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
[Ramey-Shapiro (1998), Blanchard-Perotti (2002), Mountford-Uhlig (2002), Perotti (2004)]

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 <u>ordering</u> 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 (σ) 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:**

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

- **Bars indicate after-tax prices**

- **Government balances budget period by period:**

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

- **For comparison with literature, <u>marginal</u> *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**

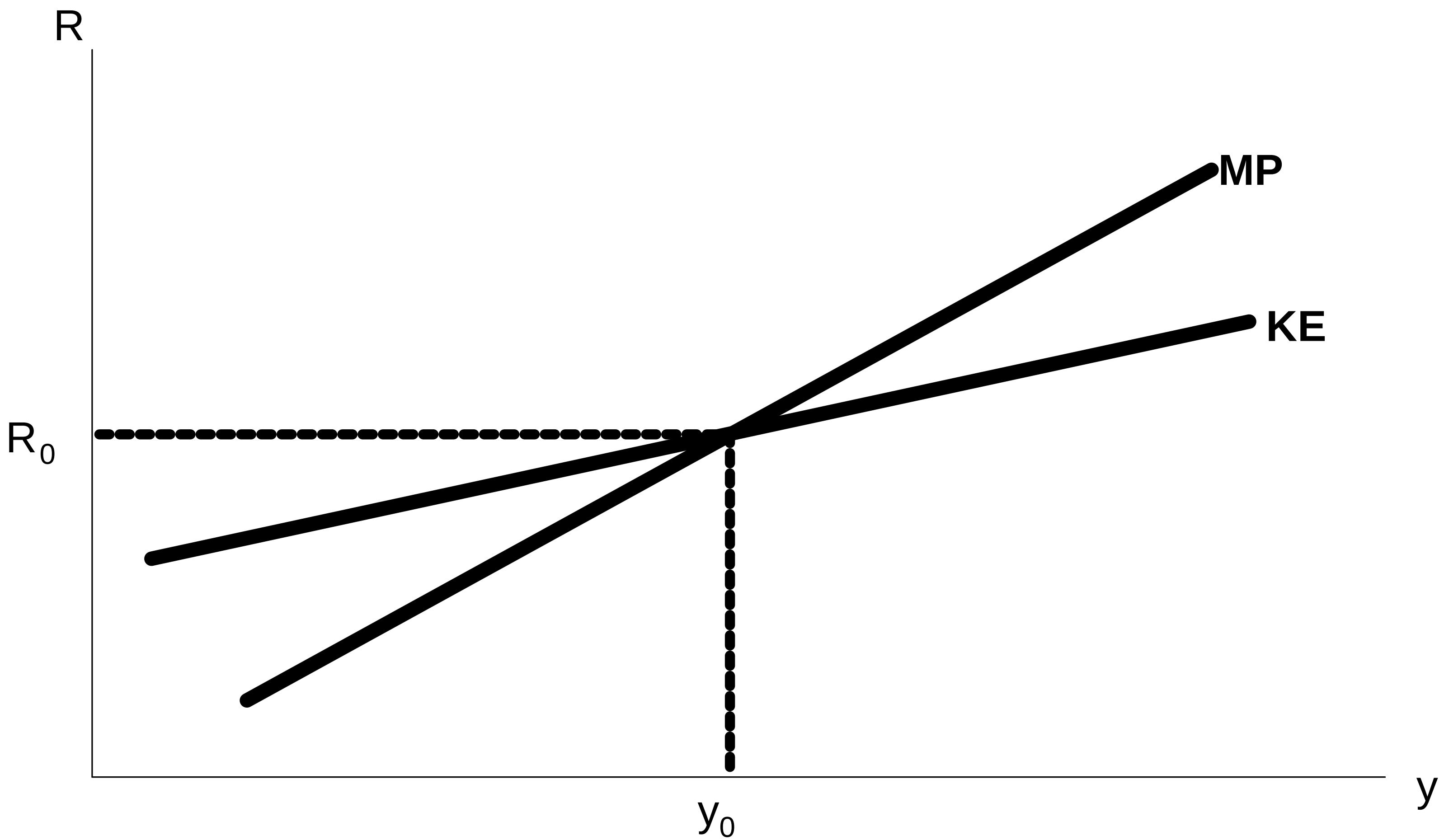
$$\Re = \left(1-\tau_K\right)\left[\frac{\alpha}{1-\alpha}\frac{WN}{K} - \delta\right]$$

where W is the <u>pre-tax</u> real wage

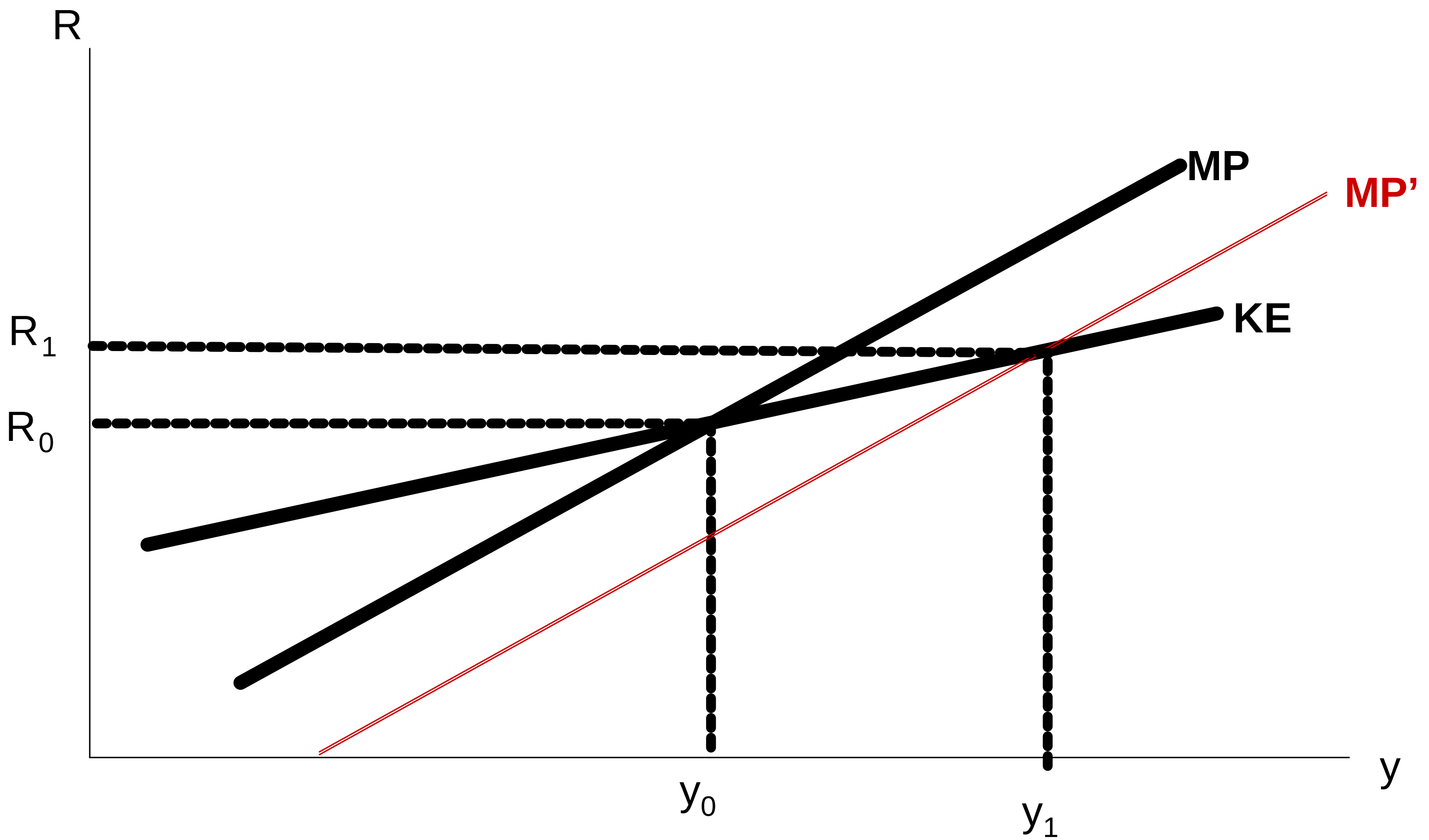
- **Call the linearization of this equation the KE curve (Tobin/Sargent)**

- **Note: WN increasing in Y, so real interest rate positively linked with output!**

The KE-MP Diagram



An Expansionary Money Shock in the Basic Model



Linearized KE curve, with household FOC substituted

$$\Re - \Re^{*} = \left(1-\tau_K^{*}\right) R^{*} \left\{ \frac{\left(1+\eta^{-1}\right)}{\Gamma\left(1-\alpha\right)} y - \left(1+\eta^{-1}\right) z - \sigma\lambda + \frac{1}{1-\tau_L^{*}}\left(\tau_L - \tau_L^{*}\right) - \left[1+\frac{\alpha\left(1+\eta^{-1}\right)}{\Gamma\left(1-\alpha\right)}\right] k \right\}$$

$$-\left(R^{*}-\delta\right)\left(\tau_K - \tau_K^{*}\right).$$

Short-run *y* and $\Re$ *fall* if

1. **Technology, *z*, improves,**
2. **Government purchases rise (higher λ), or**
3. **Distortionary labour tax rate, τ_L, falls!**

***y* and $\Re$ fall with higher capital income taxation**

Intuition:

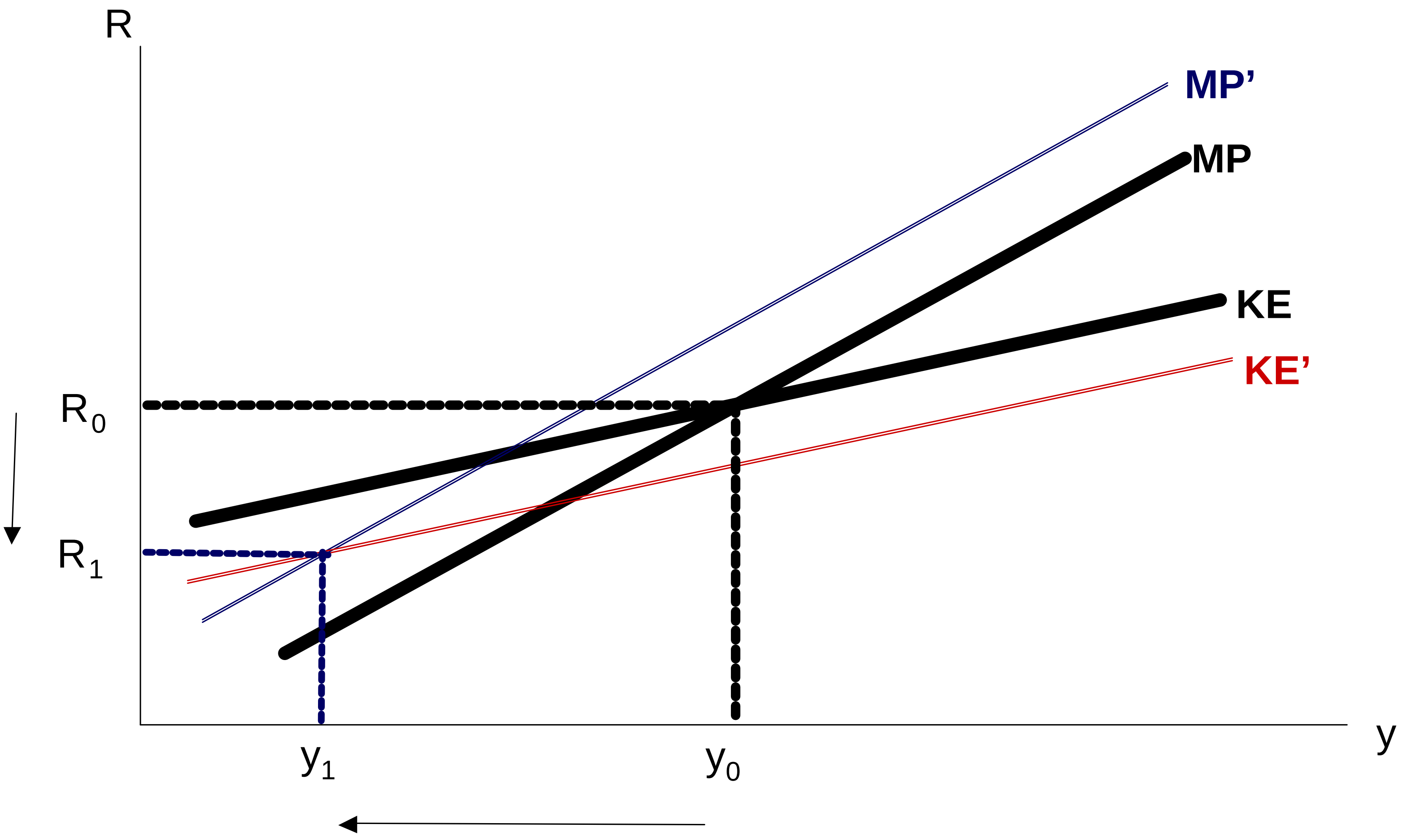
Another way of writing the capital market equilibrium condition:

$$\Re = (1-\tau_K)\left[\frac{1}{\mu(.)}\alpha\frac{Y+F}{K}-\delta\right]$$

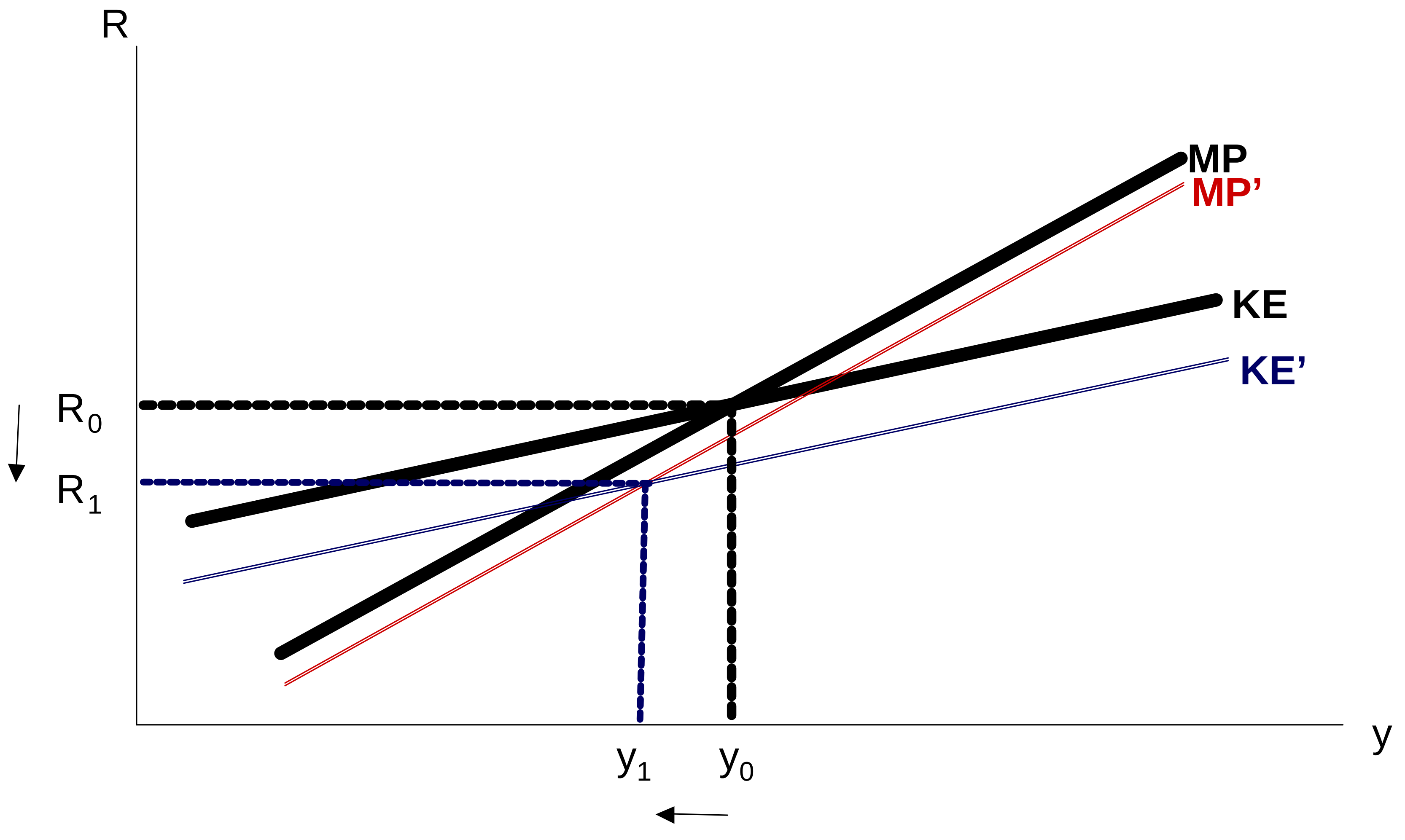
where μ is the <u>ex-post</u> markup

"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

$$\underset{S}{Max} \int_{t=0}^{\infty} e^{-\int_{\tau=0}^{t} \Re_\tau d\tau} \left[RK - K\Phi\left(S/K \right) \right] dt$$

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 γ is the rate at which investment projects are completed. Φ 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 γ than to convexity of Φ

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

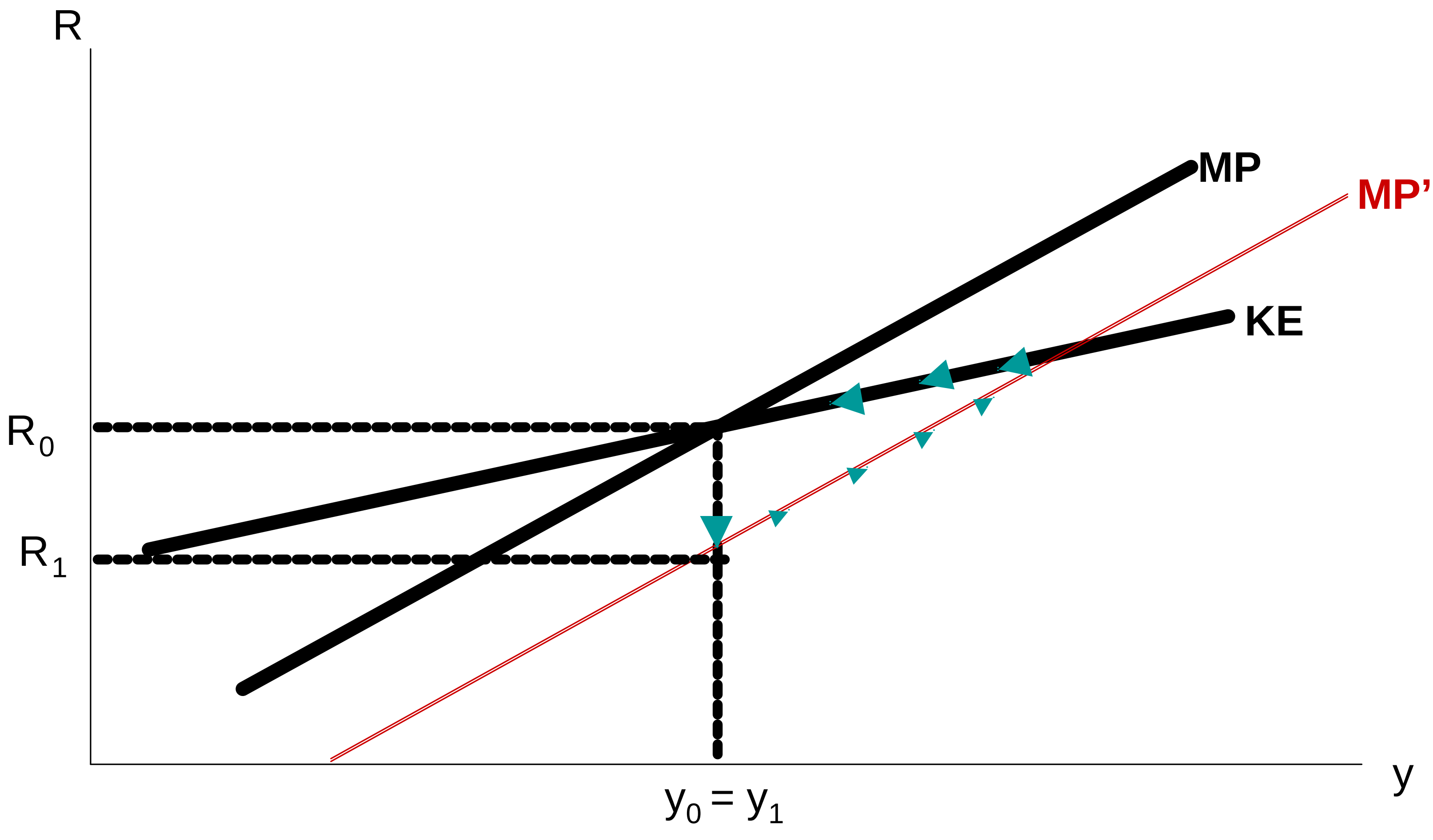


FIGURE 2. AR(1) POSITIVE GOVERNMENT SHOCK

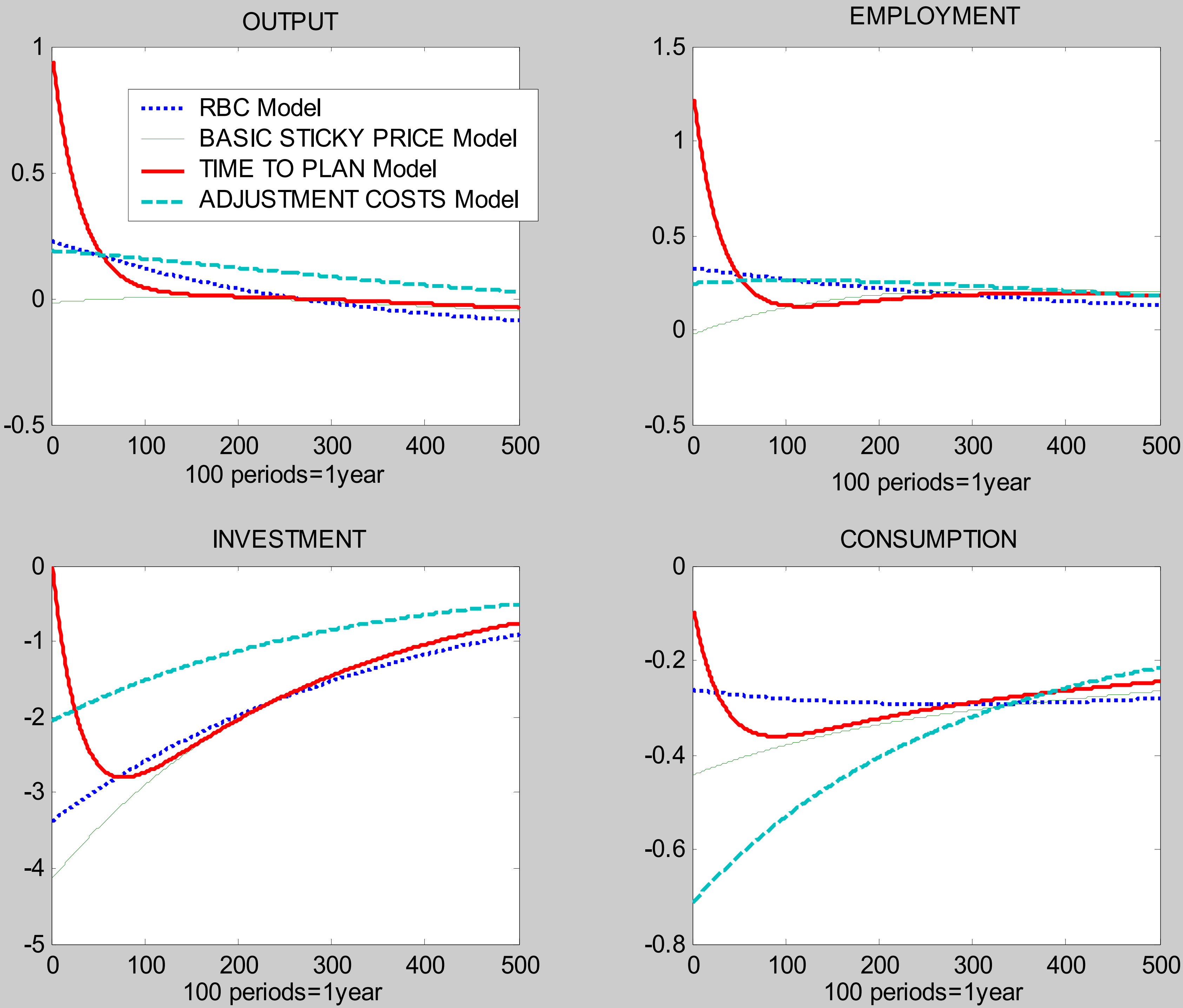
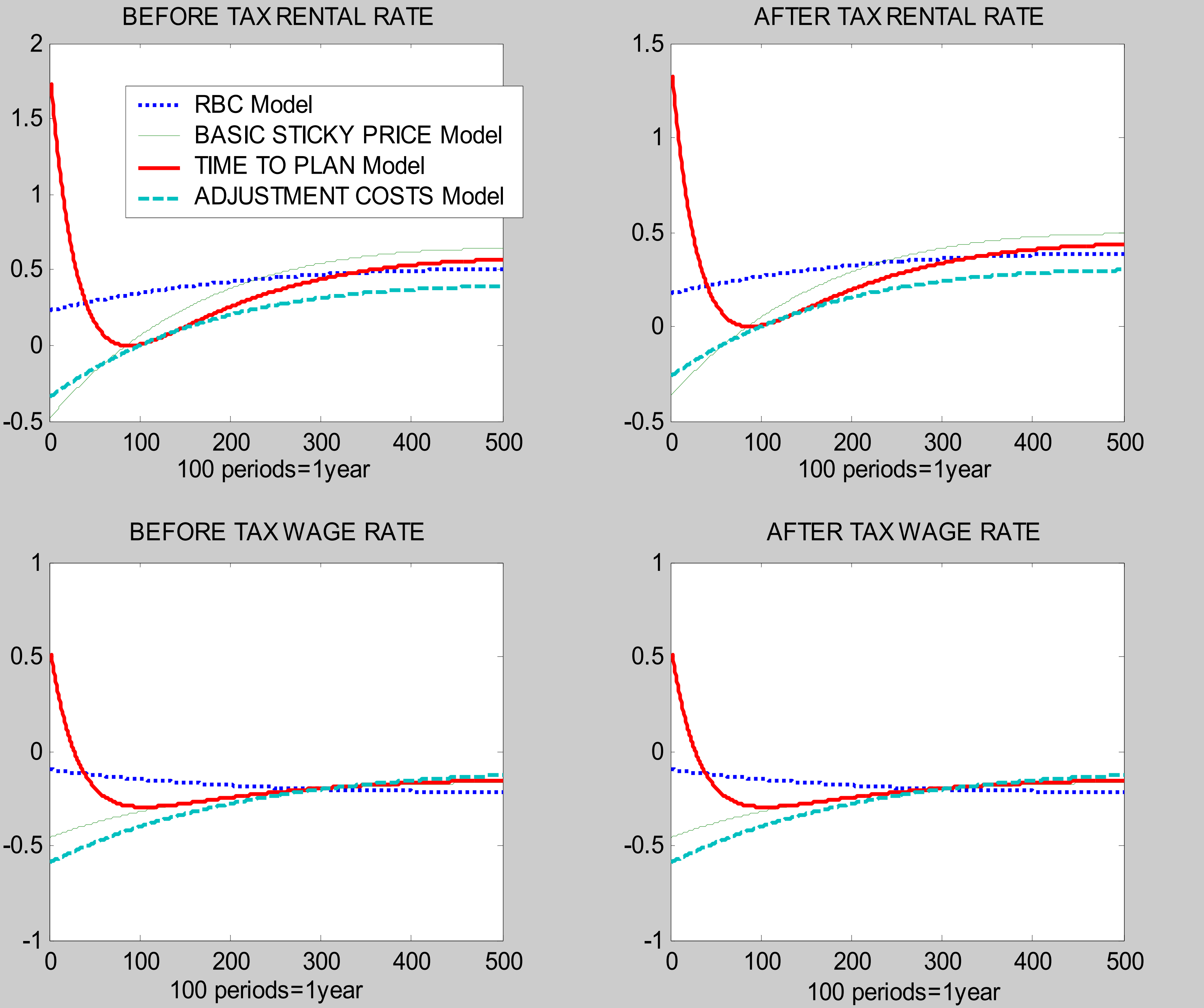


FIGURE 2. AR(1) POSITIVE GOVERNMENT SHOCK (cont'd)



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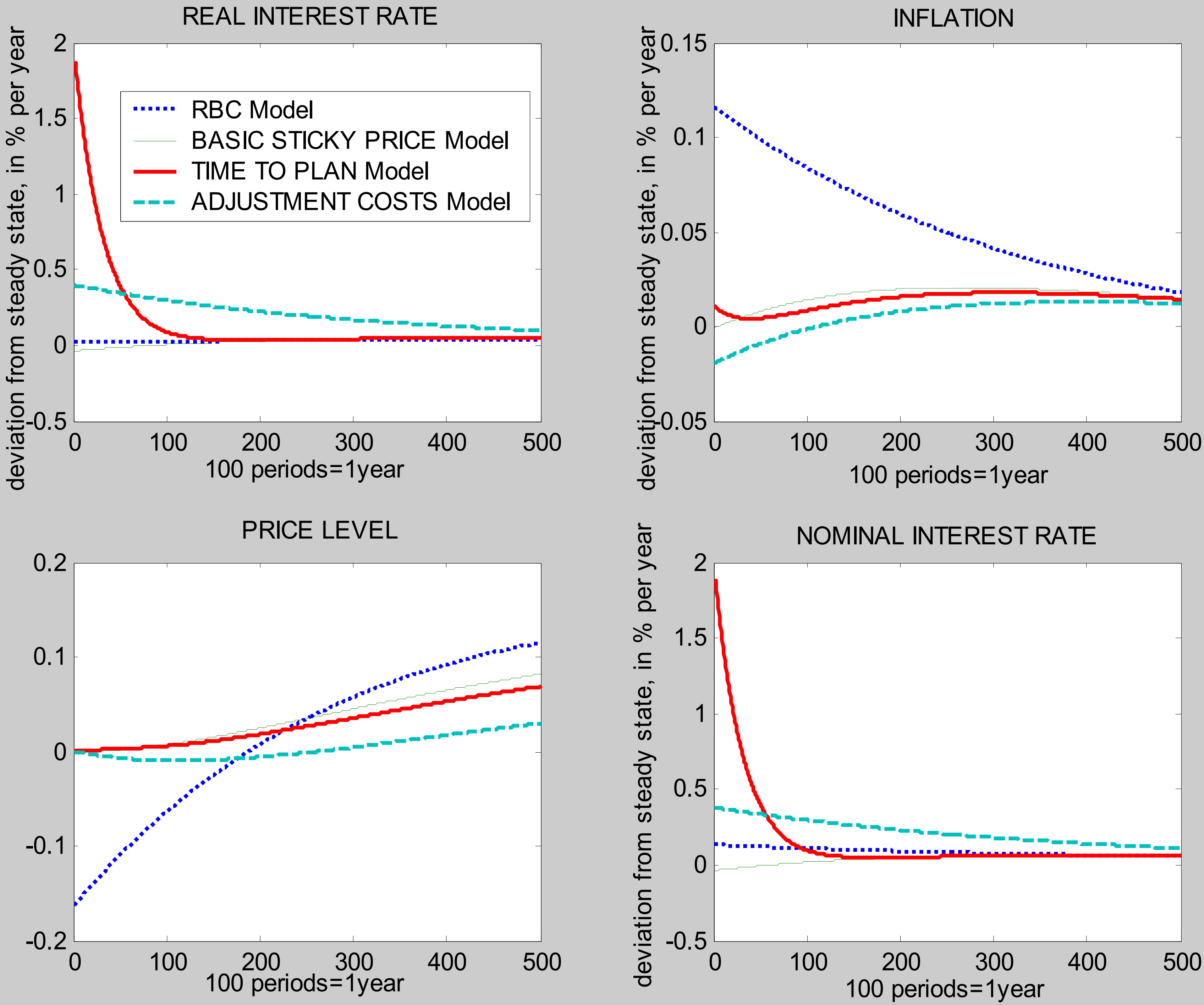

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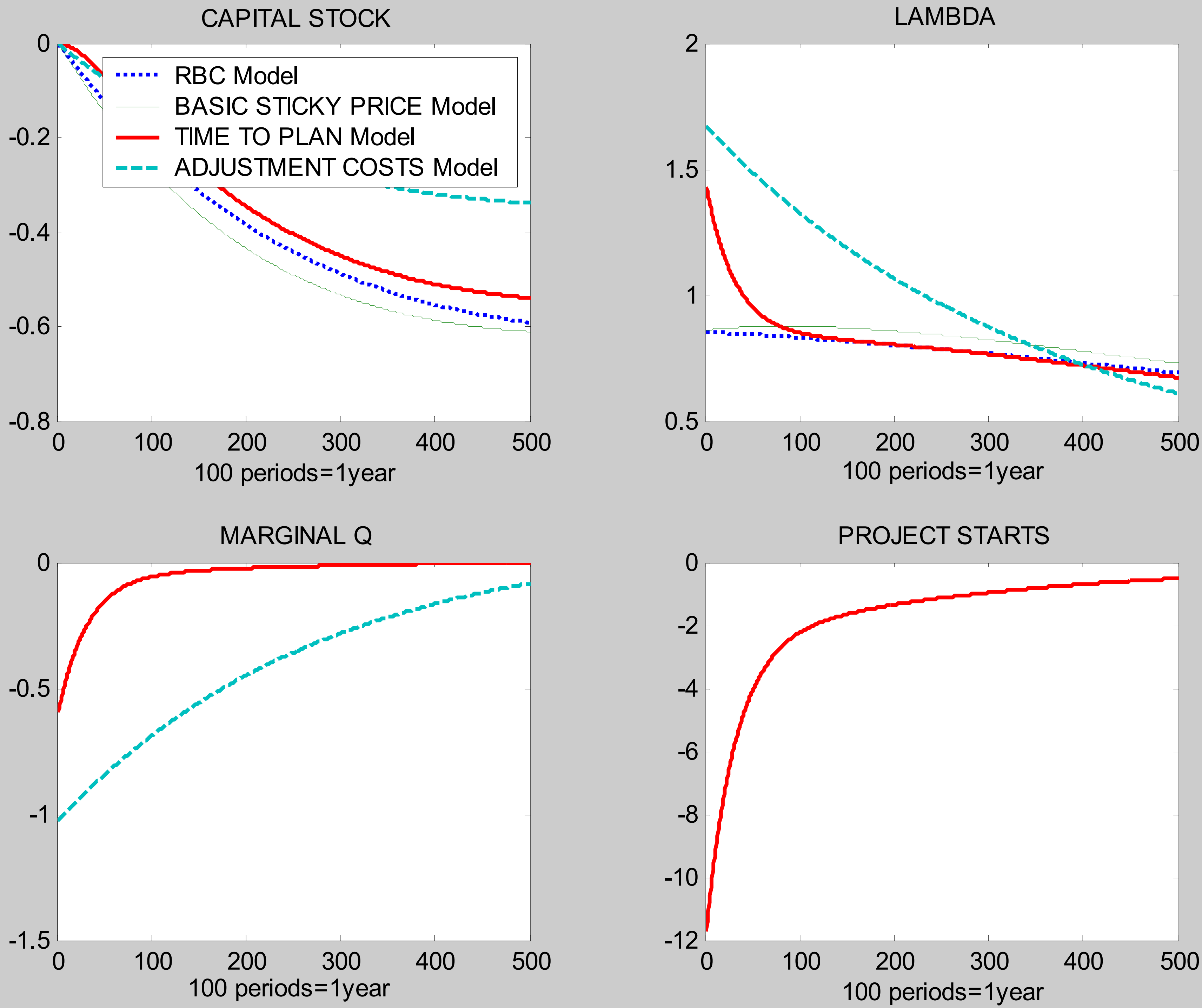


FIGURE 5. PERMANENT MONEY SHOCK

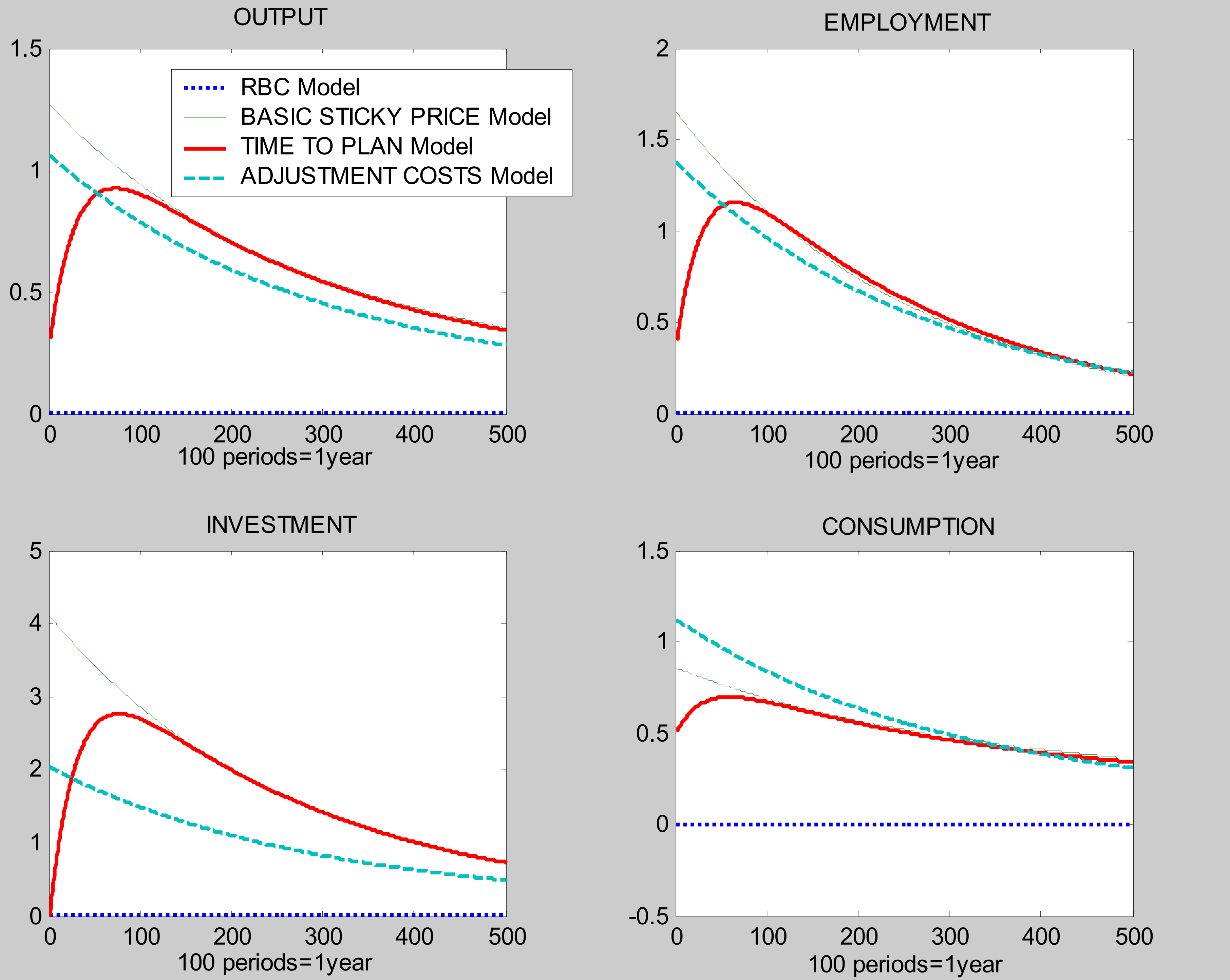
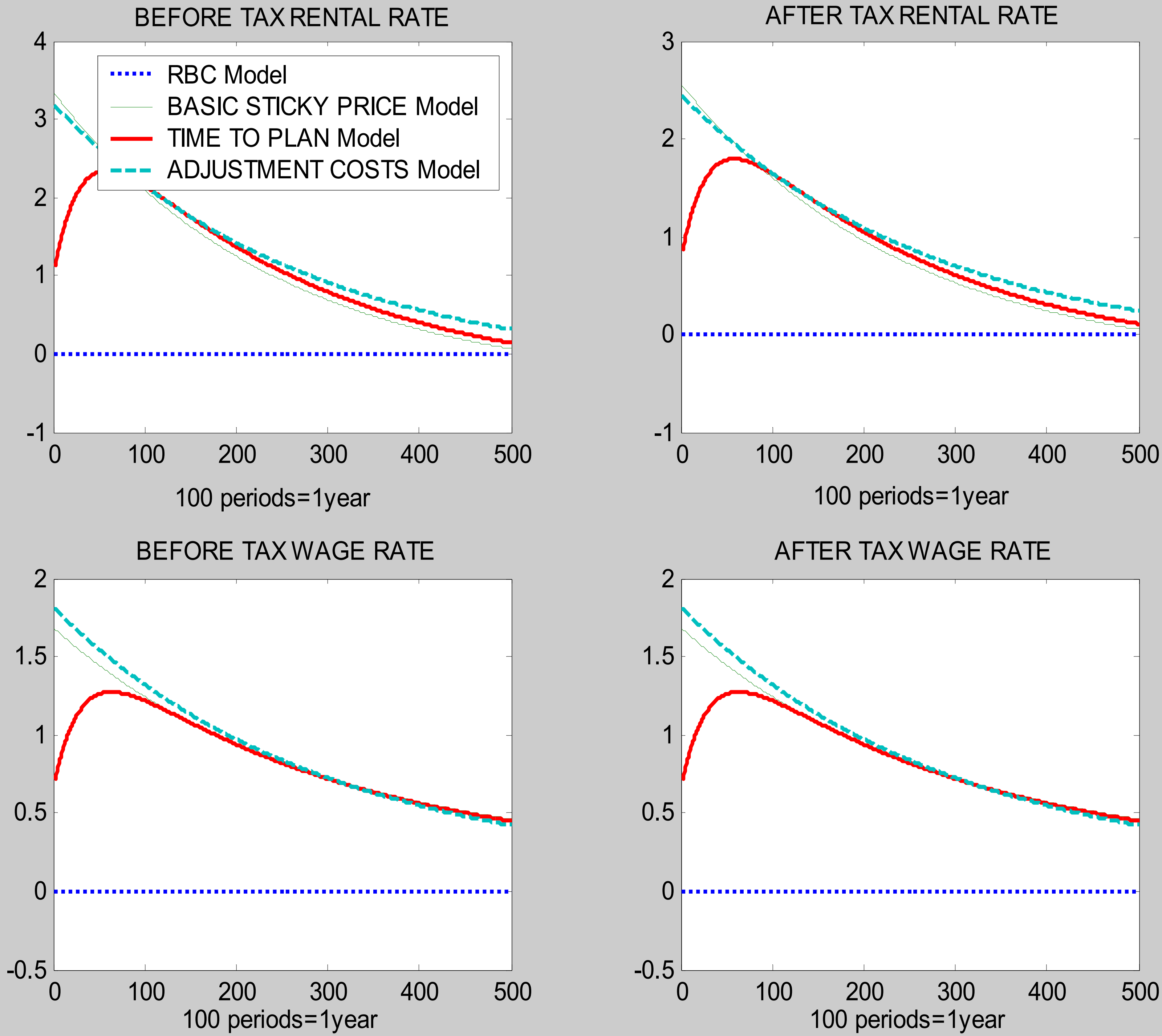


FIGURE 5. POSITIVE PERMANENT MONEY SHOCK (cont'd)



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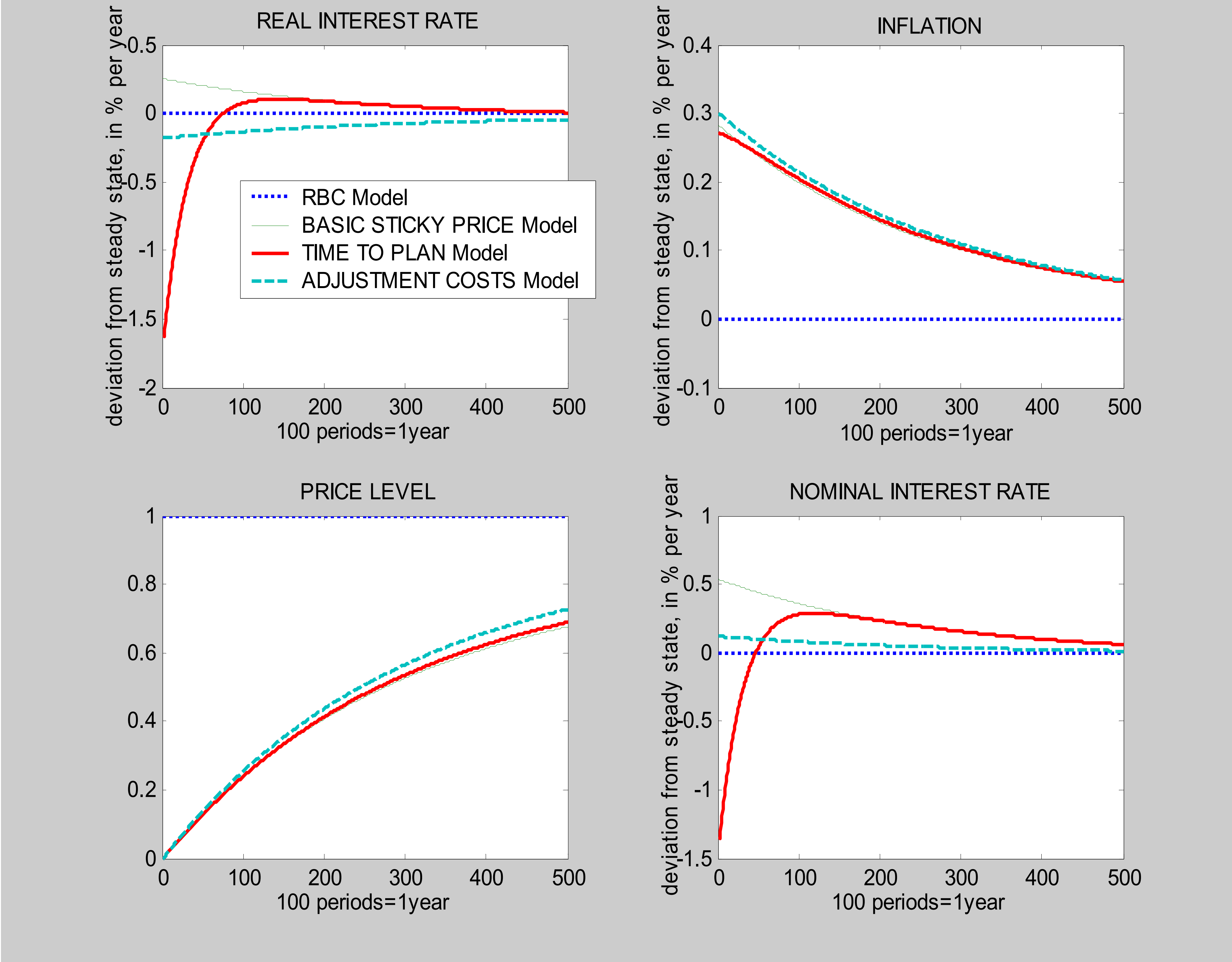
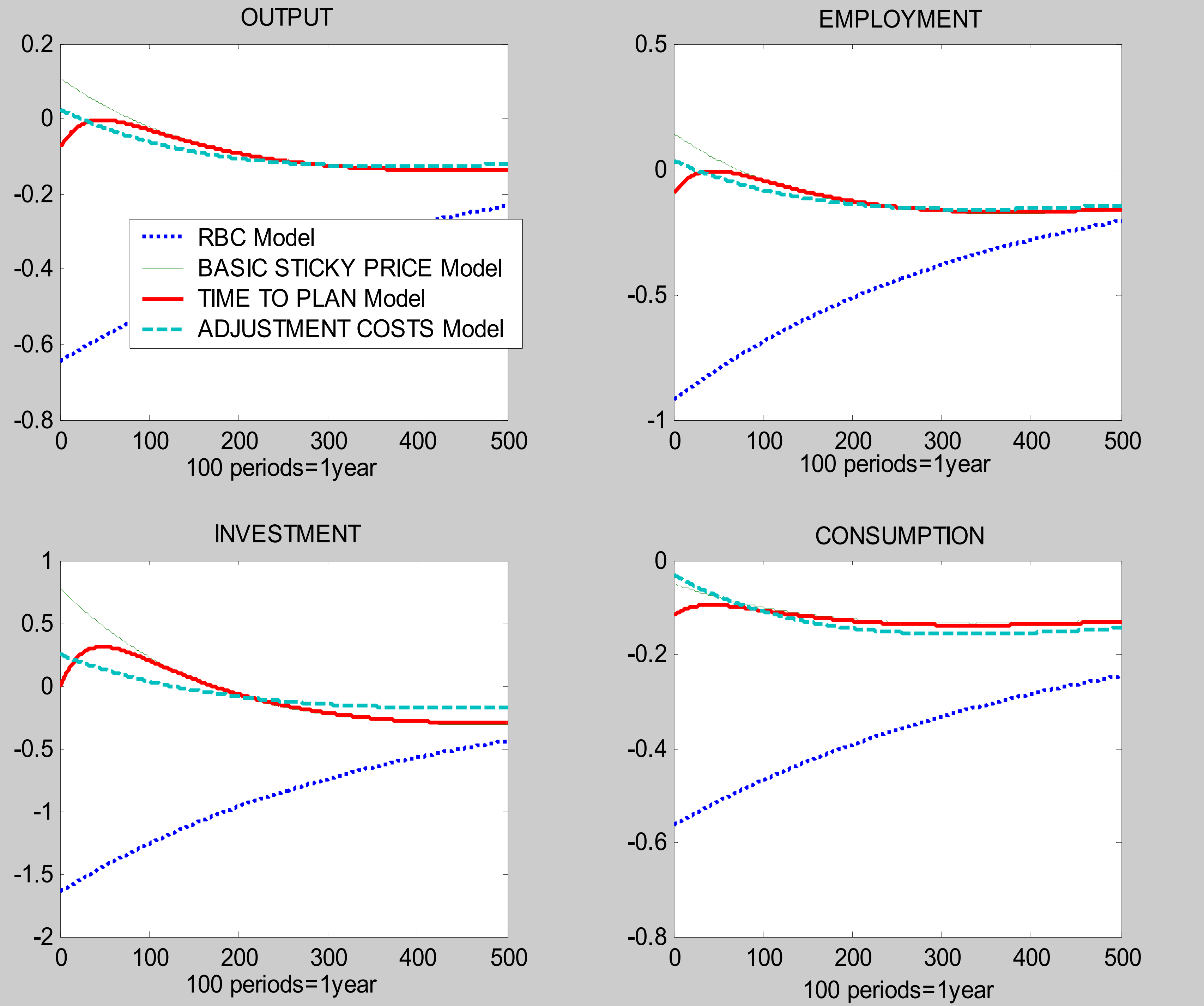


FIGURE 3. AR(1) LABOR TAX INCREASE



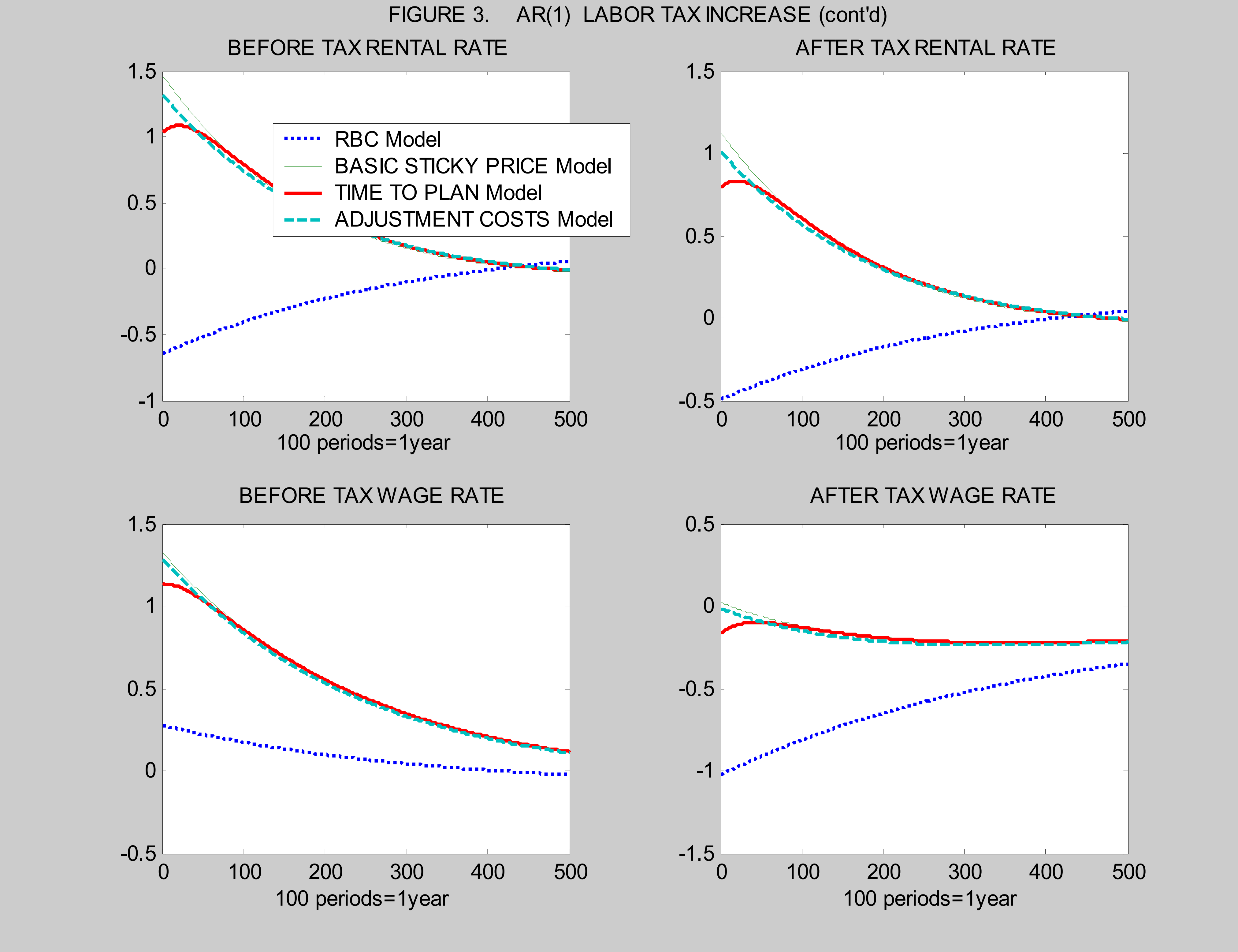
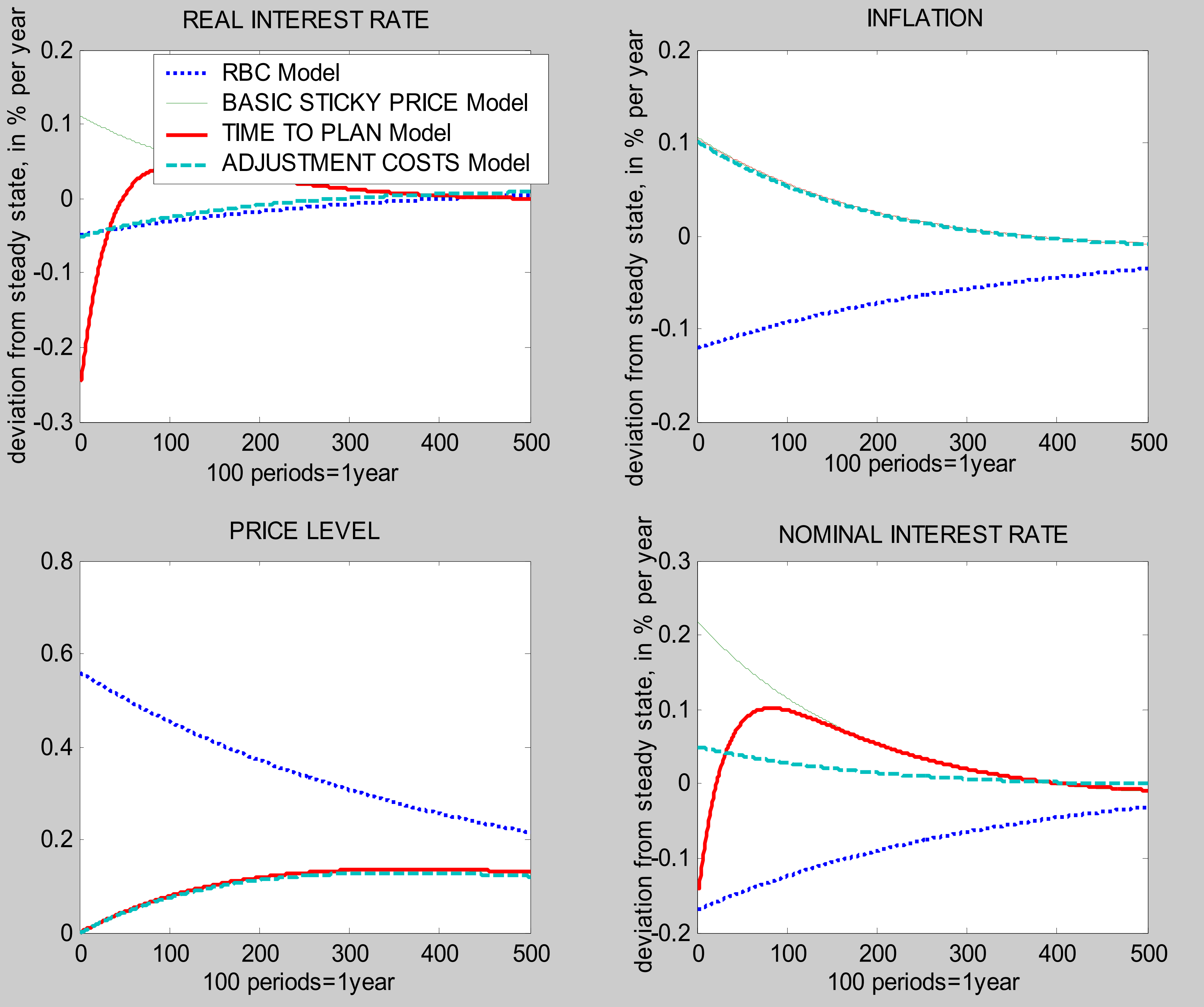


FIGURE 3. AR(1) LABOR TAX INCREASE (cont'd)
BEFORE TAX RENTAL RATE
AFTER TAX RENTAL RATE
BEFORE TAX WAGE RATE
AFTER TAX WAGE RATE
RBC Model
BASIC STICKY PRICE Model
TIME TO PLAN Model
ADJUSTMENT COSTS Model
1.5
1
0.5
0
-0.5
-1
-1.5
0
100
200
300
400
500
100 periods=1year

FIGURE 3. AR(1) LABOR TAX INCREASE (cont'd)



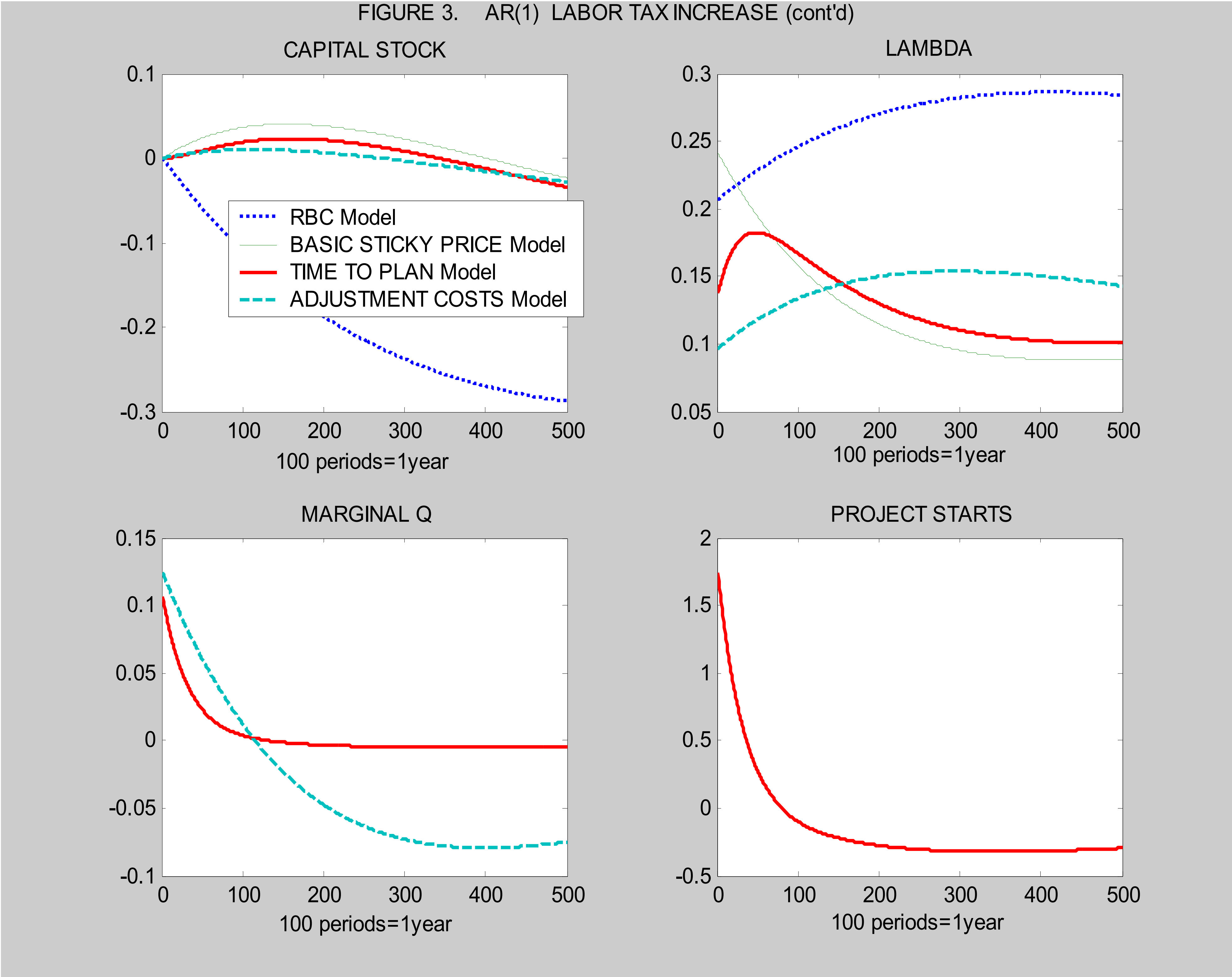


FIGURE 3. AR(1) LABOR TAX INCREASE (cont'd)
CAPITAL STOCK
0.1
0
-0.1
-0.2
-0.3
0 100 200 300 400 500
100 periods=1year
RBC Model
BASIC STICKY PRICE Model
TIME TO PLAN Model
ADJUSTMENT COSTS Model
LAMBDA
0.3
0.25
0.2
0.15
0.1
0.05
0 100 200 300 400 500
100 periods=1year
MARGINAL Q
0.15
0.1
0.05
0
-0.05
-0.1
0 100 200 300 400 500
100 periods=1year
PROJECT STARTS
2
1.5
1
0.5
0
-0.5
0 100 200 300 400 500
100 periods=1year

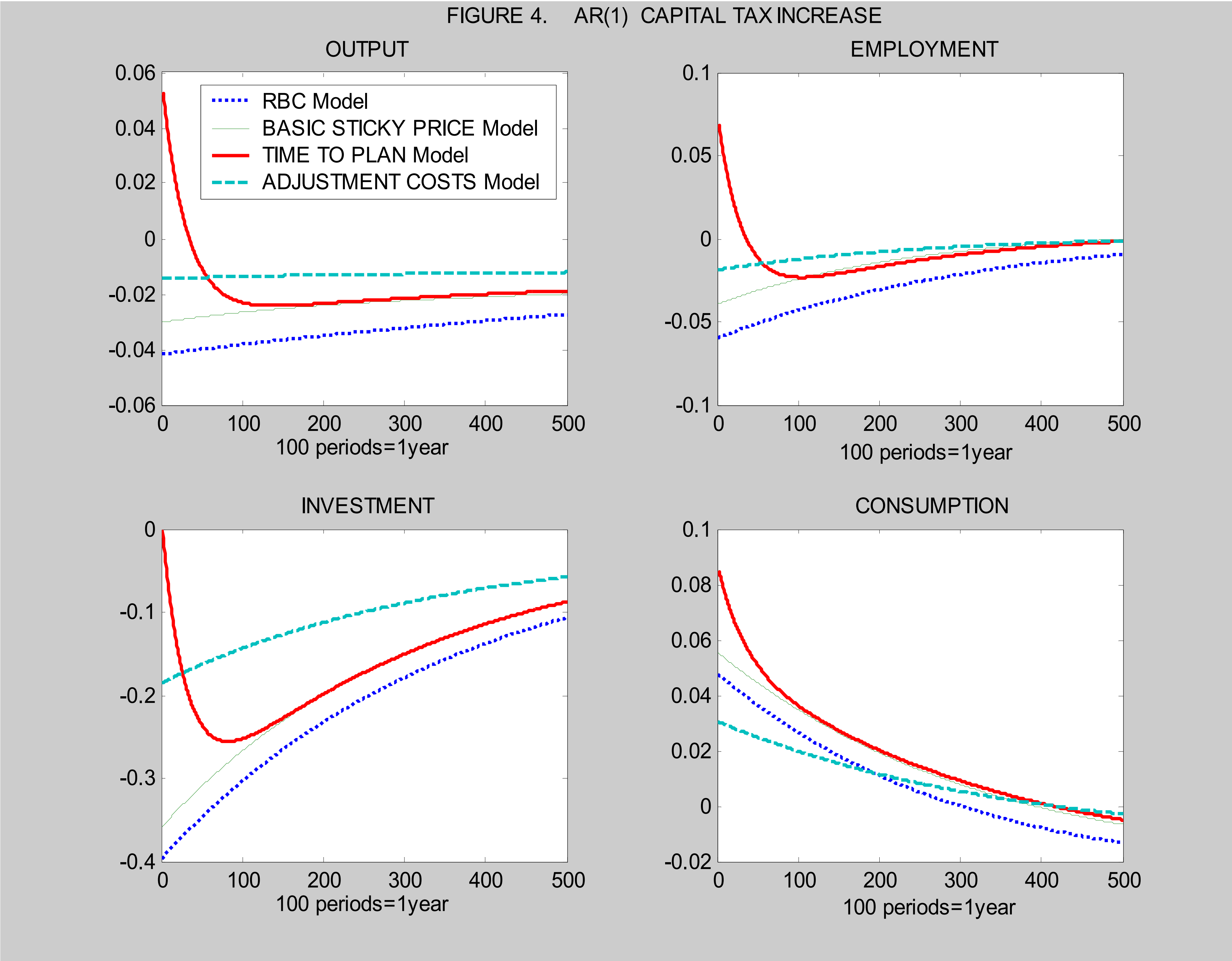


FIGURE 4. AR(1) CAPITAL TAX INCREASE
OUTPUT
EMPLOYMENT
INVESTMENT
CONSUMPTION
RBC Model
BASIC STICKY PRICE Model
TIME TO PLAN Model
ADJUSTMENT COSTS Model
100 periods=1year
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
0.1
0.05
-0.05
-0.1
-0.2
-0.3
-0.4
0.08
0.06
0.04
0.02
0 100 200 300 400 500

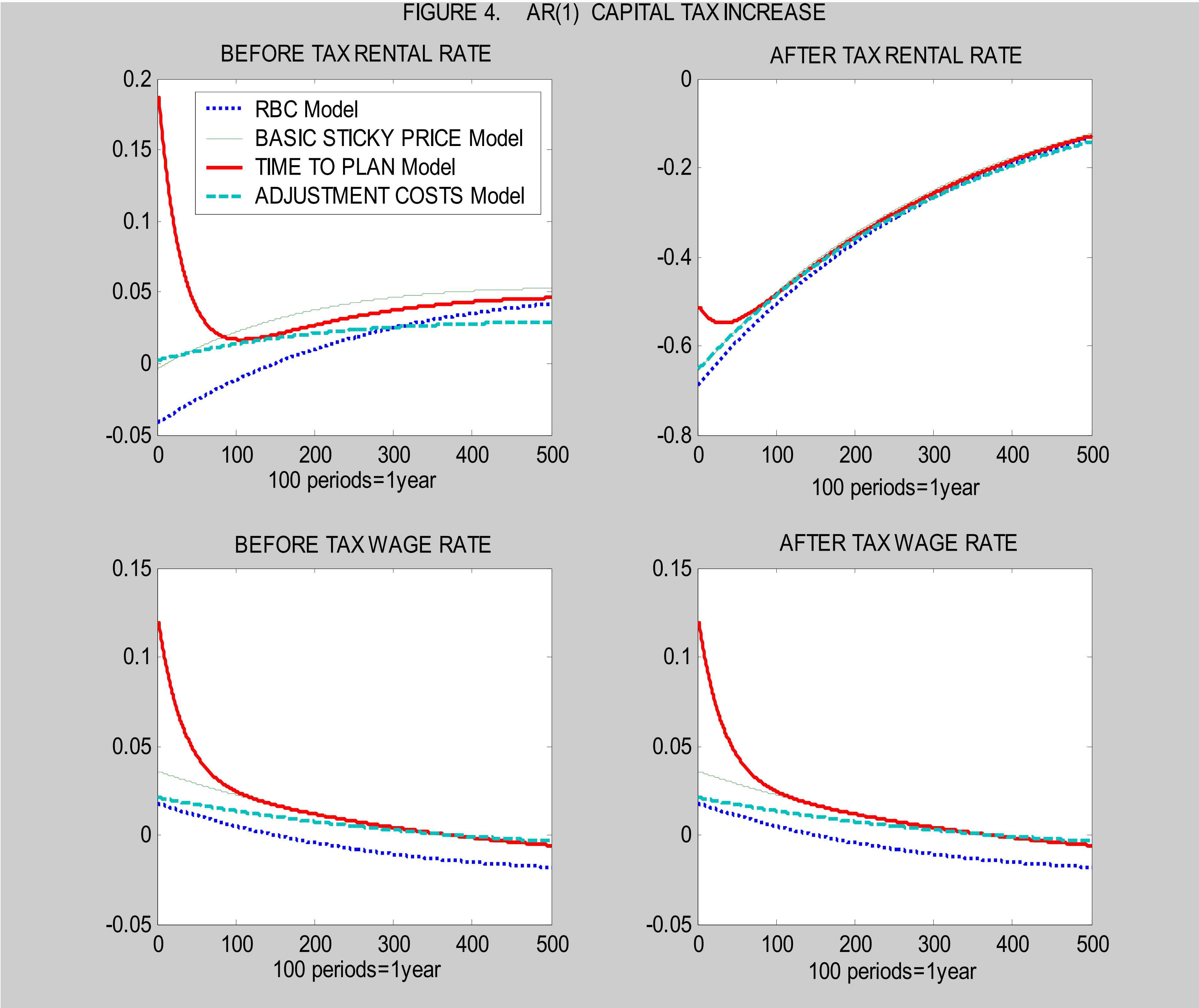
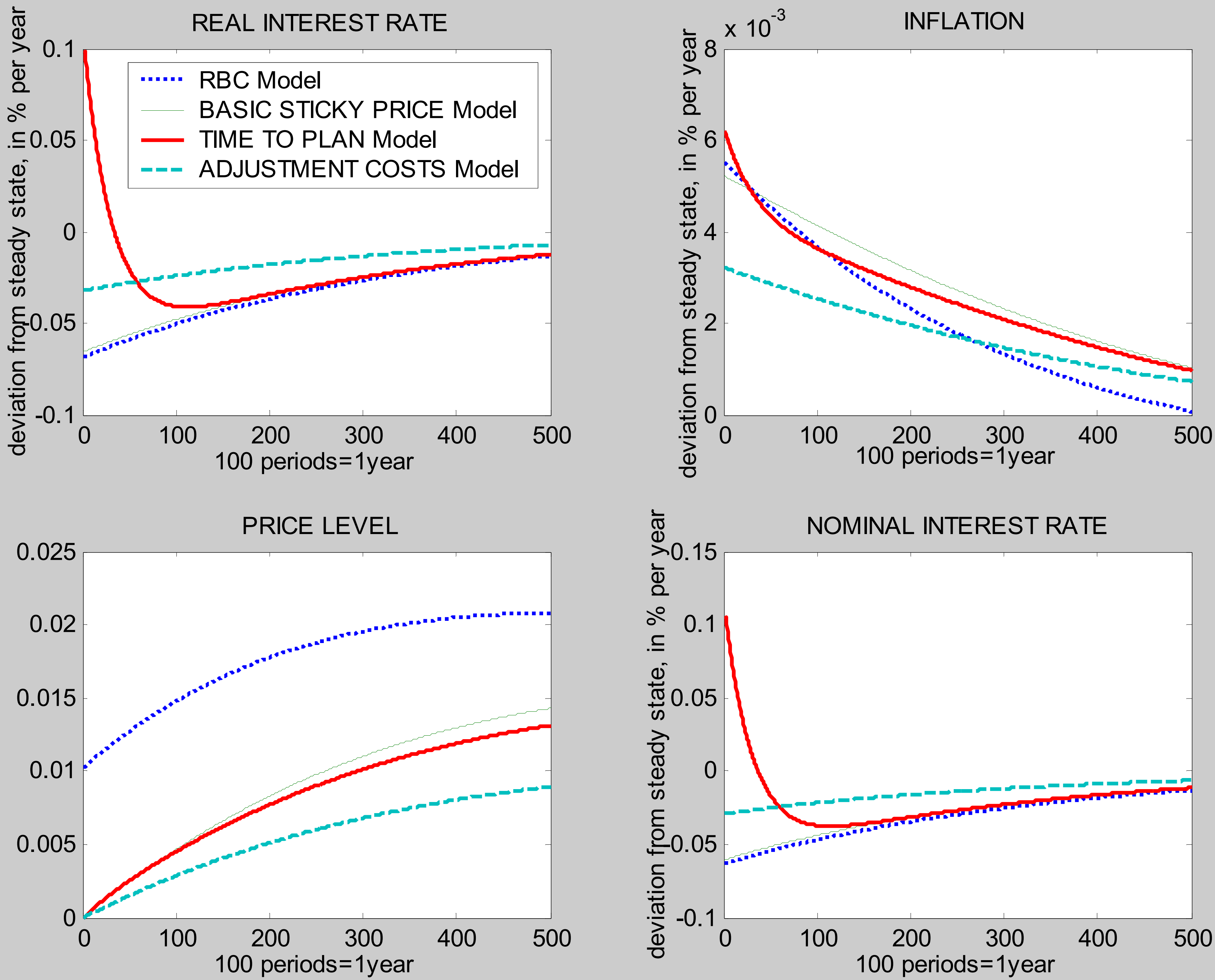


FIGURE 4. AR(1) CAPITAL TAX INCREASE
BEFORE TAX RENTAL RATE
AFTER TAX RENTAL RATE
BEFORE TAX WAGE RATE
AFTER TAX WAGE RATE
RBC Model
BASIC STICKY PRICE Model
TIME TO PLAN Model
ADJUSTMENT COSTS Model
100 periods=1year

FIGURE 4. AR(1) CAPITAL TAX INCREASE (cont'd)



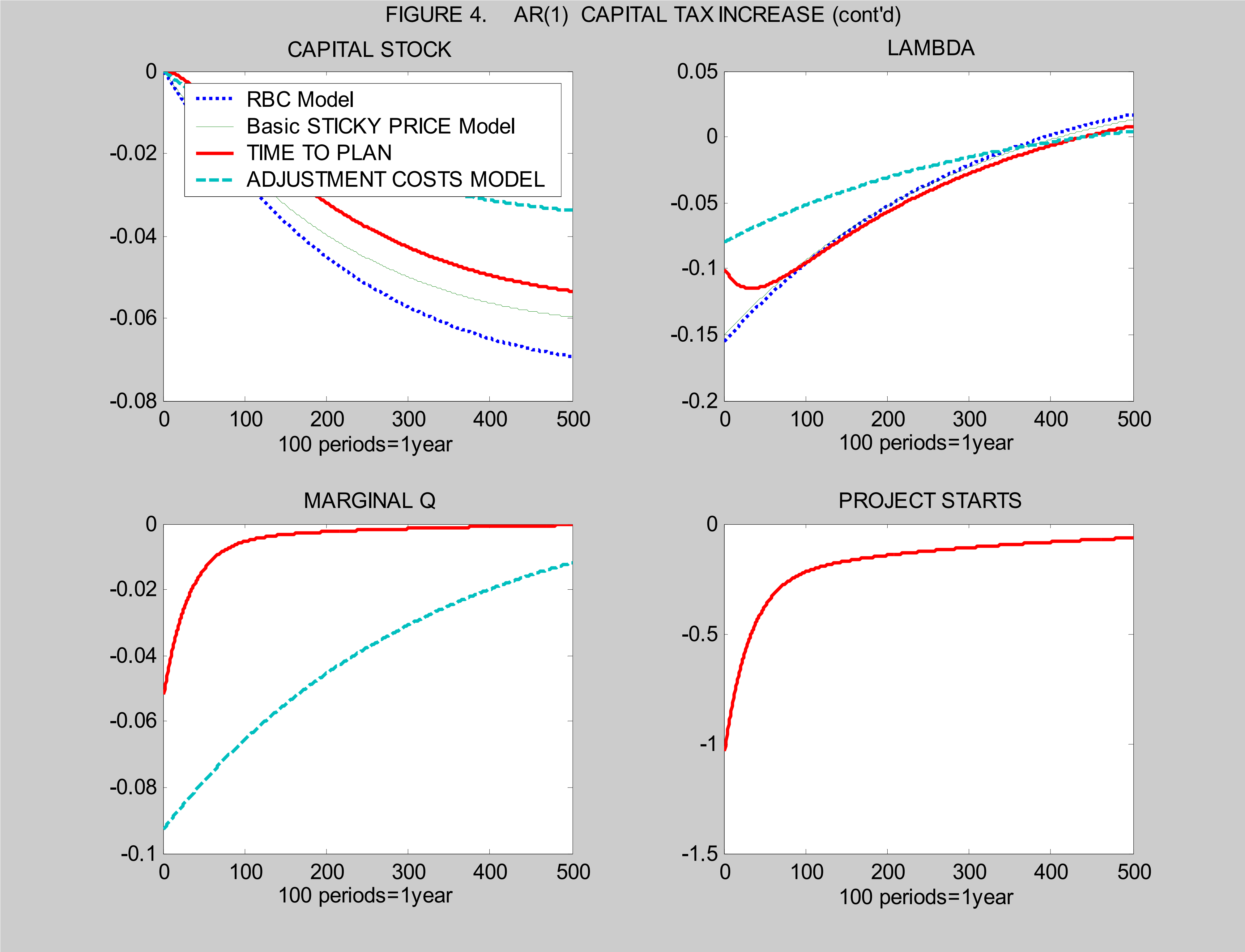


FIGURE 4. AR(1) CAPITAL TAX INCREASE (cont'd)
CAPITAL STOCK
LAMBDA
RBC Model
Basic STICKY PRICE Model
TIME TO PLAN
ADJUSTMENT COSTS MODEL
0
-0.02
-0.04
-0.06
-0.08
0.05
0
-0.05
-0.1
-0.15
-0.2
0
100
200
300
400
500
100 periods=1year
MARGINAL Q
PROJECT STARTS
0
-0.02
-0.04
-0.06
-0.08
-0.1
0
-0.5
-1
-1.5