INVESTMENT PLANNING COSTS
AND THE EFFECTS OF FISCAL AND MONETARY POLICY

Susanto Basu and Miles S. Kimball
University of Michigan and NBER
MAIN RESULTS

1. Show that a model with capital accumulation and sticky prices but no investment frictions has counterintuitive properties.
   • Real interest rates rise with monetary expansion (Tobin, 1955; King, 1993)
   • Increases in government purchases lower output and real interest rates in the short run
   • Complements earlier work with J. Fernald on contractionary technology improvements

2. Suggest a friction that might help address both problems: Investment planning costs

3. Show that planning costs make the model more plausible
   • Short-run fiscal policy expansionary (restores Keynesian Cross logic)
   • Real interest rate effect from monetary expansions
   • Propagation of shocks matches data better

4. $Q$-theory-style capital adjustment costs generally not a substitute for planning costs
WHY EXPENDITURE INERTIA?

Supposing we just want to match evidence that money shocks have delayed effect on output

Then we could think of mechanisms to create inertia in each element of private expenditure:

\[ Y = C + I + G \ (+NX) \]

OR

More parsimoniously, could build inertia into production (e.g., make \( L \) costly to adjust, output precommitments)

\[ Y = F(K, L) \]
But evidence says that $G$ shocks have immediate output effect

Then we need the inertia in expenditure, not production

Investment inertia is consistent with micro evidence (Edge, 2000; Lamont, 1999)
Complements consumption inertia; e.g., habit formation

Macro effects akin to “time to plan” (Christiano and Todd, 1996), not “time to build”—need to slow down ordering the new investment goods
BUILDING BLOCKS OF THE MODEL

- Baseline: Basic RBC model, Calvo pricing. Capital accumulation; no investment frictions

- King-Plosser-Rebelo (1988) utility

  Assume EIS ($\sigma$) less than 1 (Basu-Kimball, 2002). Implies $C$ and $N$ (labor) complements

- Real rigidities from: labor “attachment,” intermediate goods, concave demand curve

- Monopolists rent $K$ and use attached $N_i$ to produce varieties $Y_i$

  $$Y_i = Z K_i^\alpha N_i^{1-\alpha} - F$$

  $Z$ is technology. $F$ is the fixed cost. The local degree of returns to scale is

  $$\Gamma = \frac{Y^* + F}{Y^*}$$
• Distortionary taxation of capital and labour income:

\[ \dot{A} = R A + (\bar{R} - \delta)K + \bar{\Theta} + \bar{W}N - C + T \]

• Bars indicate after-tax prices

• Government balances budget period by period:

\[ G + T = \tau_k \left( (R - \delta_{\text{tax}})K + \Theta \right) + \tau_L WN \]

• For comparison with literature, marginal \( dG \) financed via lump-sum taxes, \(-dT\)

• Money introduced via exogenously-appended LM curve

(With change of parameters, can accommodate contemporaneous Taylor rule)
BASIC STICKY-PRICE MODEL: NO ADJUSTMENT COSTS

- Cost minimization by monopolists implies

\[
\frac{RK}{WN} = \frac{\alpha}{1 - \alpha}
\]

- Without adjustment costs, the real interest rate is

\[
\Re = (1 - \tau_k) \left[ \frac{\alpha WN}{1 - \alpha K} - \delta \right]
\]

where \( W \) is the pre-tax real wage

- Call the linearization of this equation the KE curve (Tobin/Sargent)

- Note: \( WN \) increasing in \( Y \), so real interest rate positively linked with output!
The KE-MP Diagram

KE

MP

$R_0$

$y_0$

$R$

$y$
An Expansionary Money Shock in the Basic Model
Linearized KE curve, with household FOC substituted

\[ \mathcal{R} - \mathcal{R}^* = (1 - \tau^*_K) R^* \left\{ \frac{(1 + \eta^{-1})}{\Gamma(1 - \alpha)} y - (1 + \eta^{-1}) z - \sigma \lambda + \frac{1}{1 - \tau^*_L} (\tau_L - \tau_L^*) - \left[ 1 + \frac{\alpha(1 + \eta^{-1})}{\Gamma(1 - \alpha)} \right] k \right\} \]

\[ - (R^* - \delta) (\tau_K - \tau_K^*). \]

Short-run \( y \) and \( \mathcal{R} \) fall if

1. Technology, \( z \), improves,

2. Government purchases rise (higher \( \lambda \)), or

3. Distortionary labour tax rate, \( \tau_L \), falls!

\( y \) and \( \mathcal{R} \) fall with higher capital income taxation
Intuition:

Another way of writing the capital market equilibrium condition:

$$\mathcal{R} = (1 - \tau_k) \left[ \frac{1}{\mu(\cdot)} \alpha \frac{Y + F}{K} - \delta \right]$$

where $\mu$ is the *ex-post* markup

“Positive” real shocks usually reduce $MC(Y,.),$ but with $P$ a state variable, markup and hence distortion is higher
The Effect of a Positive Real Supply Shock
Given a Constant Money Growth Rule
The Effect of a Positive Real Supply Shock
Given a Taylor Rule and Sluggish Inflation
ADDING PLANNING COSTS

Capital Rental Firms

$$\max_{S} \int_{t=0}^{\infty} e^{-\int_{t}^{\infty} \gamma_{t} dt} \left[ RK - K\Phi \left( \frac{S}{K} \right) \right] dt$$

subject to

$$\dot{K} = I - \delta K$$

$$\dot{I} = S - \gamma I$$

$$K_{0}, I_{0} \text{ given}$$

$S$ is investment project starts, $K\Phi(S/K)$ is the planning adjustment cost function, and $\gamma$ is the rate at which investment projects are completed. $\Phi$ is increasing and convex

This Calvo-like formulation has the advantage that there is good micro data on $1/\gamma$ (Edge, 2000). The results are much more sensitive to choice of $\gamma$ than to convexity of $\Phi$

Very small planning costs can generate significant delays—with projects lasting about a year, a 6-month delay requires costs such that a 10% increase in project starts raises overall investment costs by 0.0096%
An Expansionary Money Shock with Output Inertia

\[ y_0 = y_1 \]
FIGURE 2. AR(1) POSITIVE GOVERNMENT SHOCK

OUTPUT

EMPLOYMENT

INVESTMENT

CONSUMPTION

RBC Model
BASIC STICKY PRICE Model
TIME TO PLAN Model
ADJUSTMENT COSTS Model

100 periods=1 year

100 periods=1 year

100 periods=1 year

100 periods=1 year
FIGURE 2. AR(1) POSITIVE GOVERNMENT SHOCK (cont'd)

BEFORE TAX RENTAL RATE

AFTER TAX RENTAL RATE

BEFORE TAX WAGE RATE

AFTER TAX WAGE RATE

- RBC Model
- BASIC STICKY PRICE Model
- TIME TO PLAN Model
- ADJUSTMENT COSTS Model
FIGURE 2. AR(1) POSITIVE GOVERNMENT SHOCK (cont’d)

**REAL INTEREST RATE**
- RBC Model: Dotted blue line
- BASIC STICKY PRICE Model: Green line
- TIME TO PLAN Model: Red line
- ADJUSTMENT COSTS Model: Dash-dotted cyan line

**INFLATION**
- Deviation from steady state, in % per year

**PRICE LEVEL**
- Deviation from steady state, in % per year

**NOMINAL INTEREST RATE**
- Deviation from steady state, in % per year

100 periods = 1 year
FIGURE 2. AR(1) POSITIVE GOVERNMENT SHOCK (cont’d)

CAPITAL STOCK

LAMBDA

MARGINAL Q

PROJECT STARTS

100 periods = 1 year

100 periods = 1 year

100 periods = 1 year

100 periods = 1 year
FIGURE 5. PERMANENT MONEY SHOCK

- OUTPUT
- EMPLOYMENT
- INVESTMENT
- CONSUMPTION

Graphs showing the responses of output, employment, investment, and consumption to a permanent money shock over 100 periods, with different models represented by various lines.
FIGURE 5. POSITIVE PERMANENT MONEY SHOCK (cont'd)

BEFORE TAX RENTAL RATE
- RBC Model
- BASIC STICKY PRICE Model
- TIME TO PLAN Model
- ADJUSTMENT COSTS Model

AFTER TAX RENTAL RATE

BEFORE TAX WAGE RATE

AFTER TAX WAGE RATE
FIGURE 5.  POSITIVE PERMANENT MONEY SHOCK (cont’d)

REAL INTEREST RATE

deviation from steady state, in % per year

RBC Model
BASIC STICKY PRICE Model
TIME TO PLAN Model
ADJUSTMENT COSTS Model

INFLATION

deviation from steady state, in % per year

PRICE LEVEL

deviation from steady state, in % per year

NOMINAL INTEREST RATE
FIGURE 3. AR(1) LABOR TAX INCREASE

OUTPUT

EMPLOYMENT

INVESTMENT

CONSUMPTION

100 periods = 1 year

RBC Model
BASIC STICKY PRICE Model
TIME TO PLAN Model
ADJUSTMENT COSTS Model
FIGURE 3. AR(1) LABOR TAX INCREASE (cont’d)

BEFORE TAX RENTAL RATE

AFTER TAX RENTAL RATE

BEFORE TAX WAGE RATE

AFTER TAX WAGE RATE

- The graphs show the behavior of rental rates and wage rates over time under different models.
- The models include RBC, Basic Sticky Price, Time to Plan, and Adjustment Costs models.
- The figures display trends over 500 periods, with 100 periods representing 1 year.
FIGURE 3. AR(1) LABOR TAX INCREASE (cont’d)

REAL INTEREST RATE

deviation from steady state, in % per year

100 periods=1 year

RBC Model
BASIC STICKY PRICE Model
TIME TO PLAN Model
ADJUSTMENT COSTS Model

INFLATION

deviation from steady state, in % per year

100 periods=1 year

PRICE LEVEL

deviation from steady state, in % per year

100 periods=1 year

NOMINAL INTEREST RATE

deviation from steady state, in % per year

100 periods=1 year
FIGURE 3. AR(1) LABOR TAX INCREASE (cont’d)

CAPITAL STOCK

LAMBDA

MARGINAL Q

PROJECT STARTS

- RBC Model
- BASIC STICKY PRICE Model
- TIME TO PLAN Model
- ADJUSTMENT COSTS Model

100 periods=1year

100 periods=1year

100 periods=1year

100 periods=1year
FIGURE 4. AR(1) CAPITAL TAX INCREASE

OUTPUT

EMPLOYMENT

INVESTMENT

CONSUMPTION

- The graphs show the effects of an AR(1) capital tax increase on various economic variables over 500 periods, with each variable measured in years.
- The variables include Output, Employment, Investment, and Consumption.
- Different models are represented by distinct lines:
  - RBC Model: Blue dashed line
  - BASIC STICKY PRICE Model: Green line
  - TIME TO PLAN Model: Red line
  - ADJUSTMENT COSTS Model: Cyan line
- The x-axis represents time in 100 periods, while the y-axis represents the change in each variable.
FIGURE 4. AR(1) CAPITAL TAX INCREASE

BEFORE TAX RENTAL RATE

- RBC Model
- BASIC STICKY PRICE Model
- TIME TO PLAN Model
- ADJUSTMENT COSTS Model

AFTER TAX RENTAL RATE

BEFORE TAX WAGE RATE

AFTER TAX WAGE RATE

100 periods=1 year
FIGURE 4. AR(1) CAPITAL TAX INCREASE (cont'd)

REAL INTEREST RATE

- Deviation from steady state, in % per year
- RBC Model
- BASIC STICKY PRICE Model
- TIME TO PLAN Model
- ADJUSTMENT COSTS Model

INFLATION

- Deviation from steady state, in % per year
- x 10^{-3}

PRICE LEVEL

- Deviation from steady state, in % per year

NOMINAL INTEREST RATE

- Deviation from steady state, in % per year
FIGURE 4. AR(1) CAPITAL TAX INCREASE (cont'd)

CAPITAL STOCK

LAMBDA

MARGINAL Q

PROJECT STARTS

100 periods=1year

RBC Model
Basic STICKY PRICE Model
TIME TO PLAN
ADJUSTMENT COSTS MODEL

100 periods=1year

0 100 200 300 400 500

0 100 200 300 400 500

0 100 200 300 400 500

0 100 200 300 400 500