Complex interplay between monetary and fiscal policies in a real economy model

F. Cavalli[1] - A. Naimzada[1] - N. Pecora[2]

[1] DEMS, University of Milano - Bicocca
[2] DISES, Catholic University, Piacenza

11th Conference on Nonlinear Economic Dynamics (NED)

Kyiv, September 5, 2019

Plan of the Talk

- **Business cycle models and the money market**
- **Monetary vs. fiscal policies for stabilization purposes**
- **A baseline multiplier-accelerator model with the money market**
- **Stability conditions, dynamics and policy implications**
- **Concluding remarks**

Motivation I

- Macroeconomic variables exhibit **persistent** and **irregular** fluctuations and several models aim at detecting the endogenous sources of such oscillations.
- The literature that stems from this idea is widespread and developed (see e.g. Kalecki, Samuelson, Kaldor, Hicks).
- Among these, the Samuelsonian **multiplier-accelerator** modelling approach is considered a **benchmark** to explain business cycle fluctuations.
- An objection to business cycle models based on the interaction of the multiplier and the accelerator is that they usually **neglect monetary factors**.
- Only a few papers examined the role of the monetary policy within this framework (Smith, 1963; Lovell and Prescott, 1968; Karpetis and Varelas, 2012).

Motivation II

- **Fiscal** policy and **monetary** policy are the two tools used to achieve the macroeconomic objectives.
- There exists a debate on the proper **degree of activism** in fiscal and monetary policy making.
- By 2008-2009, as monetary policy became less effective, the alternative to monetary policy was to turn back to fiscal policy.
- What are the **key properties** to design simple rules governing the conduct of a **stabilization** policy?
- How much to **vary** monetary and fiscal instruments to reduce market turmoil?

This paper I

- We augment the nonlinear multiplier-accelerator setting by taking into account a **money market**.
- We examine the effects of the **interplay** between monetary factors and the fiscal policy instruments.
- A **nonlinear investment function** takes into account the presence of the monetary sector through the interest rate.
- The **money supply** is influenced by the discrepancy between the full employment national income level and the more recent output realizations.
- The public sector may influence the possibility to reach a full employment output level through a **level-adjusting** rule.

This paper II

- The introduction of the monetary policy is able to lead the economy toward the **targeted** level of output.
- There is not an unambiguous role played by the two policies.
- **Endogenous fluctuations** may arise in the presence of overreaction to the real economy signals.
- The effect of endogenizing the money market may also imply **multistability**.

The baseline model

- The macroeconomic **equilibrium condition** is given by

$$Y_t = C_t + I_t + G_t \tag{1}$$

where Y_t, C_t, I_t and G_t respectively denote the national income, consumption, investments and public expenditures.

- **Consumption** is described as

$$C_t = \bar{C} + cY_{t-1} \tag{2}$$

- The **government** establishes a full employment income Y^F and modifies its **expenditures** according to

$$G_t = \bar{G} + g(Y^F - Y_{t-1}) \tag{3}$$

- **Investments** increase in the national income variation and negatively depend on the interest rate

$$I_t = \bar{I} + \gamma a_2 \left(\frac{a_1 + a_2}{a_1 e^{-(Y_{t-1} - Y_{t-2})} + a_2} - 1 \right) + \varphi R_t \tag{4}$$

The money market

- The usual equilibrium condition in the **money market** reads as

$$\frac{M_t^S}{\bar{P}} = \frac{M_t^D}{\bar{P}} \tag{5}$$

- The **money demand** function is determined in accordance with the liquidity preference

$$M_t^D = d_1 Y_{t-1} + d_2 R_t \tag{6}$$

- The monetary authority aims at **moderating** economic fluctuations with respect to the benchmark of a full employment income Y^F (see also Gavin and Kydland, 1999):

$$M_t^S = M_{t-1}^S + \mu(Y^F - (1-\theta)Y_{t-1} - \theta Y_{t-2}), \tag{7}$$

where $\mu > 0$ and $\theta \in [0, 1)$.

- From the money market equilibrium we get

$$R_t = \frac{1}{d_2}(M_{t-1}^S + \mu(Y^F - (1-\theta)Y_{t-1} - \theta Y_{t-2}) - d_1 Y_{t-1}) \tag{8}$$

A 3D map for the dynamics of Y and M

- The evolution of national income and money is described by the following **three-dimensional** map

$$T:\begin{cases} Y_t &= A + Y_{t-1}c - g(Y_{t-1} - Y^F) + a_2\gamma\left(\frac{a_1+a_2}{a_2+a_1 \mathrm{e}^{-(Y_{t-1}-Z_{t-1})}} - 1\right) \\ &\quad + \frac{\varphi}{d_2}(M_{t-1} + \mu(Y^F - (1-\theta)Y_{t-1} - \theta Z_{t-1}) - d_1 Y_{t-1}), \\ M_t &= M_{t-1} + \mu(Y^F - (1-\theta)Y_{t-1} - \theta Z_{t-1}), \\ Z_t &= Y_{t-1}. \end{cases} \tag{9}$$

  where $Z_t \equiv Y_{t-1}$ has been introduced.

- We shall focus on the role of the **policy parameters** g, μ and θ.

Existence of the steady state

Proposition

The system in (9) *has a unique steady state given by*

$$(Y^*, M^*, Z^*) = \left(Y^F, \frac{d_2 \left(Y^F(1-c) - A + \frac{Y^F d_1 \varphi}{d_2} \right)}{\varphi}, Y^F \right)$$

to which corresponds the interest rate

$$R^* = \frac{Y^F(1-c) - A}{\varphi}.$$

Moreover, the values of (Y^*, M^*, Z^*) *are positive provided that*

$$\frac{A}{(1-c) + d_1\varphi/d_2} < Y^F < \frac{A}{(1-c)}.$$

Local stability conditions

Proposition

The steady state (Y^*, M^*, Z^*) *is* ***locally asymptotically stable*** *if* $\tilde{\gamma} < 1$ *and*

- *when* $0 \leq \theta < \dfrac{1}{2}$

$$0 \leq \mu < s_2 \quad \textit{if} \quad g < c + 4\tilde{\gamma} - 1 + 4\theta(1 - \tilde{\gamma}) - d_1\tilde{\varphi}$$
$$0 \leq \mu < s_1 \quad \textit{if} \quad c + 4\tilde{\gamma} - 1 + 4\theta(1 - \tilde{\gamma}) - d_1\tilde{\varphi} \leq g < 2\tilde{\gamma} + 1 + c - d_1\tilde{\varphi}$$

- *when* $\dfrac{1}{2} \leq \theta \leq 1$

$$0 \leq \mu < s_2 \quad \textit{if} \quad g < c + 2\tilde{\gamma} + 1 - d_1\tilde{\varphi}$$
$$s_1 < \mu < s_2 \quad \textit{if} \quad 2\tilde{\gamma} + 1 + c - d_1\tilde{\varphi} < g < c + 4\tilde{\gamma} - 1 + 4\theta(1 - \tilde{\gamma}) - d_1\tilde{\varphi}$$

where

$$s_1 = \frac{2\tilde{\varphi}(2\tilde{\gamma} - (g - c + d_1\tilde{\varphi}) + 1)}{1 - 2\theta} \textit{ and } s_2 = \frac{\tilde{\varphi}(g - c + d_1\tilde{\varphi} + 1)(1 - \tilde{\gamma})}{(\tilde{\gamma}(1 - \theta) + \theta)}.$$

Stability regions I

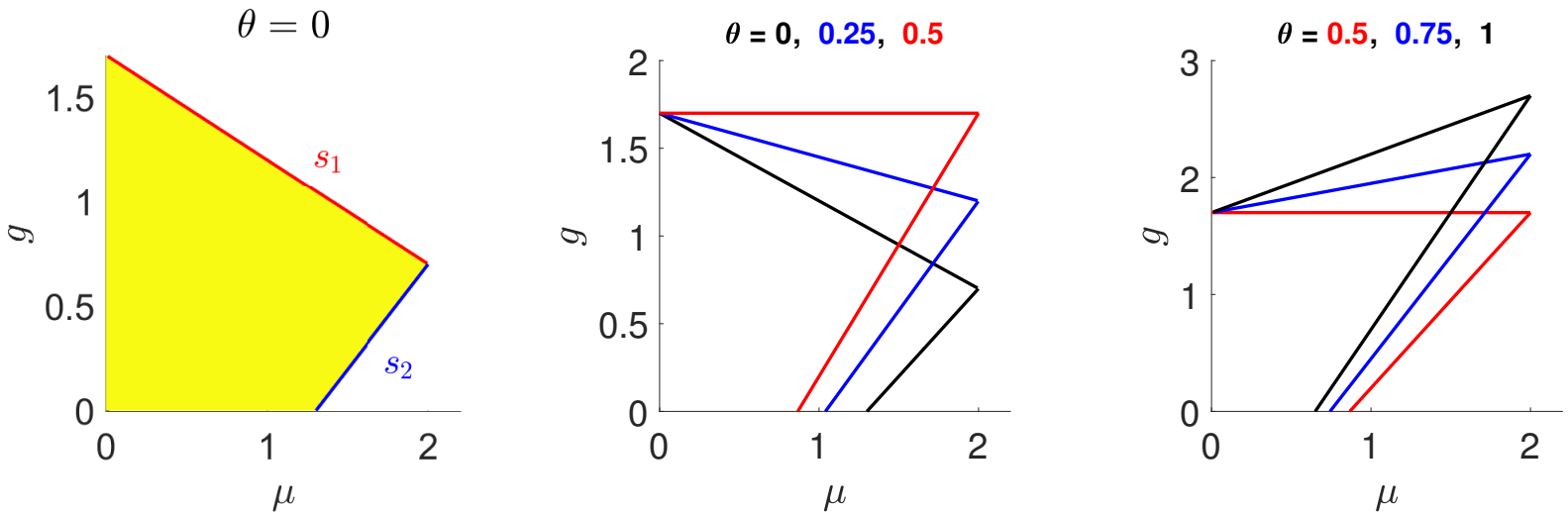


Figure: Stability regions of (Y^*, M^*, Z^*) for different θ, on varying μ and g.

- If μ increases, introducing a fiscal policy has an **initial stabilizing** effect, which is thwarted by increasing the degree of its reactivity g.
- When a higher weight is assigned to the past levels of national income, a **stronger** reaction of the fiscal policy is required.
- When $1/2 < \theta \leq 1$ a sufficiently reactive monetary policy can **counterbalance** the destabilizing effects of the fiscal policy.

Stability regions II

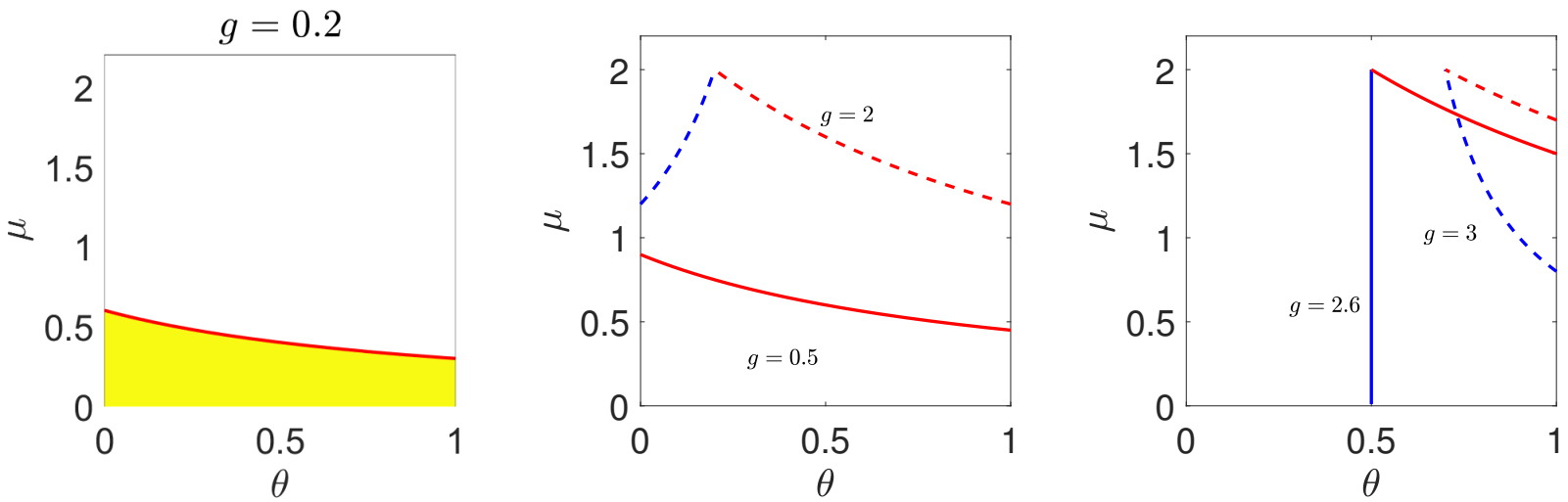
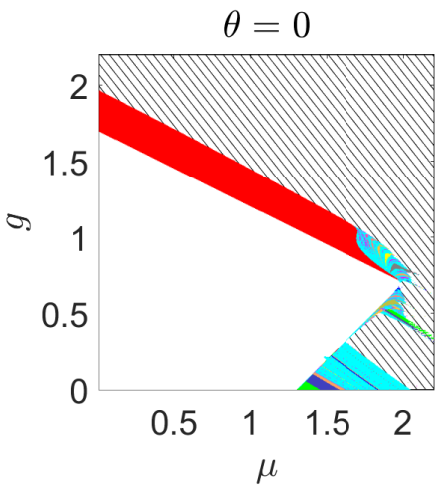
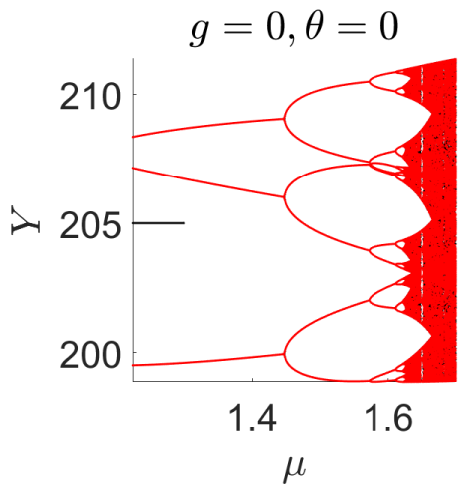


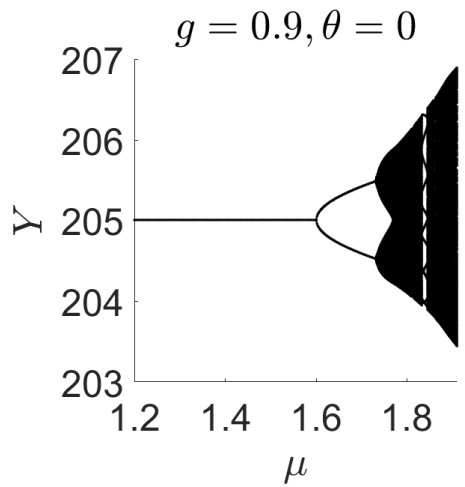
Figure: Stability regions of (Y^*, M^*, Z^*) for different g, on varying θ and μ.

- The steady state can be **destabilized** on increasing θ as long as the monetary authority reacts slightly more to the output deviations.
- When the degree of the fiscal reactivity increases, there exists a **double stability threshold** on increasing μ.
- If the reactivity of the fiscal policy is too large, a form of **inertia** in the response of the monetary policy $(\theta > 1/2)$ allows to gain stability.

No monetary policy inertia

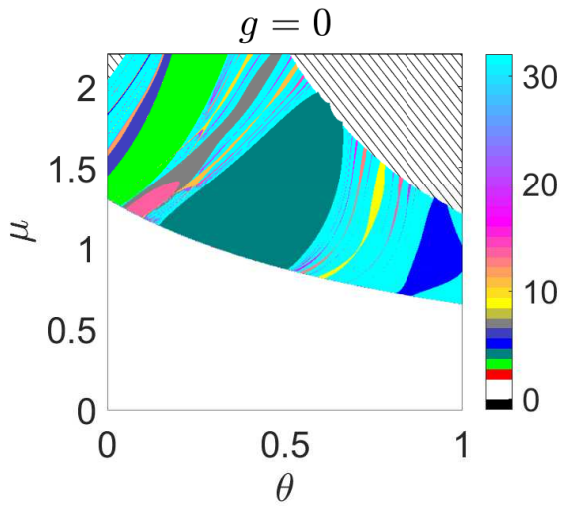


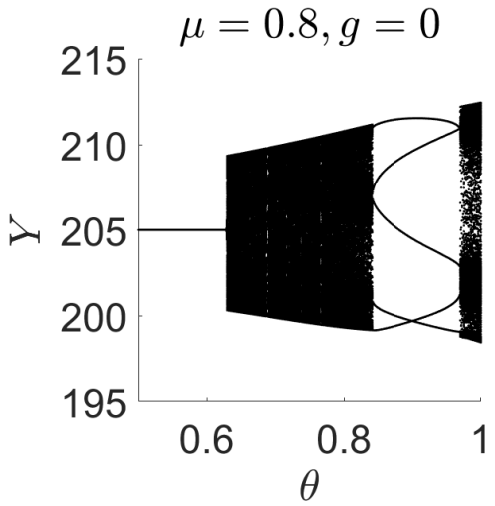




- Convergence to the steady state may be replaced by convergence to a 2-cycle (red region).
- **Path dependence**: the steady state may coexist with a cycle of period 3.
- A strong reactivity of the monetary policy coupled with a sufficient reactivity of the fiscal policy may lead to **complex dynamics**.

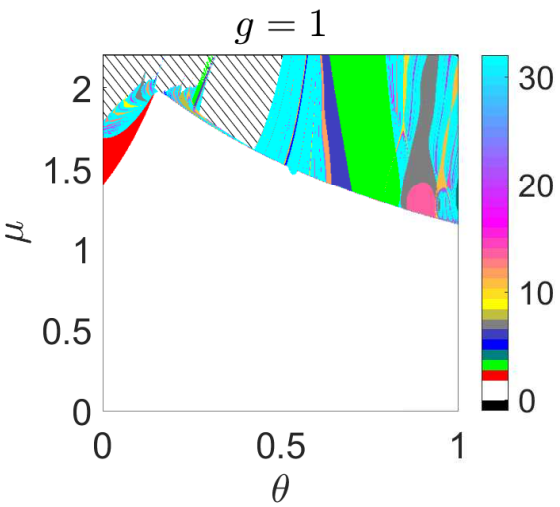
No fiscal policy

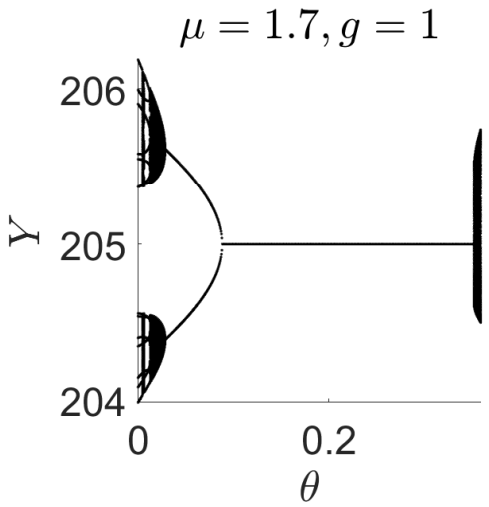




- For increasing values of μ, the steady state turns unstable and complex dynamics arise with **endogenous fluctuations** in the business cycle.
- When there is no space for the fiscal policy and the monetary policy inertia is low, the steady state is stable.
- When θ grows the steady state loses stability via a (subcritical) **Neimark-Sacker** bifurcation.
- An increase in the degree of **inertia** in the money supply rule is **not necessarily** an advantage in terms of reaching the desired output level.

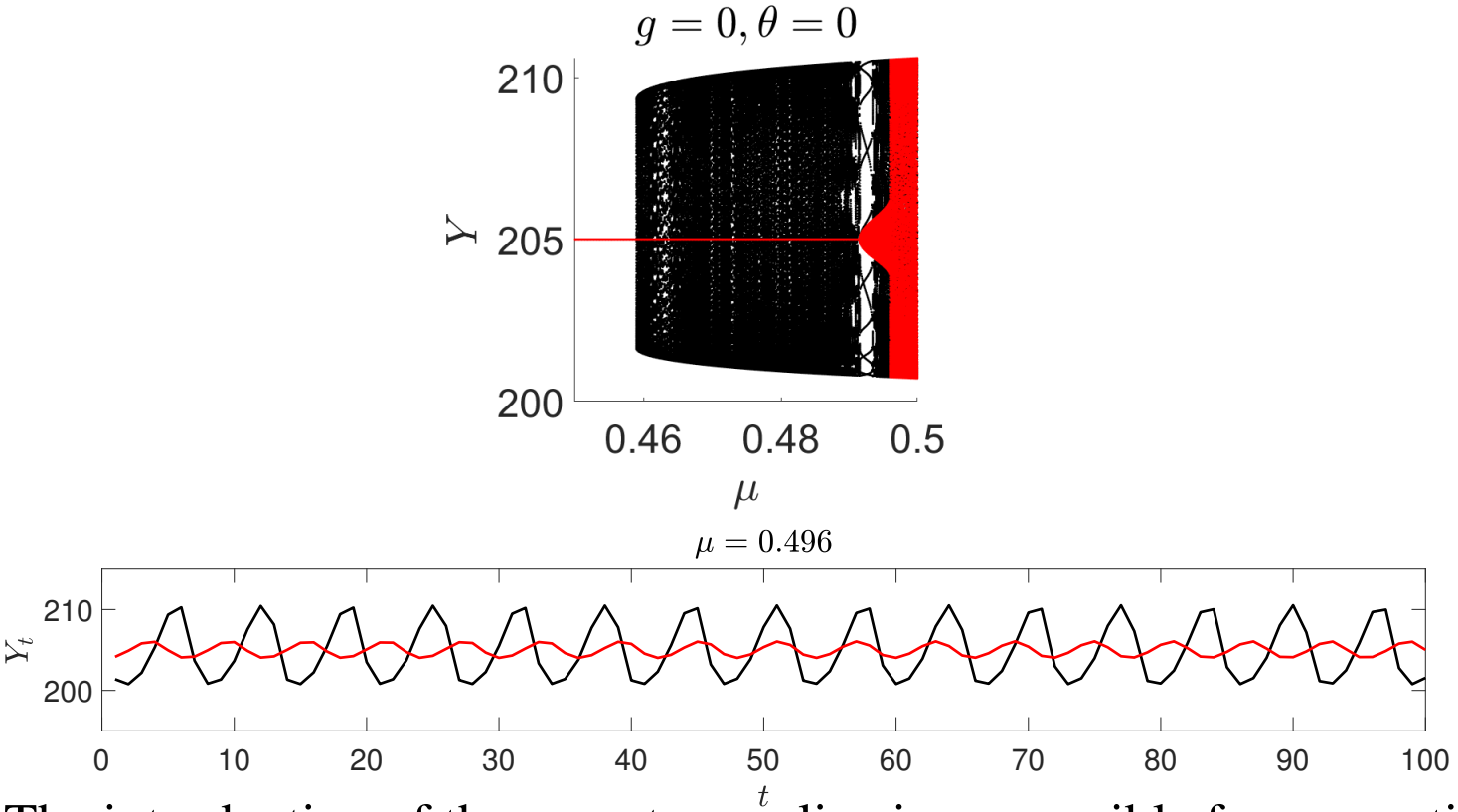
Joint role of monetary and fiscal policy





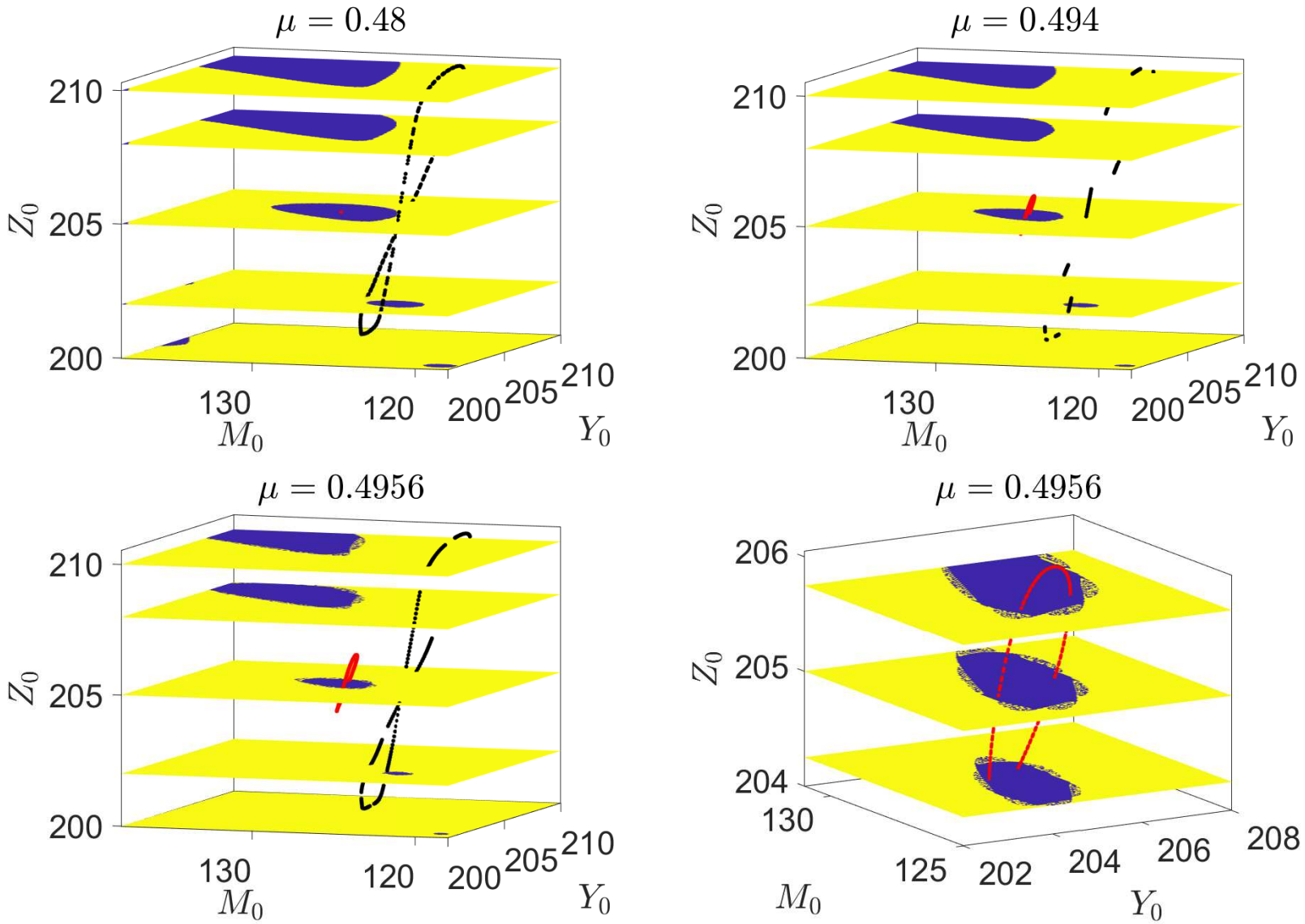
- General increase in the size of the white region, which is associated to the stability of the steady state.
- Double stability threshold when the monetary policy **aggressively** reacts.
- The range of parameters θ for which the steady state remains locally stable is quite **narrow** and a Neimark-Sacker bifurcation of the steady state occurs.

Multistability and coexisting business cycles



- The introduction of the monetary policy is responsible for generating the **business cycle**.
- An **excessive tightening** of monetary policy may lead to **instability** in other sectors, with a negative effect on economic actors' behavior by weakening their assessment of the future dynamics.

Basins of attractions



Concluding remarks

- We sneak into the debate on which of the two instruments is better able to purse the **stabilization objective**.
- From a static viewpoint, the monetary policy is **able** to lead the economy to the desired output equilibrium level.
- The **interaction** of the two policy instruments causes a variety of **local bifurcation** scenarios.
- The introduction of the monetary policy can have **beneficial** effects in leading the economy toward the full employment income.
- Both the **government** and the **monetary authority** are able to **influence** the size and the persistence of the oscillations by properly tuning their policy instruments.
- **Coexistence** of different attractors, making the choices of policy makers crucial to shift the output in the desired direction.