Money in the Production Function

Some Policy Implications

Edward C. Prescott

May 27, 2019

10th Annual CIGS Conference on

Macroeconomic Theory and Policy

Microeconomic Science

- Microeconomics and Macroeconomics are different Sciences
- Microeconomics is a powerful science for addressing micro issues
- But in addressing macro problems it has failed spectacularly (Lucas and Sargent)

Macroeconomic Science

- It is a unified hard quantitative science
- Conceptually it is simple
  - Smart undergraduates can master the basic concepts in a single course
  - Supply and demand are not used in this science
  - General equilibrium reasoning is used with agents on both sides of every transaction
  - All accounting identities must hold for the model economy being used to address the given question

- To answer the question: What is the aggregate consequences of some interest rate targeting regime?

- Until recently when the President of the Minneapolis Federal Reserve Bank asked me what the Fed should do, my answer was that economic theory does not provide an answer.

- Today I will report on a recent advance of macro theory that can be helpful to answer such questions.

Motivation

- Technology is rapidly advancing in the information processing area
- This is changing the monetary/payment system
- A currency–less fiat monetary system is now feasible (Sweden)
- U.S. is moving in this direction

History of Aggregate Monetary Theory

- Using the Stokey and Lucas (1981) framework, money was introduced into dynamic macroeconomics

- The finding was that with this household transaction framework monetary policy had virtually no consequences for real output and employment (Cooley and Hansen, 1989)

History of Value

- The price of a good is in units of value
- Commodity value system
  - Value is in units of a commodity, e.g. ounces of gold/silver
  - Used in U.S. before 1933

- Fiat currency value system
  - Value is in units of currency, e.g. dollar, pound, etc.
  - Its use economizes on resources needed to acquire gold
  - Used in U.S. after 1933

What is the unit of value in a currency-less system?

Fiat Value System

- Fiat value is a form of government debt
- Prices are in units of ***fiat value***
- Name of units of value is unimportant

Fiat Value System

- Use valuation equilibrium theory of Debreu (1954)
  - Commodity space is a linear topological space
  - “Value services” is a commodity
- Use sequence of valuation equilibria
  - This is the way statistics are collected (quarterly)

- Fiat value is the numeraire
  - GE theory prior to Debreu had finite number of goods and only *relative* values of commodities were determined
  - In fiat value system, prices are in units of fiat value

Traditional and Commercial Banks

- Traditional Banks
  - Played important role in commodity value system
  - Fractional reserves reduced the amount of commodity used by the payment system

- Commercial Banks
  - Play important role in fiat currency value system
  - Accept demand deposits, originate loans, and have fractional reserves
  - But, managing assets is their major activity

Banks in a Fiat Value System

Proposal: totally separate transaction services from asset management services

Transaction Services

- Businesses hold large amounts of cash reserves
- Businesses hold over $10 trillion in highly liquid assets that earn zero real return
- Services of these “cash reserves” are a factor of production
- Just like human capital and other capital services

Asset Management

- Trusts that do not accept demand deposits
- They pool savings and make investments
- This is the way most lending to finance business is done
  - Checkable deposits only 0.08 **annual** GNP
  - Time and savings deposits only 0.57 GNP
  - Yet business borrowing is 2.5 GNP *(Flow of Funds L104, L105)*
- BlackRock alone manages 0.25 GNP of debt assets

Key Features of System

- Fiat value is a form of government debt
- Prices are in units of fiat value
- Fiat value is a capital stock
- It is rented to the business sector

Note: Money is short for fiat value in what follows

The Model Used to Explore How Such a System Would Operate

Aggregate Production Properties

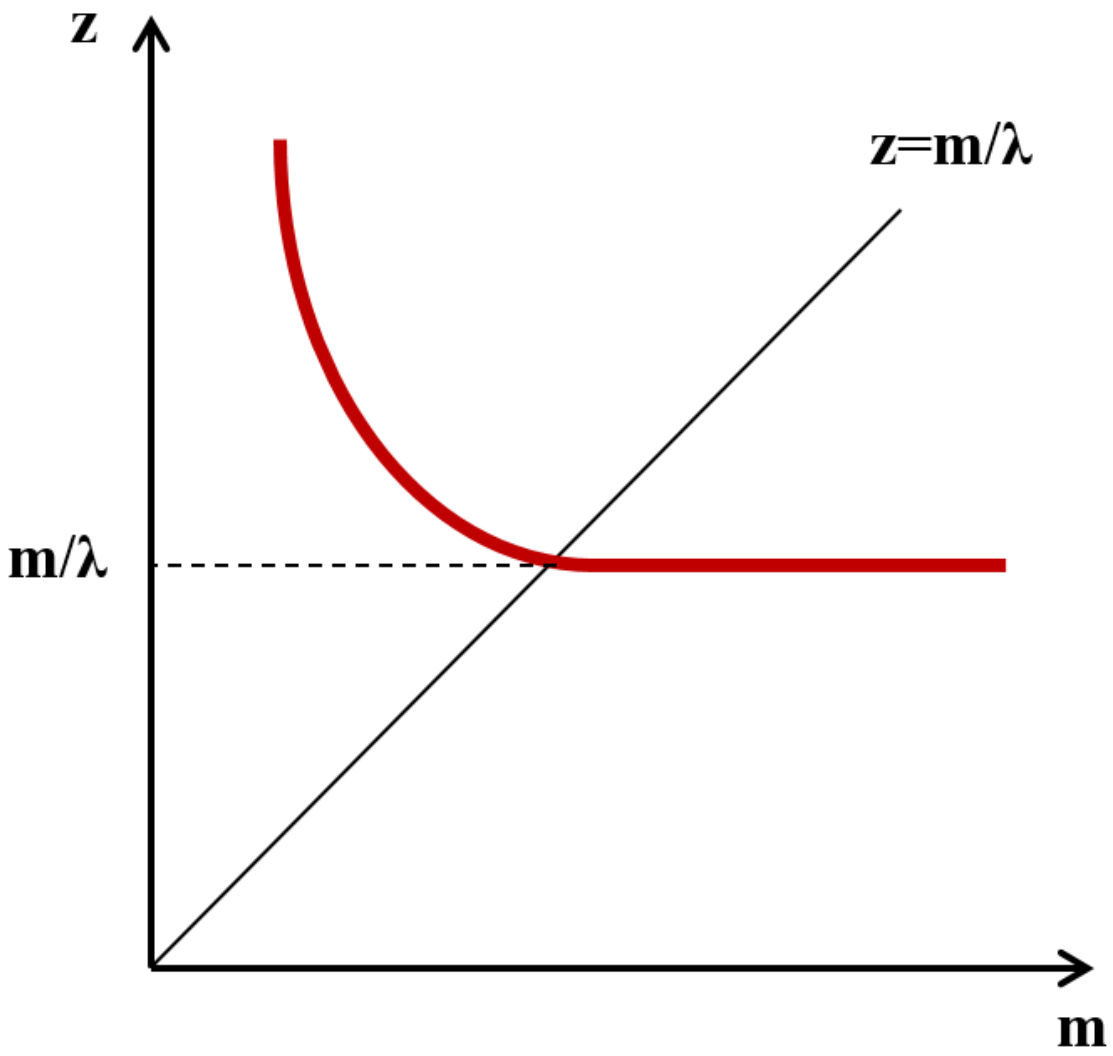
- Want marginal product of money to be zero if money services input is large enough
- Want standard production function properties (McKenzie)
  - Constant returns to scale (CRS)
  - Concavity
  - Increasing
  - Differentiable
- An isoquant defines a production function, given CRS

Technology

- h labor, k capital services, m money services, y output, A, λ and θ parameters, and $z_t = k_t^{\theta} h_t^{1-\theta}$
- CRS aggregate production function

$$y_t = f(m_t, z_t) = \begin{cases} A\lambda^{1-f} z_t & \text{if} \quad m_t = \lambda z_t \\ A z_t^{f} m_t^{1-f} & \text{if} \quad m_t < \lambda z_t \end{cases}$$

A Production Function Isoquant



Technology

- When $m/z = \lambda$, the marginal product of money is zero

- We term this **“satiation”**

- When satiation, the marginal product of money is zero

Households and Their Preference Ordering

- Measure one of identical households
- Preferences ordered by

$$\sum_{t=0}^{\infty}(1+\rho)^{-t}[\log c_t + \alpha \log(1-h_t)]$$

- h is the fraction of time allocated to the market

Government Policy Variables

- Variables
  - π : inflation rate
  - τ : labor tax rate
  - g : gov't purchases of final product
  - ψ : transfers to household
  - m : stock of money
  - b : stock of gov't bonds issued
  - i_m : interest rate on money
  - i_b : interest rate on gov't bonds

Government

- Government pays interest on two types of debt:
  - i_m : **nominal** interest paid on money
  - i_b : **nominal** interest paid on bonds
  - Absent monetary satiation i_b is the bigger

Note

- An equilibrium condition is $r_m + i_m = i_b$

- When monetary satiation, the rental price of money services is zero and $i_m = i_b$

Budget Constraints

- All quantities are real
- All prices are **nominal**

Budget Constraints

- Household budget constraint is

$$c + [k' - (1-\delta)k] + [(1+\pi)m' - m] + [(1+\pi)b' - b] = (1-\tau)wh + r_k k + r_m m + i_m m + i_b b + \psi$$

- HH consume and invest in capital, money, and bonds
- HH income from business sector (wage, capital rental, money rental) and from government (interest received on money and bonds, transfers)

Budget Constraints

- Firm budget constraint is

$$y = wh + r_k k + r_m m$$

- Constant returns to scale so no economic profits in equilibrium

Budget Identity

- Government budget identity is

$$g + \psi + i_m m + i_b b =$$
$$\tau w h + \left[m'(1+\pi) - m \right] + \left[b'(1+\pi) - b \right]$$

- Gov't consumes, transfers to HH and pays interest on m and b
- Gov't finances its expenditures from labor taxes, producing money (inflation tax), and new debt.

Balanced Growth Analysis

- Dynasty and overlapping generations in our model economies are essentially equivalent
- We use dynasty because it simplifies the presentation
- In balanced growth, stocks are constant relative to output, so we will drop the prime on beginning of next period's stocks

A Note on Government Financing

- In balance growth, the government budget constraint is

$$g + \psi + i_m m + i_b b = \tau w h + \pi m + \pi b$$

- Government revenue is from the labor tax and from the inflation "tax"

- Money production is a government monopoly

Equilibrium

- Prices are $\{w_t, r_{kt}, r_{mt}, i_{mt}, i_{bt}\}_{t=0}^{\infty}$
- Equilibrium conditions are
  - Given prices and budget constraint, **household** chooses its best $\{c_t, h_t, k_{t+1}, m_{t+1}, b_{t+1}\}_{t=0}^{\infty}$
  - Given prices, **firm** chooses $\{k_t, h_t, m_t\}$ that maximizes its value for every t
  - The **government** selection of $\{g_t, \psi_t, b_{t+1}, m_{t+1}, \pi_t, \tau_t\}_{t=0}^{\infty}$ are such that its budget identity is satisfied for all t
- We study balanced growth only

Baseline Economy

- We have specified a parametric set of economies

- We choose a set of parameters so that model matches selected U.S. National Income and Product Account data (following Larry Klein)

- Targets:
  - Consumption/investment shares
  - Fraction of time worked
  - Asset stocks to output ratios
  - Factor income shares

Baseline Economy: *Parameters*

Preference and Technology Parameters		
α	relative preference for leisure	0.68
β	discount rate (annual)	0.98
δ	depreciation rate (annual)	0.04
θ	capital cost share	0.35
φ	money cost share	0.01
A	TFP	1.13
λ	money satiation parameter	2

Baseline Economy: *Parameters*

Policy Parameters

g / y	gov't public goods share	0.05
ψ / y	transfer share	0.25
m / y	money output ratio	1.50
b / y	gov't privately held debt to output	0.50
τ	labor tax rate	0.52
i_m	interest rate on money	6.54%
i_b	interest rate on gov't bonds	7.21%
π	inflation rate (annual %)	2.00%

Baseline Economy: *National Accts*

- This theory necessitates a change in how National Accounts are constructed

National Accounts

Product	**1.08**
HH Consumption	0.68
Gov't C & Invest.	0.05
HH Invest. in k	0.27
Money Production	0.08
Income	**1.08**
Wages	0.64
Depreciation of Capital	0.15
Capital Rental Income	0.19
Money Rental Income	0.01
Central Bank Profits	0.08

Government Accounts

Receipts	**0.44**
Tax Revenue	0.33
Money Issuance	0.08
Debt Issuance	0.03
Expenditures	**0.44**
Gov't Consumption	0.05
Transfers to HH	0.25
Bond Interest Payments	0.04
Money Interest Payments	0.10

Three Explorations

- Government policy variables $\{\pi, \tau, i_m, \frac{m}{y}, \frac{b}{y}, \frac{\psi}{y}, \frac{g}{y}\}$
- We are concerned with MONETARY policy not FISCAL policy.
- Therefore, fix government debt, spending, and transfers relative to output y
- Gov't policy variables $\{\pi, \tau, i_m, \frac{m}{y}\}$
- Restriction on two MONETARY policy variables
  - interest on money and money stock cannot both be fixed.

1. Monetary Policy with Endogenous Tax Rate

- What consequences do money supply policies have?

Policy Regimes

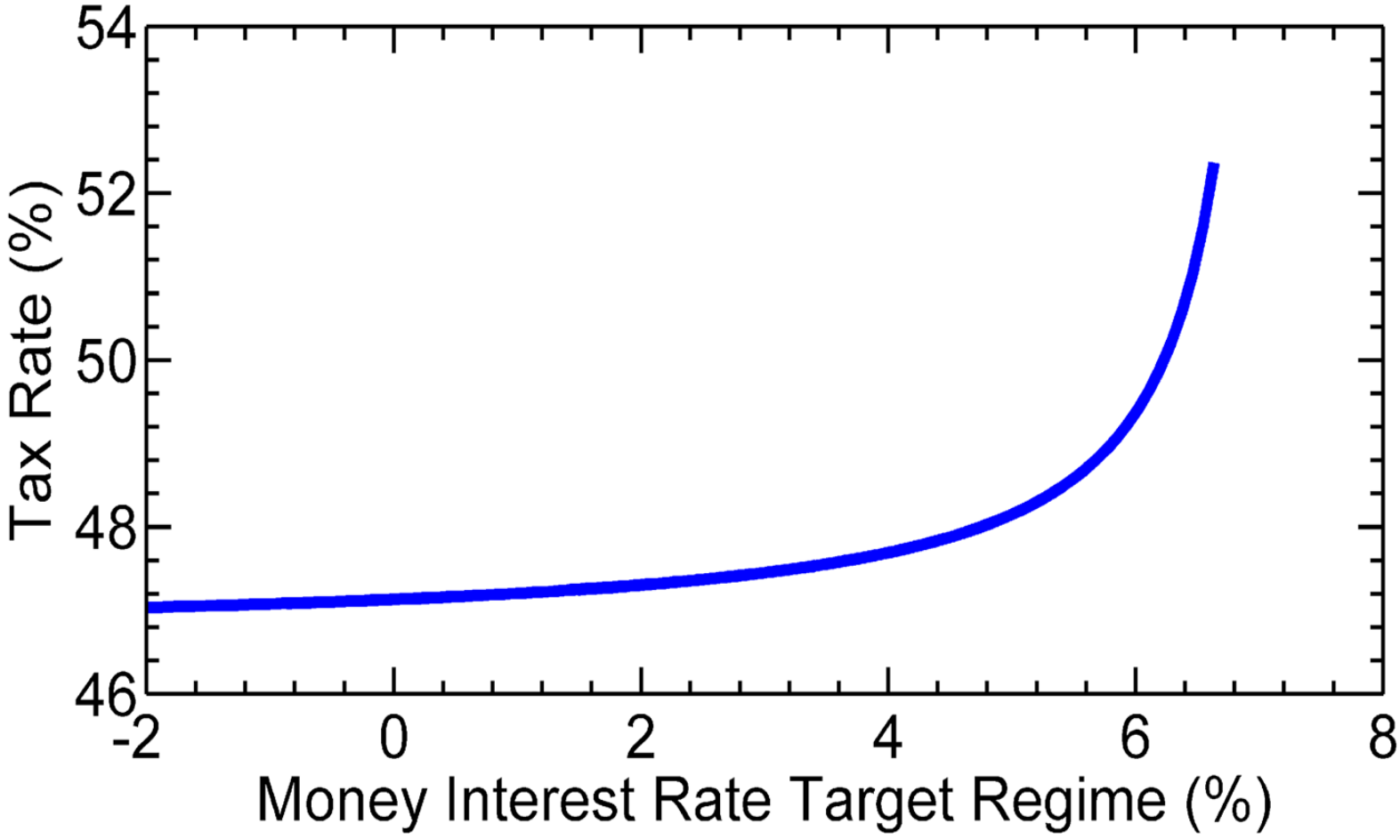
Fixed across regimes

$$\left\{\frac{g}{y}=0.05,\ \ \frac{\psi}{y}=0.25,\ \ \frac{b}{y}=0.50,\ \ \pi=0.02\right\}$$

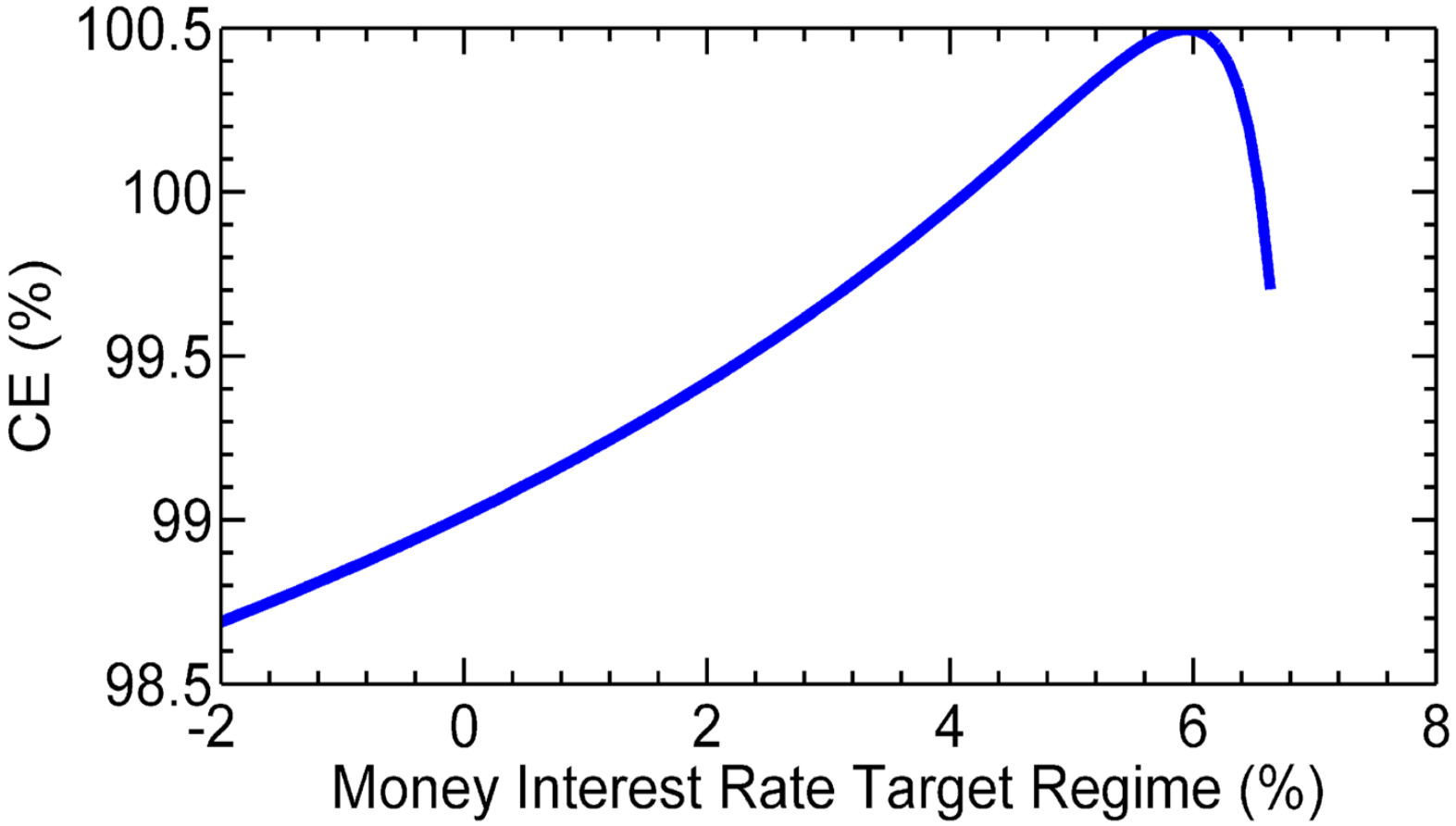
Varies across regimes

$$\left\{\frac{m}{y}, i_m, \tau\right\}$$

Labor tax rates for different interest rate targets



Welfare for interest rate target regimes



Implications

- In a regime with a fixed inflation rate target, FISCAL POLICY must respond to changes in INTEREST RATE POLICY
- Hump shape welfare arises for two reasons
  - Higher interest means more money => more output
  - Higher interest means high labor tax => less output
- Welfare highest when interest on money is 6% ***in this economy***

2. Monetary Policy with Endogenous Inflation Rate

- What consequences do money supply policies have?

Policy Regimes

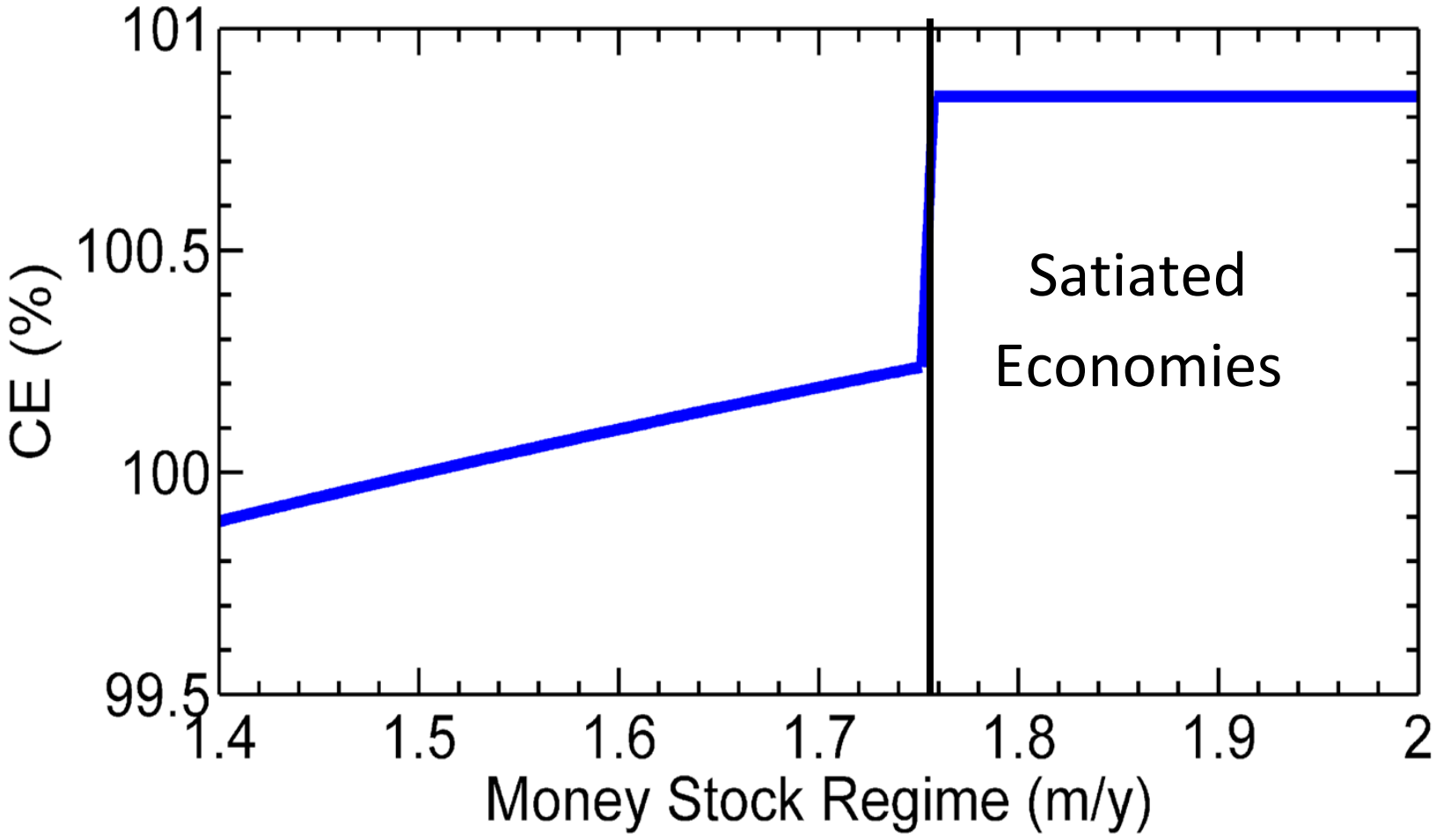
Fixed across regimes

$$\left\{\frac{g}{y}=0.05,\quad \frac{\psi}{y}=0.25,\quad \frac{b}{y}=0.50,\ \tau=0.52\right\}$$

Varies across regimes

$$\left\{\frac{m}{y}, i_m, \pi\right\}$$

Welfare for interest rate target regimes



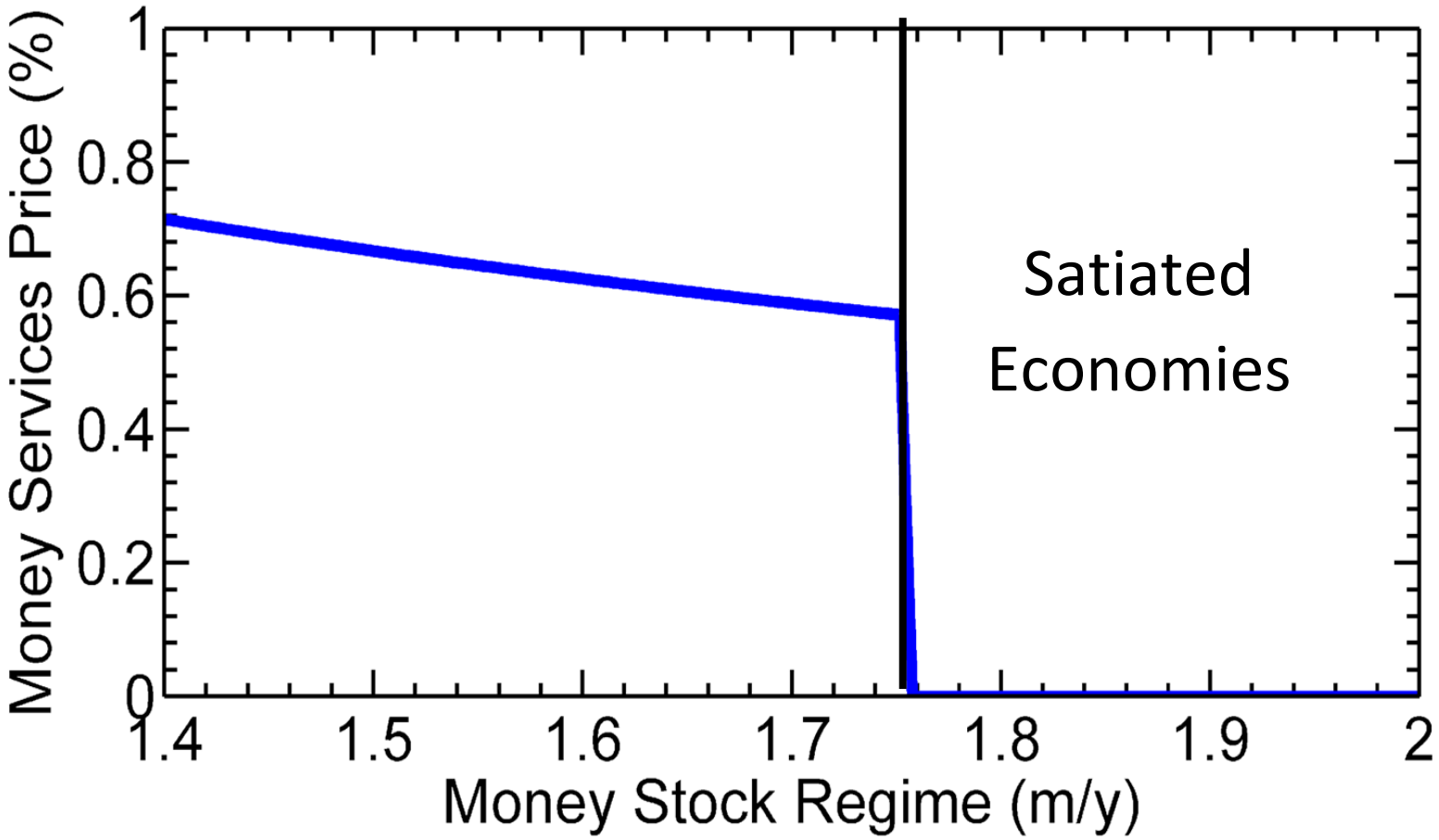
Friedman Rule

- Friedman Rule calls for nominal return on money equal to social cost of producing money (which is zero for our economies)
- Achieved with deflation equal to real interest rate
- Friedman rule not feasible with a fiat valued currency system (see McAndrews 2015)

Friedman Satiation

- With a fiat value system, **Friedman Satiation** can be implemented with **positive inflation!**
- With satiation $r_m = 0$; $i_m = i_b$
- Private marginal cost of holding money equals the social cost of producing money

With satiation, rental price of money is zero



3. Inflation Rate Targeting Regimes

- What are the consequences of different inflation rate targets?

Policy Regime

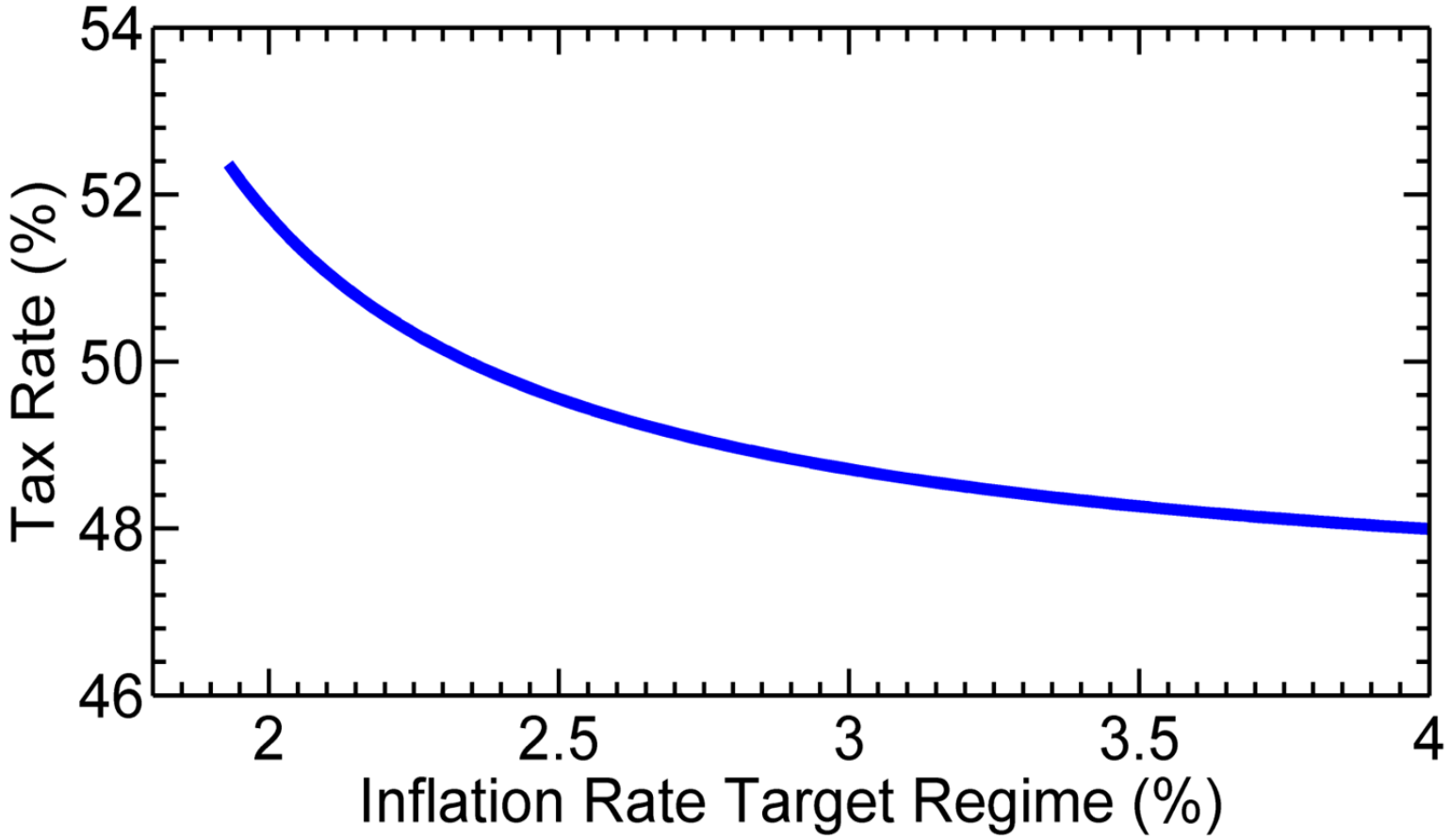
Fixed across regimes

$$\left\{\frac{g}{y}=0.05,\quad \frac{\psi}{y}=0.25,\quad \frac{b}{y}=0.5,\quad i_m=0.06\right\}$$

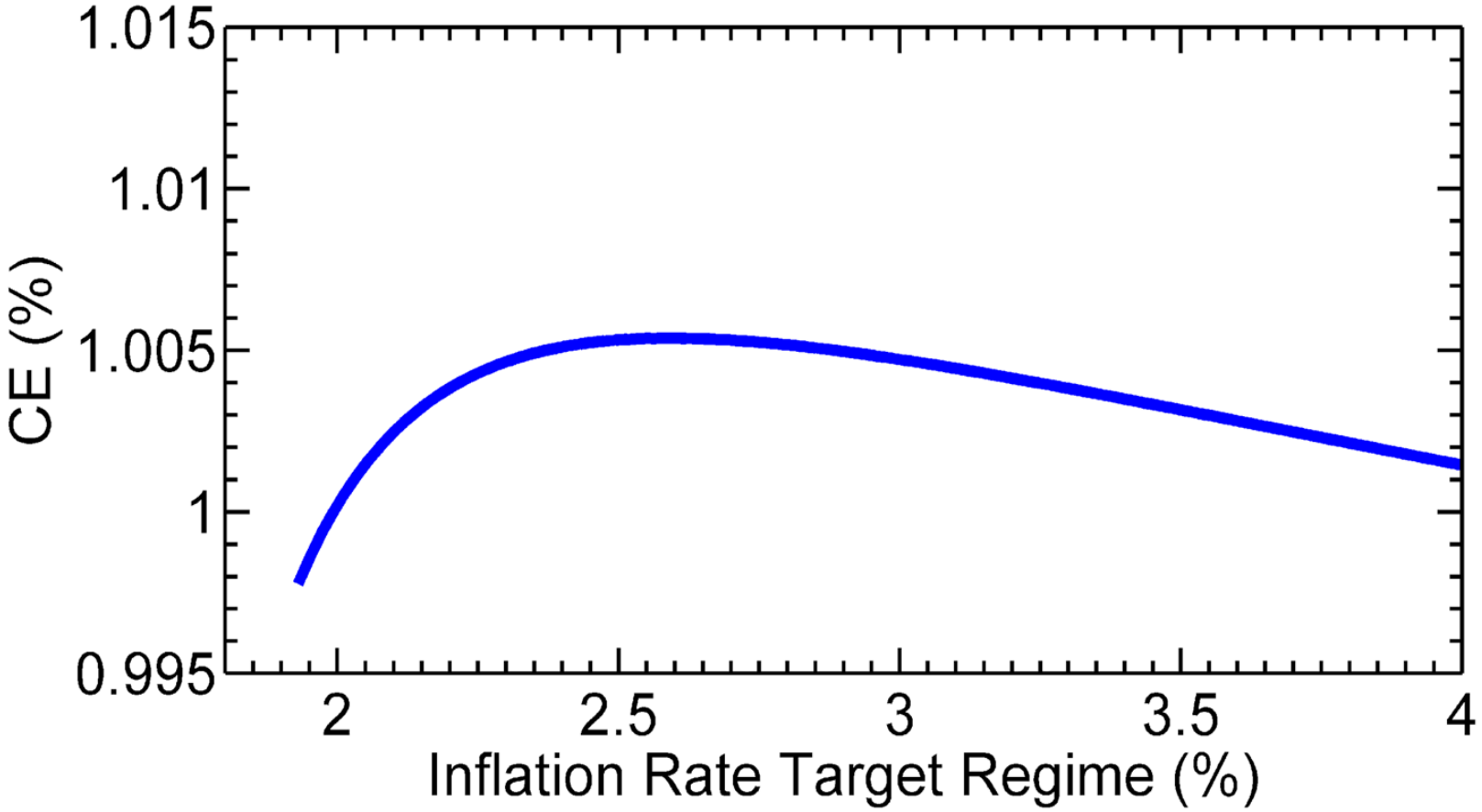
Varies across regimes

$$\left\{\pi,\tau,\frac{m}{y}\right\}$$

Labor tax rates for inflation rate target regimes



Welfare for inflation rate target regimes



Implications

- Welfare indicator highest when inflation is 2.5% and labor tax rate is 49.5% (lower than baseline)
- Some inflation is an effective method of financing government consumption
- High inflation is not an effective financing option because labor tax rate decreases very little

Possible Problems and Advantages

Possible Problems with This System

Before initiating this system, should consider:

- Privacy protection and time consistency
  - See work of Rabee Tourky (ANU) who makes a case for privacy protection
  - Will not deal with these big problems here
- Shadow Banking
  - There is a way to deal with this problem

Possible Solution to the Shadow Banking Problem

- Tax net interest income at a 100% rate for limited liability businesses
- This effectively eliminates businesses that borrow low from one group and lend high to another

Advantages of System

- No bank runs
- No too-big-to-fail problem
- No need for costly regulation as with the U.S. deposit insurance system
  - These costs are about one-half a percent per year of deposits at banks

Conclusion

- We explored a fiat value system which is technically possible given the current state of information-processing technology
- We put money services in the aggregate production function

Conclusion Continued

- It is consistent with both traditional money demand functions and with zero nominal interest rates for extended periods (Japan, 1992-2018)
- Much more research is needed
- Whether going to a currency-less system is good or bad is an open question

Conclusion Continued

- We have shown that monetary policy and fiscal policy are not independent, and evaluating a policy regime is an advanced exercise in public finance