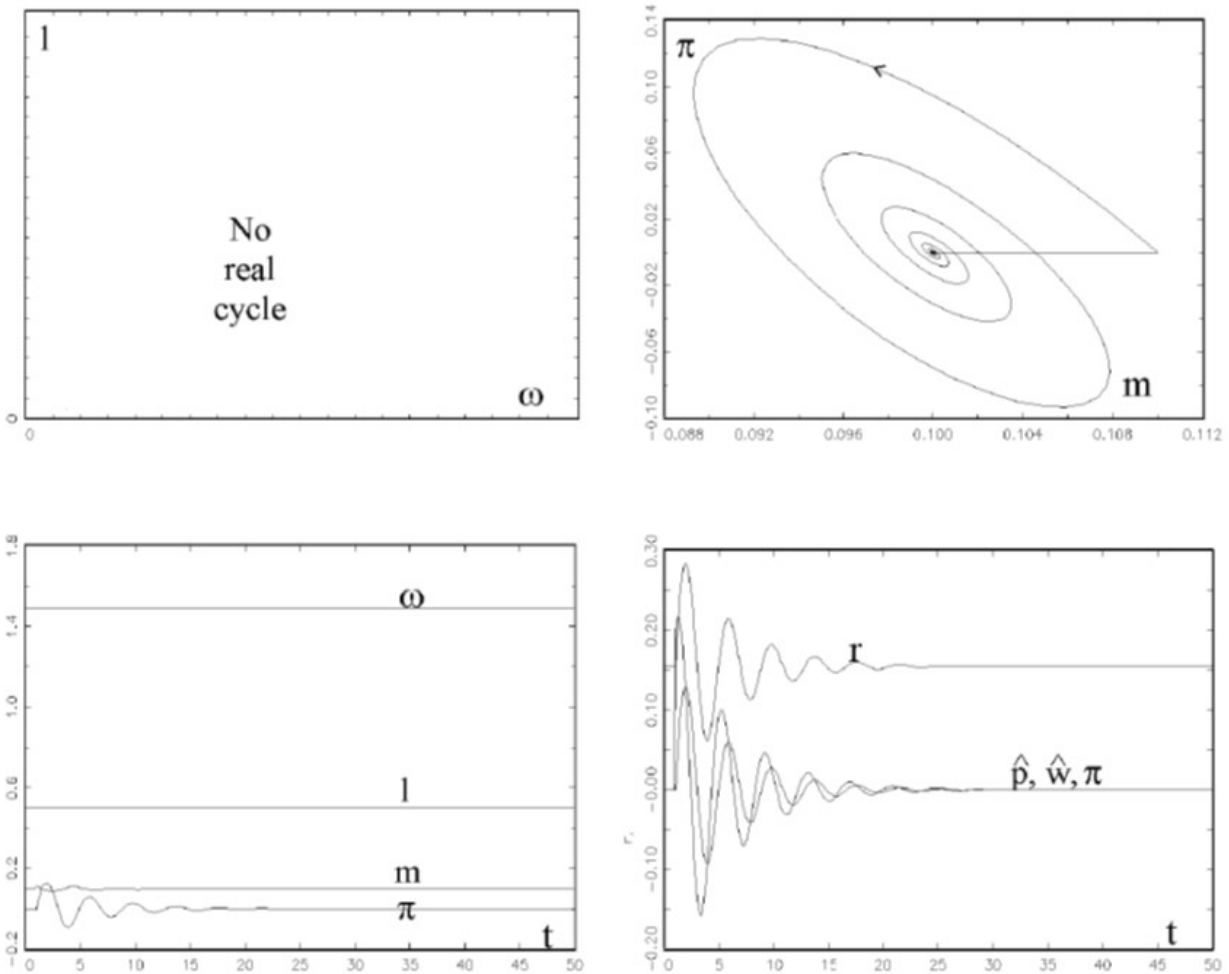


Figure: The pure monetary growth cycle ($\kappa_w = 0$, $\beta_w = 0$, $l = l_o$). Source: Chiarella & Flaschel (2000)

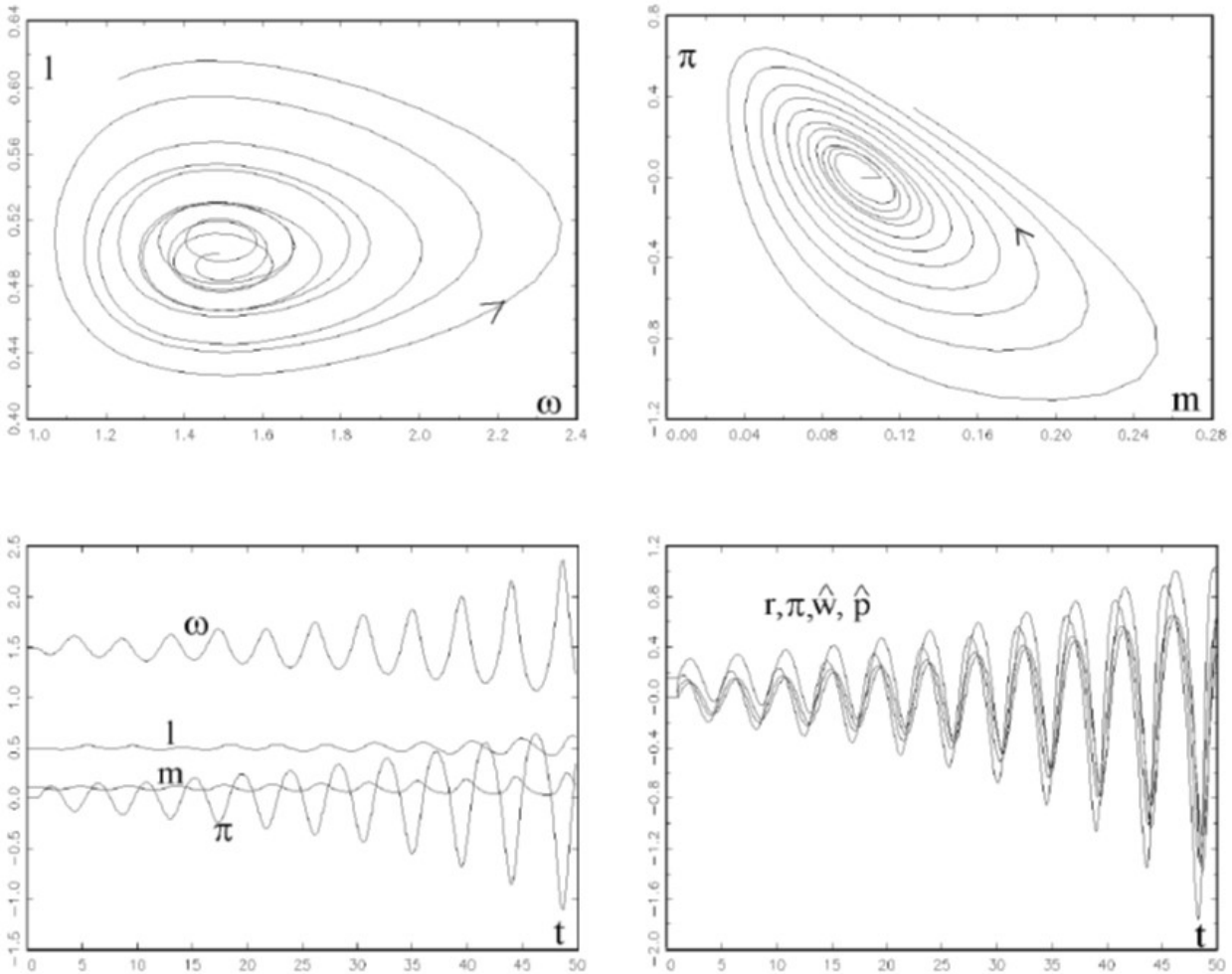


Figure: The combined real-monetary growth cycle. Source: Chiarella & Flaschel (2000)

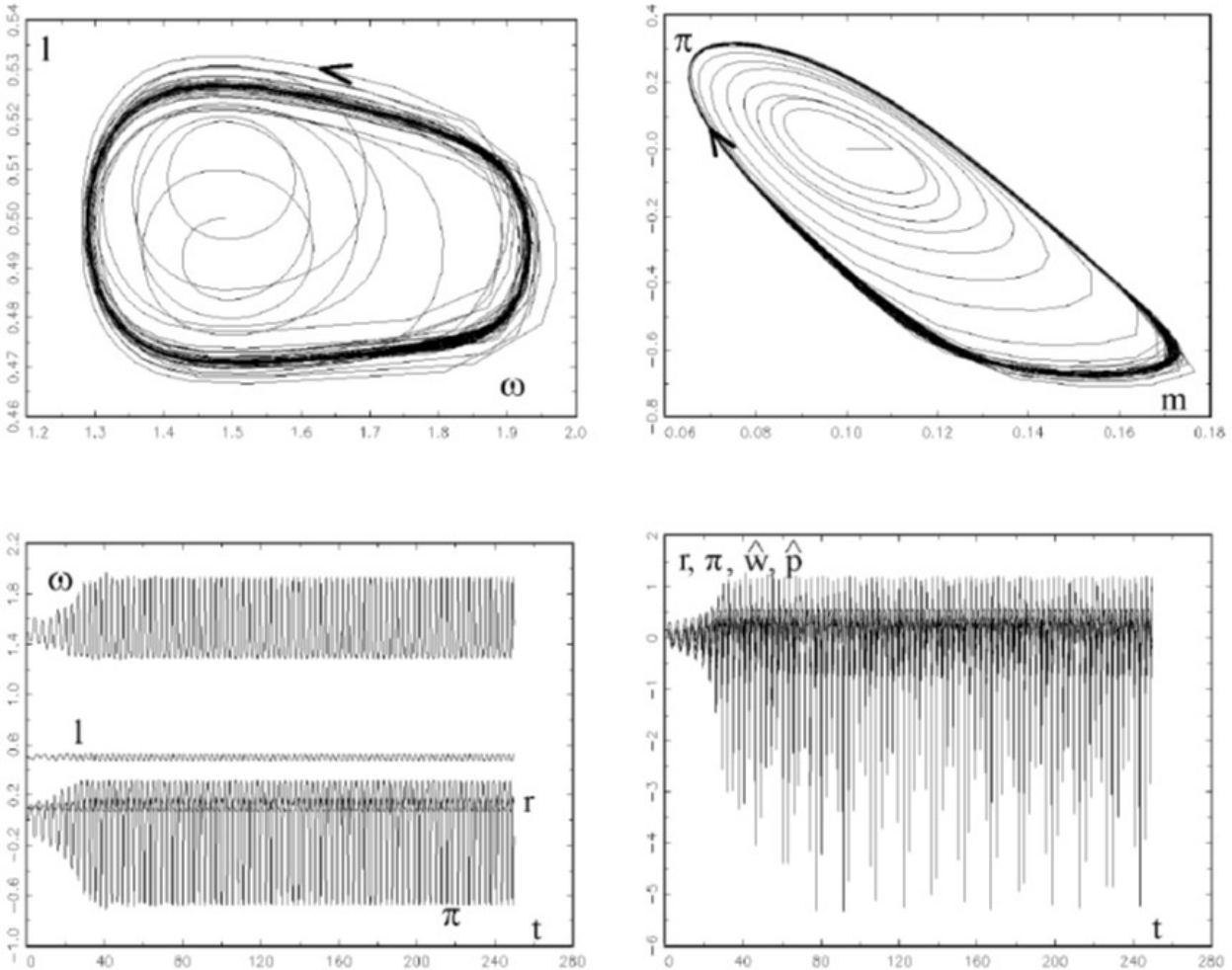


Figure: The real-monetary growth cycle with nonlinear price adjustment function. Source: Chiarella & Flaschel (2000)

The "Cascades of Stable Matrices" Approach

1. Systematic approach to local stability analysis based on Routh-Hurwitz conditions.
2. Analyze the Routh-Hurwitz local stability conditions of the (tractable) 2D or 3D subsystem.
3. Increase the system by one dimension assuming certain parameters to be different than zero. Prove that the determinant of the new enlarged system has the opposite sign than the previous system
4. Increase the system by another dimension again ...

$\Longrightarrow$ Identification of stabilizing and destabilizing feedback mechanisms!

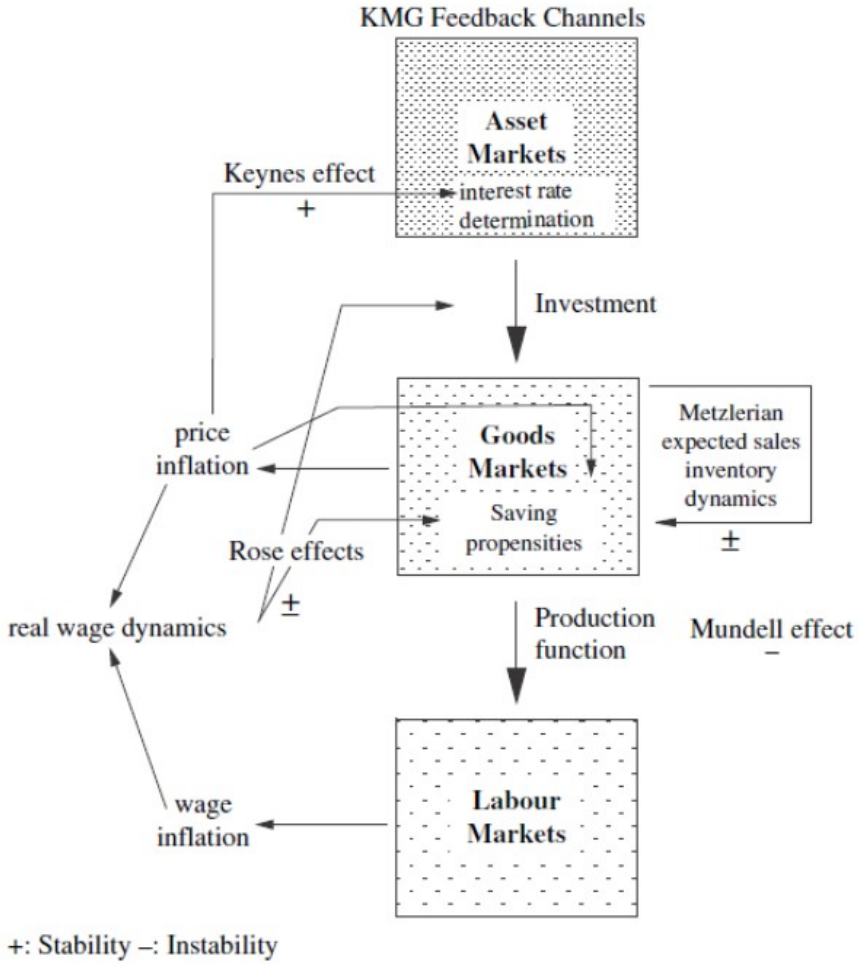


Figure: The feedback channels of the KMG modeling approach and their stabilizing/destabilizing tendencies

The Next Step

The Keynes-Metzler-Goodwin (KMG) model

- Explicit analysis of the role of income distribution for investment and growth (Goodwin)
- Incorporation of (Taylor) Interest Policy Rule instead of money supply growth rule $\Longrightarrow$ KMGT model
- Empirical perspective $\Longrightarrow$ Calibration approach

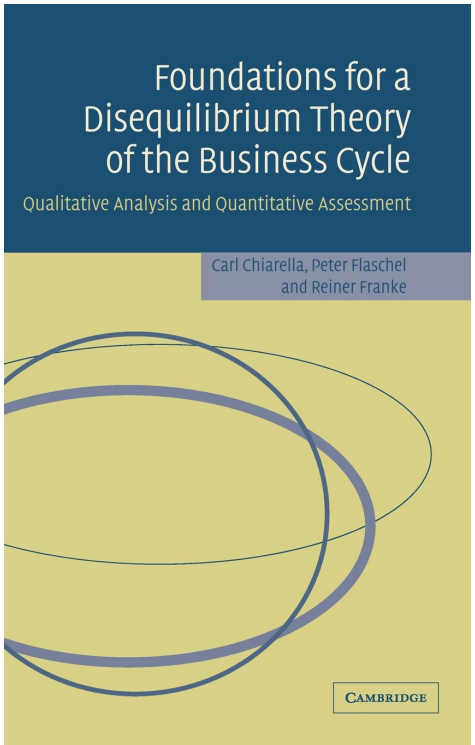


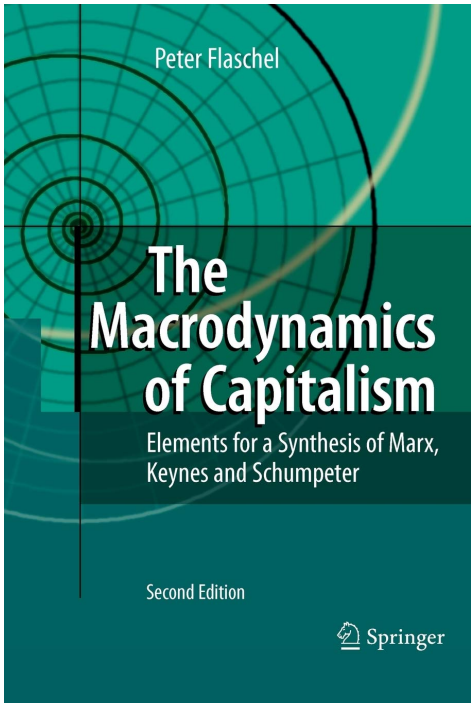
Table: A succinct characterization of the parameter stability effects in KMG and KMGT (Chiarella, Flaschel & Franke 2005, p. 499)

Parameter	Theoretical context	In KMG	In KMGT
β_{Iu}	Utilization in fixed investment	Destabilizing	Destabilizing
β_{Iq}	Return differential in investment	Stabilizing	Ambiguous
β_{pu}	Utilization in price Phillips curve	Stabilizing	Stabilizing
β_{pv}	Wage share in price Phillips curve	Ambiguous	Ambiguous
κ_p	Weight of current inflation in price Phillips curve	Stabilizing	Stabilizing
β_{we}	Employment rate in wage Phillips curve	Destabilizing	Destabilizing
β_{wv}	Wage share in wage Phillips curve	Ambiguous	Destabilizing
κ_w	Weight of current inflation in wage Phillips curve	Destabilizing	Stabilizing
β_π	Adjustment speed for inflation climate π	Ambiguous	Ambiguous
κ_π	Weight of adaptive expectations in revisions of π	Ambiguous	Stabilizing
β_y	Adjustment speed for expected sales	Ambiguous	Destabilizing
β_{nn}	Stock adjustment speed	Ambiguous	Destabilizing
$\eta_{m,i}$	Interest elasticity of money demand	Destabilizing	n.a.
α_i	Adjustment speed of i towards Taylor rate	n.a.	Stabilizing
α_p	Inflation gap coefficient in Taylor rule	n.a.	Ambiguous
α_u	Utilization coefficient in Taylor rule	n.a.	Stabilizing

A "Simplified" Perspective

Keynesian DAD-DAS Modeling

- Simplified framework alternative to the baseline "3D New Keynesian Model"
- Further empirical validation (GMM estimations)
- Flexicurity as "Schumpeterian" labor market with social safety net



The MKS System (by Richard Goodwin, 1969)

By combining elements from all three of our thinkers, one attains one good schemata for the analysis of capitalism as a system in variable states of turmoil.

1. Marx - the law of Moses and the prophets is profits and accumulation. But accumulation by itself would lead to falling profits, so another aspect of his theory was elaborated by
2. Schumpeter - The driving force of capitalism is innovation in production (not in consumption, which is passive). [...] Also necessary is
3. Keynes, who taught us that effective demand, as well as, and more often than, the existing resources, determines the level and rate of change of output.

Further Research Topics

- Marxian theory of value
- Income distribution and the wage-led/profit-led debate
- Dual labor markets and minimum wages
- Monetary and fiscal policy
- Financial crises, debt deflation and macrofinancial stability
- etc.

Critical Appreciation

- Deep and insightful analysis of macroeconomic transmission channels at the aggregate level
- Prominent role of nonlinearities in (at least local) instability, cycles and global stability
- Insufficient empirical validation
- Incomplete incorporation of expectations
- "Macrofounded" approach has limitations
- Missing critical mass, also for development of software

The Way Forward

- Worthwhile to work and develop the Bielefeld School further
- Needed:
  - Empirical validation with state-of-the-art estimation techniques
  - More up-to-date modeling of expectations e.g. through adaptive learning, Brock-Hommes or Weidlich-Haag approaches, see e.g. Proaño (2011, 2013), Flaschel et al. (2015, 2018).
  - Incorporation of further dimensions, e.g. the ecological one
  - Analysis of "sustainability" in the broader sense: ecological, economic and social.

A Bielefeld Climate-Macroeconomic Model?

- Climate change has an intrinsical distributional dimension
- Previously: Struggle for generated income and power
- Now/Future: Struggle for resources and damage mitigation
- Great uncertainty (e.g. w.r.t. to "point-of-no-return") supports "bounded rationality approach"
- Different resource-intensive production functions against the background of climate change (the missing S in MKS?)
- Nonlinear dynamics and overall instability should be a central feature in a climate-macro model

[. . .] two current schools of macroeconomic thought that I see as offering a wise way forward, the Bielefeld School and the related Ancona School. [. . .] While the former school is somewhat more aggregated-oriented and the latter is more "bottom-up" agent-based oriented, [. . . b]oth schools emphasize modeling nonlinear interactions between financial and real output markets. [. . .] Again, while these two schools have some differences in their approaches, I see them as closely related in methodology and general views, and some combination of the two looks to me to provide as good a view of what is going on now as we have, as well as a promising way forward in terms of research and understanding.

J. Barkley Rosser Jr. (2009)

"E pur si muove"

Peter Flaschel (1943 - 2021)

Thank you for your attention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SUUM CUIQUE

Appendix

Local Stability and Global Stability in Differential Equations Systems

- Let $\dot{x} \equiv \frac{dx}{dt} = f(x),\ x \in R^n$ be a system of $n-$dimensional differential equations that has an equilibrium point x^* such that $f(x^*) = 0$, where t is interpreted as 'time'.
- The equilibrium point of this system is said to be *locally asymptotically stable*, if every trajectory starting sufficiently near the equilibrium point converges to it as $t \to +\infty$.

Local Stability/Instability Theorem

Let $\dot{x}_i = f_i(x)$, $x = [x_1, x_2, \cdots, x_n] \in R^n \mid (i = 1, 2, \cdots, n)$ *be an* n*-dimensional system of differential equations that has an equilibrium point* $x^* = [x_1^*, x_2^*, \cdots, x_n^*]$ *such that* $f(x^*) = 0$. *Suppose that the functions* f_i *have continuous first-order partial derivatives, and consider the Jacobian matrix evaluated at the equilibrium point* x^*

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix},$$

where $a_{ij} = \partial f_i / \partial x_j$ $(i, j = 1, 2, \cdots, n)$ *are evaluated at the equilibrium point.*

(i) *The equilibrium point of this system is locally asymptotically stable if all the roots of the characteristic equation* $|\lambda I - A| = 0$ *have negative real parts.*

(ii) *The equilibrium point of this system is unstable if at least one root of the characteristic equation* $|\lambda I - A| = 0$ *has positive real part.*

(iii) *The stability of the equilibrium point cannot be determined from the properties of the Jacobian matrix if all the roots of the characteristic equation* $|\lambda I - A| = 0$ *have non-positive real parts but at least one root has zero real part.*

Routh-Hurwitz conditions for stable roots in an n-dimensional system (Gandolfo 1996, 221-222)

All of the roots of the characteristic equation negative real parts if and only if the following set of inequalities is satisfied:

$$\Delta_1 = a_1 > 0, \quad \Delta_2 = \begin{vmatrix} a_1 & a_3 \\ 1 & a_2 \end{vmatrix} > 0, \quad \Delta_3 = \begin{vmatrix} a_1 & a_3 & a_5 \\ 1 & a_2 & a_4 \\ 0 & a_1 & a_3 \end{vmatrix} > 0, \cdots,$$

$$\Delta_n = \begin{vmatrix} a_1 & a_3 & a_5 & a_7 & \cdots & 0 \\ 1 & a_2 & a_4 & a_6 & \cdots & 0 \\ 0 & a_1 & a_3 & a_5 & \cdots & 0 \\ 0 & 1 & a_2 & a_4 & \cdots & 0 \\ 0 & 0 & a_1 & a_3 & \cdots & 0 \\ \vdots & \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & 0 & \cdots & a_n \end{vmatrix} > 0.$$

Routh-Hurwitz conditions for a two-dimensional system

All of the roots of the characteristic equation

$$\lambda^2 + a_1\lambda + a_2 = 0$$

have negative real parts if and only if the set of inequalities

$$a_1 > 0, \quad a_2 > 0$$

is satisfied.

The "Cascades of Stable Matrices" Approach

1. Let some parameters be zero in order to reduce the dimensions of the model. Analyze the Routh-Hurwitz local stability conditions of the (tractable) 2D or 3D subsystem.
2. Increase the system by one dimension assuming certain parameters to be different than zero. Prove that the determinant of the new enlarged system has the opposite sign than the previous system
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$\Longrightarrow$ Identification of stabilizing and destabilizing feedback mechanisms!