General-equilibrium Effects of Investment Tax Incentives

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Motivation

Temporary partial expensing allowances have been an important component of stimulus legislation in the past two U.S. recessions:

- The Job Creation and Worker Assistance Act of 2002 included a 30 percent expensing allowance on equipment expenditures made between September 11, 2001 and September 10, 2004.
- The Jobs and Growth Tax Relief Reconciliation Act of 2003 increased the previously enacted allowance to 50 percent and extended it to December 31, 2004.
- The Economic Stimulus Act of 2008 included a 50 percent expensing allowance on equipment expenditures made between January 1, 2008 and December 31, 2008.

What is a partial expensing allowance?

A partial expensing allowance permits a firm to deduct (at the time of acquisition) a fraction of the cost of its newly purchased capital from its taxable income.

- Taking this deduction implies a reduction in the depreciation allowances that the firm can claim in future periods.
- Nonetheless, this lowers the implicit price of investment goods and should therefore stimulate investment spending.

A bonus depreciation allowance is another name for a partial expensing allowance.

An investment tax credit allows a firm to deduct a fraction of the cost of its newly purchased capital from its taxable income.

- Taking this deduction does *not* imply a reduction in the depreciation allowances the firm can claim in future periods.

Motivation, continued

Despite the increased reliance on temporary expensing allowances for countercyclical fiscal policy, no attempt has been made to assess these policies in a new-Keynesian, GE framework.

Previous analyses have considered only:

- The *partial-equilibrium* effects of expensing allowances (Abel, 1982, and Cohen, Hansen, and Hassett, 2002); and,
- The effects of *permanent* changes in expensing allowances (Elmendorf and Reifschneider, 2003).

A notable exception is House and Shapiro (2006), although they:

- Consider a model without any nominal rigidities; and,
- Do not treat expectations explicitly.

Overview of the paper

The paper incorporates a nominal tax system with depreciation allowances and partial expensing into an otherwise-standard new-Keynesian DSGE model.

- The model is used to analyze the effect of a temporary partial expensing allowance on investment and real activity.

The paper then explores two practical policy questions associated with partial expensing allowances. Specifically, it examines:

- A claim by Christiano (1984) that temporary tax incentives on investment can exacerbate business-cycle fluctuations; and,
- The relative effectiveness of two tax-based investment incentives: a temporary partial expensing allowance and a temporary reduction in the capital tax rate.

Preview of results

The new-Keynesian and nominal tax system features of the model boost the size of the economy's response to a temporary partial expensing allowance. These results:

- Contradict the conventional view that partial-equilibrium calculations overstate the effect that expensing allowances have on investment; and,
- Argue for the use of new-Keynesian models in analyzing fiscal stabilization policy.

The policy exercises find that:

- The form of capital/investment adjustment costs assumed in the model determine whether temporary tax incentives exacerbate business-cycle fluctuations; and,
- Consistent with previous research, temporary partial expensing provides a greater stimulus to investment and real activity than a cut in capital taxes.

Model overview

The model is a sticky-price and sticky-wage new-Keynesian DSGE model with endogenous capital accumulation, modified such that:

- Nominal, rather than real, interest income is subject to taxation; and,
- Households can deduct depreciation from taxable income, where these deductions are based on the historic nominal cost of a capital expenditure (not the current-dollar cost).

In its benchmark form the model contains few of the real frictions now common in larger-scale new-Keynesian DSGE models.

- Adding these frictions does not alter our conclusions.

Virtually all of the changes to the model that result from the tax system appear in the household's utility-maximization problem.

Some notation

Variables

$F_t^h =$ Tax rate on personal (that is, labor and asset) income.

$F_t^k =$ Tax rate on capital income.

$T_t\ =$ Lump-sum government transfers.

$X_t =$ Expensing allowance (X_t=0.5 for a 50 percent allowance).

$R_t =$ *Gross pre-tax* nominal interest rate.

$R_t^f = R_t - F_t^h(R_t - 1) =$ *Gross post-tax* nominal interest rate.

$R_t^k =$ Nominal rental rate on capital.

The household's utility maximization problem

$$\max_{\left\{C_t^i, H_t^i, W_t^i, I_t^i, K_{t+1}^i\right\}_{t=0}^{\infty}} E_0 \left\{ \sum_{t=0}^{\infty} \beta^t \left[\frac{1}{1-\sigma} \left(C_t^i\right)^{1-\sigma} - \frac{1}{1+s} \left(H_t^i\right)^{1+s} \right] \right\}$$

subject to

1. $$\begin{aligned} A_{t+1}^i / R_t^f &= A_t^i + R_t^k K_t^i + W_t^i H_t^i + Profits_t^i - P_t C_t^i - P_t I_t^i \\ &- F_t^k \left(R_t^k K_t^i - X_t P_t I_t^i - \sum_{v=1}^{\infty} \delta (1-\delta)^{v-1} \left(1 - X_{t-v}\right) P_{t-v} I_{t-v}^i \right) \\ &- F_t^h \left(W_t H_t^i + Profits_t^i \right) + T_t^i; \end{aligned}$$
2. The demand curve it faces for its differentiated labor; and,
3. The capital evolution process.

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2. The demand curve it faces for its differentiated labor; and,
3. The capital evolution process.

Capital taxation in the budget constraint

Without partial expensing allowances:

$$-F_t^k\left(R_t^k K_t^i - \sum_{v=1}^{\infty}\delta(1-\delta)^{v-1}P_{t-v}I_{t-v}^i\right).$$

With partial expensing allowances:

$$-F_t^k\left(R_t^k K_t^i - X_t P_t I_t^i - \sum_{v=1}^{\infty}\delta(1-\delta)^{v-1}(1-X_{t-v})P_{t-v}I_{t-v}^i\right).$$

Capital taxation in the budget constraint, continued

With depreciation allowances calculated based on historic nominal cost and with partial expensing allowances

$$-F_t^k\left(R_t^k K_t^i - X_t P_t I_t^i - \sum_{v=1}^{\infty}\delta(1-\delta)^{v-1}\left(1-X_{t-v}\right) P_{t-v} I_{t-v}^i\right).$$

This implies that nominal interest rates influence demand.

With depreciation allowances (fictitiously) calculated based on current-dollar cost and with partial expensing allowances:

$$-F_t^k\left(R_t^k K_t^i - X_t P_t I_t^i - \sum_{v=1}^{\infty}\delta(1-\delta)^{v-1}\left(1-X_{t-v}\right) P_t I_{t-v}^i\right).$$

Here, only real interest rates influence demand.

Evolution of the capital stock

We consider the following adjustment-cost specifications, where ξ_t^k is a zero-mean investment efficiency shock.

1. No adjustment costs:

$$K_{t+1}^i = (1-\delta)K_t^i + I_t^i \exp\left[\xi_t^k\right].$$

2. Capital adjustment costs:

$$K_{t+1}^i = (1-\delta)K_t^i + I_t^i \exp\left[\xi_t^k - \frac{\chi^k}{2}\left(\frac{K_{t+1}^i}{K_t^i} - 1\right)^2\right].$$

3. Investment adjustment costs:

$$K_{t+1}^i = (1-\delta)K_t^i + I_t^i \exp\left[\xi_t^k - \frac{\chi^i}{2}\left(\frac{I_{t+1}^i}{I_t^i} - 1\right)^2\right].$$

Model equations

The households' utility-maximization problems yield:

- A consumption Euler equation;
- A wage new-Keynesian Phillips curve (in the sticky-wage version of the model);
- A capital-market equilibrium condition (or capital supply curve); and,
- The capital evolution equation.

Model equations, continued

The firms' cost-minimization and profit-maximization problems yield:

- A labor demand curve;
- A capital demand curve;
- A price new-Keynesian Phillips curve (in the sticky-price version of the model); and,
- The production function.

The monetary authority sets the pre-tax nominal interest rate according to an interest-rate feedback rule with smoothing.

The fiscal authority runs a balanced budget, raising revenues that are rebated to households as lump-sum transfers.

Evolution of fiscal variables

First, assume the fiscal authority sets the tax rates $\{F_t^h, F_t^k\}_{t=0}^{\infty}$ and partial expensing allowances $\{X_t\}_{t=0}^{\infty}$ exogenously.

In our partial expensing simulations we consider both:

- A *permanent* partial expensing allowance—this is like a one-time shock to X_t, where X_t follows a unit-root *AR(1)* process:

$$X_t = X_{t-1} + \xi_t^x.$$

- A *temporary* (n-period) partial expensing allowance—this is like an innovation to an *MA(n-1)* process for X_t:

$$X_t = \xi_t^x + \xi_{t-1}^x + \cdots + \xi_{t-n+1}^x.$$

Calibrated values of structural parameters

Param.	Description	Value
α	Elasticity of output with respect to capital	0.30
σ^{-1}	Intertemporal elasticity of substitution	0.20
θ, ψ	Elast. of substitution of intermediates, labor	11
δ	Depreciation rate (quarterly rate)	0.034
β	Household discount factor (quarterly rate)	0.99
χ^k	Param. in capital adj. cost function	170
χ^i	Param. in investment adj. cost function	4.2
s	Inverse labor supply elasticity	2.75
F_*^h	Steady-state income tax rate	0.30
F_*^k	Steady-state capital tax rate	0.48

The partial-equilibrium and fully-real models

We begin by considering a partial expensing allowance in these models, and then move on to consider sticky-price/wage models.

The partial-equilibrium model consists of only:

- The capital market equilibrium condition (or capital supply curve);
- The capital demand curve;
- The capital evolution equation; and,
- The exogenous evolution of the expensing allowances X_t.

The fully-real model omits (relative to the sticky-price/wage model):

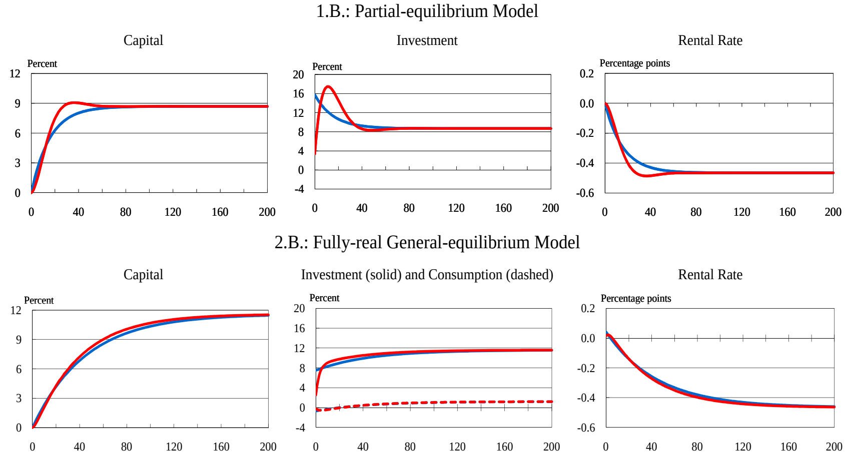
- The price and the wage new-Keynesian Phillips curves; and,
- The monetary authority's interest rate feedback rule.

The key equations of the partial-equilibrium model

$$
\begin{aligned}
E_t r^k_{t+1} &= \left[\frac{1}{1-\beta(1-\delta)}\right]\left(r^f_t - E_t\pi_{t+1}\right) \\
&\quad + \left[\frac{1}{1-\beta(1-\delta)}\cdot\frac{\delta F^k_*}{1-\beta(1-\delta)-\delta F^k_*}\right] r^f_t \\
&\quad - \left[\frac{1}{1-\beta(1-\delta)}\cdot\frac{(1-\delta)F^k_*}{1-\beta(1-\delta)-\delta F^k_*}\right]\left(X_t - \beta(1-\delta)E_t X_{t+1}\right) \\
k_t &= ((\theta-1)/\theta)\,y_t - \left(r^k_t - mc_t\right) \\
i_t &= (1/\delta)k_{t+1} - ((1-\delta)/\delta)k_t
\end{aligned}
$$

- Only the variables in red vary in the partial-equilibrium model.
- The expressions above abstract from adjustment costs and other sources of shocks.
- Consider first a permanent 50 percent expensing allowance.

Effects of a permanent 50 percent expensing allowance



Note: Blue lines denote capital adjustment costs; red lines denote investment adjustment costs

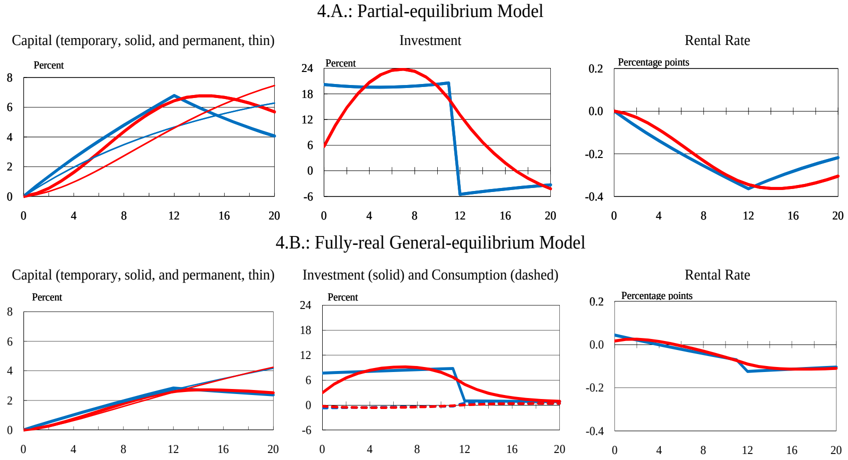
A temporary 50 percent expensing allowance

- In the absence of adjustment costs and general-equilibrium effects, there is a *massive* drop in user cost in the (fully anticipated) final period of the expensing allowance.

$$
\begin{aligned}
E_t r^k_{t+1} = & \left[\frac{1}{1-\beta(1-\delta)}\right]\left(r^f_t - E_t \pi_{t+1}\right) \\
& + \left[\frac{1}{1-\beta(1-\delta)} \cdot \frac{\delta F^k_*}{1-\beta(1-\delta)-\delta F^k_*}\right] r^f_t \\
& - \left[\frac{1}{1-\beta(1-\delta)} \cdot \frac{(1-\delta) F^k_*}{1-\beta(1-\delta)-\delta F^k_*}\right](X_t - \beta(1-\delta) E_t X_{t+1})
\end{aligned}
$$

- This leads to an equally massive peak in capital that period, and a sharp spike (and subsequent plunge) in investment.
- Adjustment costs and the response of interest rates in general equilibrium smooth through or limit this effect.

Effects of a temporary 50 percent expensing allowance



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Key partial-equilibrium and fully-real model results

- The responses of the capital stock and investment spending in the partial-equilibrium model are more than twice as large as in the fully-real general-equilibrium model.
  - The partial-equilibrium responses reflect pull-forward.
  - The pull-forward is completely attenuated in the fully-real general-equilibrium model due to offsetting effects of interest rates.
- In the partial-equilibrium model there is an investment "pothole" following the expiration of the expensing allowance.
  - In the fully-real model investment falls sharply following the expiration of the allowance but remains above steady state.

Motivation for using a new-Keynesian model

1. The partial expensing provisions implemented in the last two recessions were macroeconomic stabilization policies.

   - It seems appropriate to study their effects in a model where activity (in the short run) is demand determined.

2. A temporary partial expensing allowance in a flexible-price model represents a policy-induced stimulus to the supply of capital; in a new-Keynesian model it is a stimulus to investment demand.

3. A model with nominal rigidities is needed to capture the effects of inflation and nominal interest rates on the user cost.

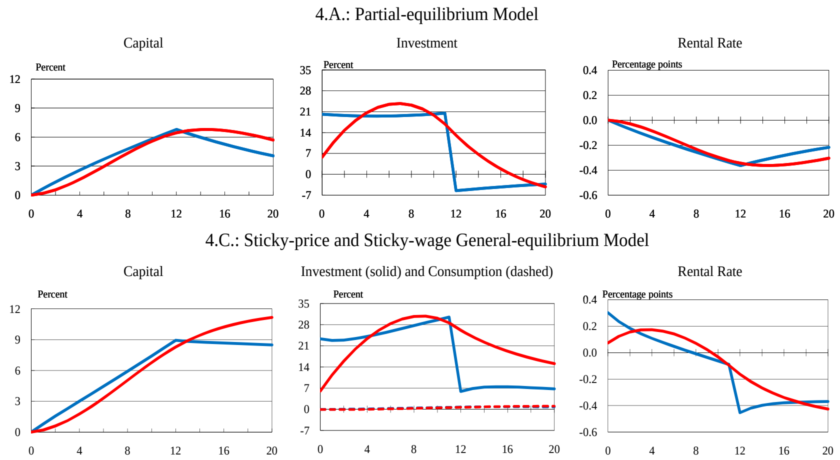
4. New-Keynesian models are the workhorse model of monetary policy analysis.

   - It is useful to know whether these models can yield sensible predictions when used to address other policy questions.

Calibrated values of structural parameters, continued

Parameter	Description	Value
$(1-\eta)$	Probability firm can reset price	0.25
$(1-\gamma)$	Probability firm can reset wage	0.25
$\bar{\Pi}$	Inflation target	1.00
ϕ_π	Taylor-rule inflation coefficient	1.80
ϕ_y	Taylor-rule output-gap coefficient	0.27/4
ρ	Taylor-rule smoothing coefficient	0.79

Effects of a temporary 50 percent expensing allowance



Note: Blue lines denote capital adjustment costs; red lines denote investment adjustment costs

Explaining the size of the new-Keynesian model results (1)

It is not that surprising that the responses from the new-Keynesian model exceed those of the fully-real model.

- Naively, the fully-real model is consistent with a vertical AS curve and the new-Keynesian model flattens the AS curve.
- Alternatively, because Tobin's q is given by:

$$\text{Tobin's } q_t = \frac{Q_t}{P_t} = \sum_{v=1}^{\infty} \frac{\beta^v \Lambda_{t+v}}{\Lambda_t} \cdot \frac{R^k_{t+v}}{P_{t+v}},$$

  more sluggish price adjustment leads to larger increases in Tobin's q and a larger response of investment spending.
- In addition, the real interest rate evolves very differently in the new-Keynesian model than in the fully-real model.

Explaining the size of the new-Keynesian model results (2)

It is more surprising that the responses from the new-Keynesian model exceed those of the partial-equilibrium model.

- The partial-equilibrium model, in which all demand is met, can be thought of as consistent with a horizontal AS curve.
- Thus, it seems surprising that the model delivers responses even larger than that of the partial-equilibrium model.

The unindexed nature of the tax system yields this outcome. If the tax system is (fictitiously) indexed to inflation:

- Responses from the new-Keynesian model no longer exceed those of the partial-equilibrium model; and,
- Even very extreme nominal-rigidity assumptions will not deliver responses larger than in partial equilibrium.

Household budget constraint (unindexed and indexed)

Unindexed:

$$A^i_{t+1}/R^f_t = A^i_t + R^k_t K^i_t + W^i_t H^i_t + Profits^i_t - P_t C^i_t - P_t I^i_t$$
$$- F^k_t \left(R^k_t K^i_t - X_t P_t I^i_t - \sum_{v=1}^{\infty} \delta(1-\delta)^{v-1} (1 - X_{t-v}) P_{t-v} I^i_{t-v} \right)$$
$$- F^h_t (W_t H^i_t + Profits^i_t) + T^i_t;$$

Indexed:

$$A^i_{t+1}/R^f_t = A^i_t + R^k_t K^i_t + W^i_t H^i_t + Profits^i_t - P_t C^i_t - P_t I^i_t$$
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$$- F^h_t (W_t H^i_t + Profits^i_t) + T^i_t;$$

Capital equilibrium condition (unindexed and indexed)

Unindexed:

$$E_t r_{t+1}^k = \left[\frac{1}{1-\beta(1-\delta)}\right]\left(r_t^f - E_t\pi_{t+1}\right)$$
$$+\left[\frac{1}{1-\beta(1-\delta)}\cdot\frac{\delta F_*^k}{1-\beta(1-\delta)-\delta F_*^k}\right]r_t^f$$
$$-\left[\frac{1}{1-\beta(1-\delta)}\cdot\frac{(1-\delta)F_*^k}{1-\beta(1-\delta)-\delta F_*^k}\right](X_t-\beta(1-\delta)E_tX_{t+1})$$

Indexed:

$$E_t r_{t+1}^k = \left[\frac{1}{1-\beta(1-\delta)}\right]\left(r_t^f - E_t\pi_{t+1}\right)$$
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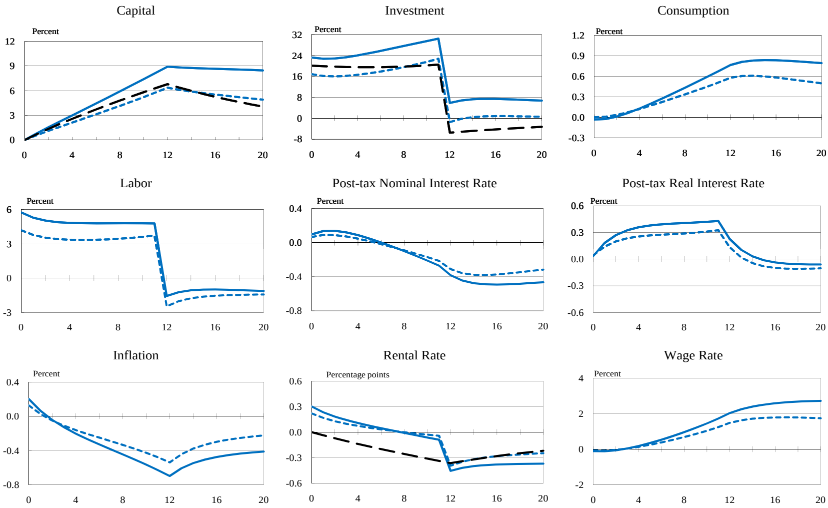
Responses with and without an indexed tax system



Unindexed (blue solid) and indexed (blue dotted) tax system. Partial equilibrium (black dashed) model.

▸ Responses with Investment Adjustment Costs

Summary of results

The new-Keynesian and nominal-tax features of the model increase the size of the response to an expensing allowance. These results:

- Contradict the view that partial-equilibrium calculations overstate the effects of expensing allowances on investment.
- Argue for the relevance of new-Keynesian models in analyzing such fiscal stabilization policies.

The results hold when additional frictions are added, including:

- Habit-persistence in consumption;
- More inertial price- and wage-setting ("hybrid" NKPCs); and,
- "Putty-clay" capital adjustment costs.

Multisector production with limited factor mobility is a more important type of friction, however. Jump to "Concluding remarks"

First policy issue

Christiano (1984) has claimed that if temporary tax incentives on investment come to be anticipated when investment weakens, this can magnify the effects of adverse investment shocks.

- Temporary investment tax incentives are usually implemented with a lag.
- If agents expect these incentives to be enacted shortly they will postpone investment and further weaken activity.
- As the last two recessions have seen the implementation of temporary expensing allowances, this is a realistic concern.

Ignoring (temporarily) the reason for the weaker investment, consider the effect of an anticipated partial expensing allowance.

An anticipated partial expensing allowance

Consider a temporary partial expensing allowance, anticipated to be implemented in four quarters' time for 12 quarters.

- For the unanticipated expensing allowance the shock is:

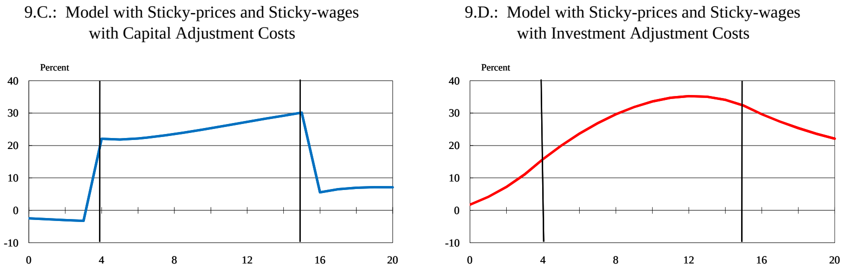
$$X_t = \xi^x_t + \xi^x_{t-1} + \cdots + \xi^x_{t-11}.$$

- For the expensing allowance, anticipated in four quarters' time, the shock is:

$$E_t X_{t+4} = \xi^x_t + \xi^x_{t-1} + \cdots + \xi^x_{t-11}, \text{ with } X_t = L^4(E_t X_{t+4}).$$

- Recall that ξ^x_t is a policy shock.

Investment response to anticipated expensing allowance



- There is an incentive to postpone investment in anticipation of the expensing allowance.
- However, there is also a competing incentive to minimize large swings in the capital stock or investment.
- Which of the effects dominates determines whether investment drops or increases in anticipation of an expensing allowance.

Suppose partial expensing is triggered by macro conditions

Suppose the partial expensing allowance is triggered by a macroeconomic event (shock), rather than a policy shock.

- For example, suppose the investment efficiency shock, ξ_t^k, in the (no-adjustment-cost) capital evolution equation,

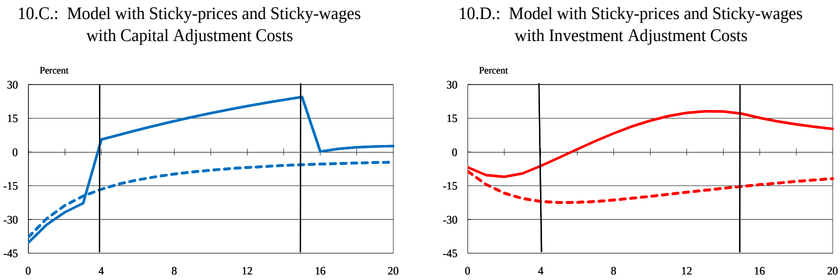
$$K_{t+1}^i = (1-\delta)K_t^i + I_t^i \exp\left[\xi_t^k\right],$$

  also activates an expensing allowance in the following way:

$$E_t X_{t+4} = \mu\left(\xi_t^k + \xi_{t-1}^k + \cdots + \xi_{t-11}^k\right).$$

- The calibration of the expensing equation reflects:
  - The effect of ξ_t^k on investment in the model;
  - The decline in investment in the 2001 recession; and,
  - The actual expensing allowance that this decline triggered.

Investment response to efficiency shock



Response to investment efficiency shock with (solid) and without (dotted) an expensing allowance response.

- Whether anticipated expensing allowances exacerbate the decline in investment depends on adjustment-cost assumptions.

Jump to "Concluding remarks"

Second policy issue

We can also consider tax changes that represent alternatives to an expensing allowance, such as a change in the capital tax rate, F^k.

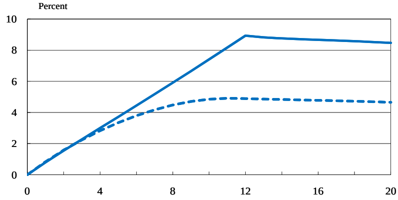
The capital supply curve with variable capital tax rates is:

$$
\begin{aligned}
E_t r_{t+1}^k = & \left[\frac{F_*^k}{1-F_*^k}\right] E_t f_{t+1}^k + \left[\frac{1}{1-\beta(1-\delta)}\right]\left(r_t^f - E_t \pi_{t+1}\right) \\
& + \left[\frac{1}{1-\beta(1-\delta)} \cdot \frac{\delta F_*^k}{1-\beta(1-\delta)-\delta F_*^k}\right]\left(r_t^f - (1-\beta(1-\delta)) E_t f_{t+1}^k\right) \\
& - \left[\frac{1}{1-\beta(1-\delta)} \cdot \frac{(1-\delta) F_*^k}{1-\beta(1-\delta)-\delta F_*^k}\right]\left(X_t - \beta(1-\delta) E_t X_{t+1}\right).
\end{aligned}
$$

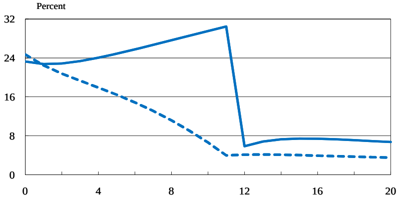
We consider a 12-quarter reduction in the capital tax rate that over a five-year horizon implies the same change in tax revenues as a 50 percent expensing allowance.

Effects of two equi-revenue investment-stimulus policies

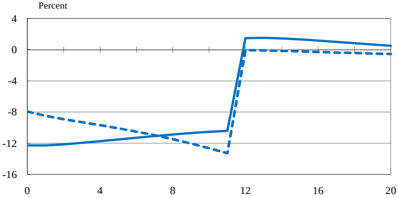
14.A.: Capital



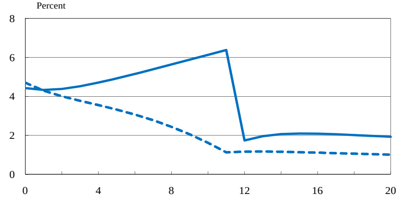
14.B.: Investment



14.C.: Tax Revenue



14.D.: Output



Solid line: 50 percent partial expensing allowance

Dotted line: 32.4 percentage point cut in the capital tax rate

Responses with Investment Adjustment Costs

Partial expensing delivers more bang-for-the-buck

If the policy objective is to boost investment demand, a partial expensing allowance delivers more "bang-for-the-buck."

- A partial expensing allowance is more targeted to boosting investment spending since it applies only to new investment.
- A cut in capital taxes, in contrast, applies to both existing and newly installed capital.
- This confirms results found in partial-equilibrium settings.

Concluding remarks

The model developed in this paper suggests that:

- Partial-equilibrium calculations do not necessarily overstate the effect that expensing allowances have on investment.

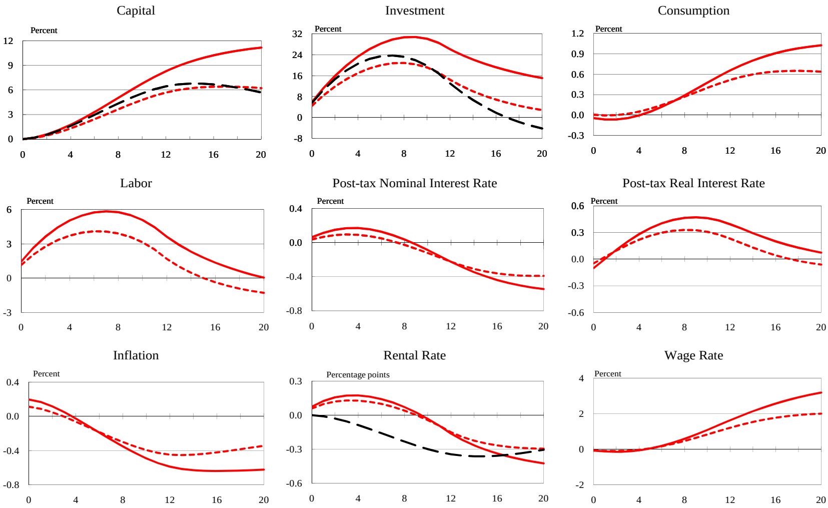
The policy exercises find that:

- Whether temporary tax incentives exacerbate business-cycle fluctuations depends on the form of adjustment costs; and,
- Expensing allowances provide more stimulus to investment and real activity than a capital tax-rate cut.

Why did partial expensing in 2002-04 have so small an effect?

- The answer likely lies outside the scope of the model.
- One explanation is that few state tax codes conformed to federal tax code changes and complying with different provisions is costly (Knittel, 2005).

Responses with and without an indexed tax system

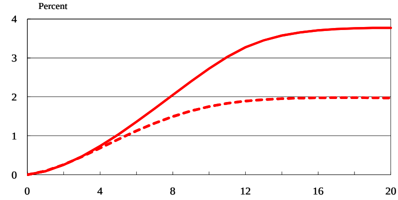


Unindexed (red solid) and indexed (red dotted) tax system. Partial equilibrium (black dashed) model.

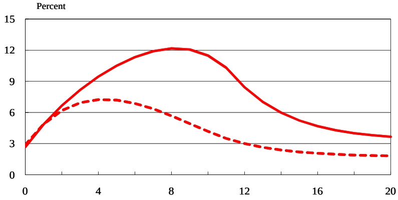
▸ Responses with Capital Adjustment Costs

Effects of two equi-revenue investment-stimulus policies

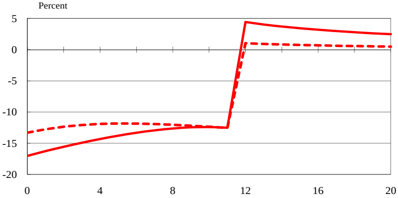
15.A.: Capital



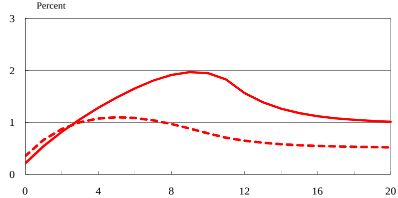
15.B.: Investment



15.C.: Tax Revenue



15.D.: Output



Solid line: 50 percent partial expensing allowance

Dotted line: 33.5 percentage point cut in the capital tax rate

Responses with Capital Adjustment Costs