Costly Capital Reallocation

and the Effects of Government Spending

by

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and

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OVERVIEW

Sectoral composition of demand is a key to understanding effects of government spending

Most changes in government spending are sector specific

- C Military purchases concentrated in aerospace, ordnance, and instruments
- C Highway program concentrated in construction
- C Medicare and Medicaid transfers effect demand for health care

Capital and labor are not perfectly mobile across sectors

Costly mobility gives the leverage for specificity of demand to have interesting effects

Outline of paper

Evidence on specificity of government demand

Two-sector model with costly capital mobility

Estimated response of key aggregates to military buildups

Key Features of Theoretical Model

Technology

2-sector dynamic general equilibrium model

2 types of production technologies considered:

- Standard Cobb-Douglas
- Leontief with a variable workweek of capital

Sectoral Specificity

Capital must be produced within the sector that it is used

There is both a time cost (1 year) and a resource cost (25 - 50% decline in productive value of capital) of shifting capital across sectors

Preferences

Log utility of consumption of good 1, good 2, and leisure

Additional disutility of working extra shifts or overtime hours (in Leontief model).

Response to an Increase in Government Purchases

<table>
<tr><th></th><th colspan="4">Model</th></tr>
<tr><th>Variable</th><th colspan="2">Keynesian</th><th>Single-Sector Neoclassical</th><th>Two-Sector Neoclassical</th></tr>
<tr><td>Output</td><td colspan="2">8</td><td>8</td><td>8</td></tr>
<tr><td>Private output</td><td colspan="2">8</td><td>8</td><td>8</td></tr>
<tr><td>Labor</td><td colspan="2">8</td><td>8</td><td>8</td></tr>
<tr><td>Consumption</td><td colspan="2">8</td><td>9</td><td>9damped
[Capital stuck in consumer sector.]</td></tr>
<tr><td>Real interest rate</td><td>8</td><td>?</td><td>8</td><td>9then8</td></tr>
<tr><td>Real wage</td><td>9
Standard</td><td>8
Increasing returns</td><td>9</td><td>Product wage up in contracting sector, down in expanding sector; Consumption wage ambiguous.</td></tr>
<tr><td>Output per hour</td><td>9</td><td>8</td><td>9</td><td>Up in contracting sector, down in expanding sector; Down overall (except with Leontief technology).</td></tr>
</table>

Key Features of Theoretical Model

Technology

- 2-sector dynamic general equilibrium model

- 2 types of production technologies considered:

  (i) Standard Cobb-Douglas

  (ii) Leontief with a variable workweek of capital

Sectoral Specificity

- Capital must be produced within the sector that it is used

- There is both a time cost (1 year) and a resource cost (25 - 50% decline in productive value of capital) of shifting capital across sectors

Preferences

- Log utility of consumption of good 1, good 2, and leisure

- Additional disutility of working extra shifts or overtime hours (in second model)

Cobb-Douglas Model

Technology

$$Y_{it} = AL_{it}^{\alpha} K'^{1-\alpha}_{it}, \quad i = 1,2.$$

where

Y_{it} = flow of output in sector i during period t.
L_{it} = total hours of employment in sector i during period t.
K'_{it} = stock of available capital in sector i during period t.

α is a parameter that lies between 0 and 1, A is a positive parameter.

Capital Accumulation

$$K_{it+1} = (1-\delta)K_{it} + I_{it} - R_{it}, \; i = 1,2$$
$$K'_{it} = K_{it} - R_{it}, \; i = 1,2$$
$$I_{1t} = X_{1t} + (1-\gamma)R_{2t}$$
$$I_{2t} = X_{2t} + (1-\gamma)R_{1t}$$

K_{it} = stock of capital in sector i at the beginning of period t, $K_{it} \geq 0 \ \forall t$.
I_{it} = purchases of new and used capital goods by sector i, $I_{it} \geq 0 \ \forall t$.
R_{it} = sales of capital by sector i, $R_{it} \geq 0, \ \forall t$.
X_{it} = production of new capital goods by sector i, $X_{it} \geq 0, \ \forall t$.

δ = geometric rate of depreciation
γ is a parameter such that $0 \leq \gamma \leq 1$.

Preferences

$$V = E_0 \sum_{t=0}^{\infty} (1+\rho)^{-t} \{\log(C_{1t}) + \theta \log(C_{2t}) + \phi \log(T - L_{1t} - L_{2t})\}$$

where

C_{it} = consumption of good i in period t

T = total time available

L_{it} = total hours supplied to sector i

E_0 = expectations based on information in period 0

ρ, θ, and ϕ are positive parameters, $0 < \rho < 1$

Resource Constraints

$$Y_{1t} = C_{1t} + X_{1t} + G_{1t}$$

$$Y_{2t} = C_{2t} + X_{2t} + G_{2t}$$

Leontief Model

Technology

Y_{it} = flow of output in sector i during period t.
N_{it} = number of workers employed at any instant in sector i during period t
K'_{it} = stock of capital available in sector i at any instant during period t
S_{it} = number of overtime hours or extra shifts hours that capital is in use in
sector i during period t, $S_{it} \geq 0$
D_{it} = number of hours of short-weeks or shutdowns of capital in sector i,
$D_{it} \geq 0$.
α's are parameters

Preferences

$$V = E_0 \sum_{t=0}^{\infty} (1+\rho)^{-t} \{\log(C_{1t}) + \theta \log(C_{2t}) + \phi \log(T - L_{1t} - L_{2t}) - \sigma[N_{1t} S_{1t}^2 + N_{2t} S_{2t}^2]\}$$

where $L_{it} = (1 + S_{it} - D_{it}) \cdot N_{it}$

L_{it} = total hours supplied to sector i
N_{it} = number of workers supplied at any instant to sector i
S_{it} = extra shifts or overtime hours in sector i
D_{it} = number of hours of shutdowns in sector i
ρ, θ, ϕ, and σ are positive parameters, $0 < \rho < 1$

Calibration of Shift and Overtime Premia and Hours

Empirical Evidence

Overtime Premium: Statutory = 50 %;
Trejo finds actual < 50%

Shift Premium: Nominal = 5 to 10 %; Shapiro finds 25 %

Shift hours: On average manufacturing workers spend ¼ of hours working nights

Calibration

Expression for shift premium derived from consumer's first-order conditions, where labor income is given by:

$$\text{Income} = W_{b1t}\,(1 + \lambda_{1t}S_{1t} - D_{1t})\,N_{1t} + W_{b2t}\,(1 + \lambda_{2t}\,S_{2t} - D_{2t})\,N_{2t}$$

W_{bit} = straight-time wage in sector i

λ_{it} = shift premium in sector i

S_{it} = late shift hours as a fraction of regular hours

σ = 0.01 gives steady-state values:

λ = 0.388, S = 0.266

Summary of Simulation Results

Impact of an Increase in Government Spending (Relative to Frictionless Model)

Results	**Cobb-Douglas, no shifts (50% K loss)**	**Leontief with shifts (50% K loss)**
Magnified **output** response	no	yes
Magnified **employmen**t response	yes	yes
Significantly smaller **consumption** response	no	yes
Declines in **interest rates**	yes	yes
Declines in real product **wages** in expanding sector	yes	yes
Increase in aggregate consumption wage	Yes	yes
Wage differentials across sectors	no	yes
Decline in **labor productivity**	Yes	no

Table 2
Numerical Values of Parameters for Simulations

Parameters (common to both models)	Values	Parameters (model-specific)	Values
θ	0.05	α	0.75
φ	2	A	0.5
T	200		
δ	0.1	α_n	2
ρ	0.04	α_k	2
γ	0.5 or 0.25	σ	0.01

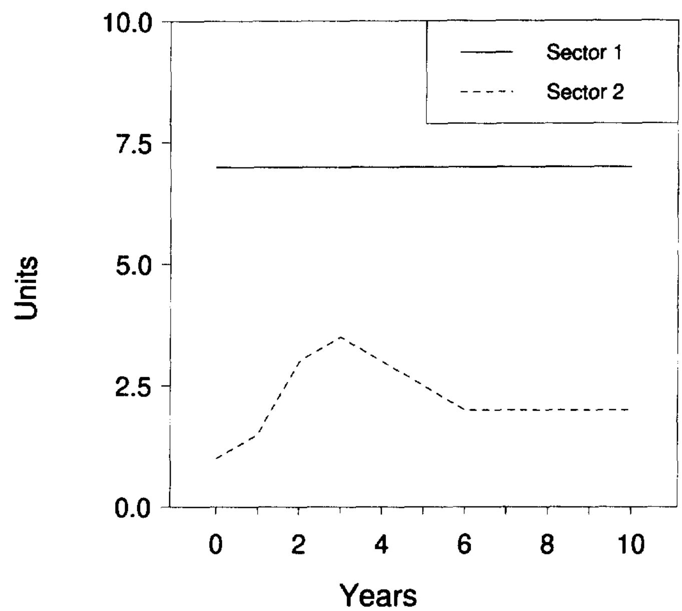
Table 3A
Steady-State Values for Cobb-Douglas Model

Variable	Value	Variable	Value
G_1	7	G_2	1
Y_1	35.232	Y_2	2.553
K_1	62.914	K_2	4.559
L_1	73.177	L_2	5.302
C_1	21.940	C_2	1.097
X_1	6.291	X_2	0.456
R_1	0	R_2	0
P_2/P_1	1		

Table 3B
Steady-State Values for Leontief Model

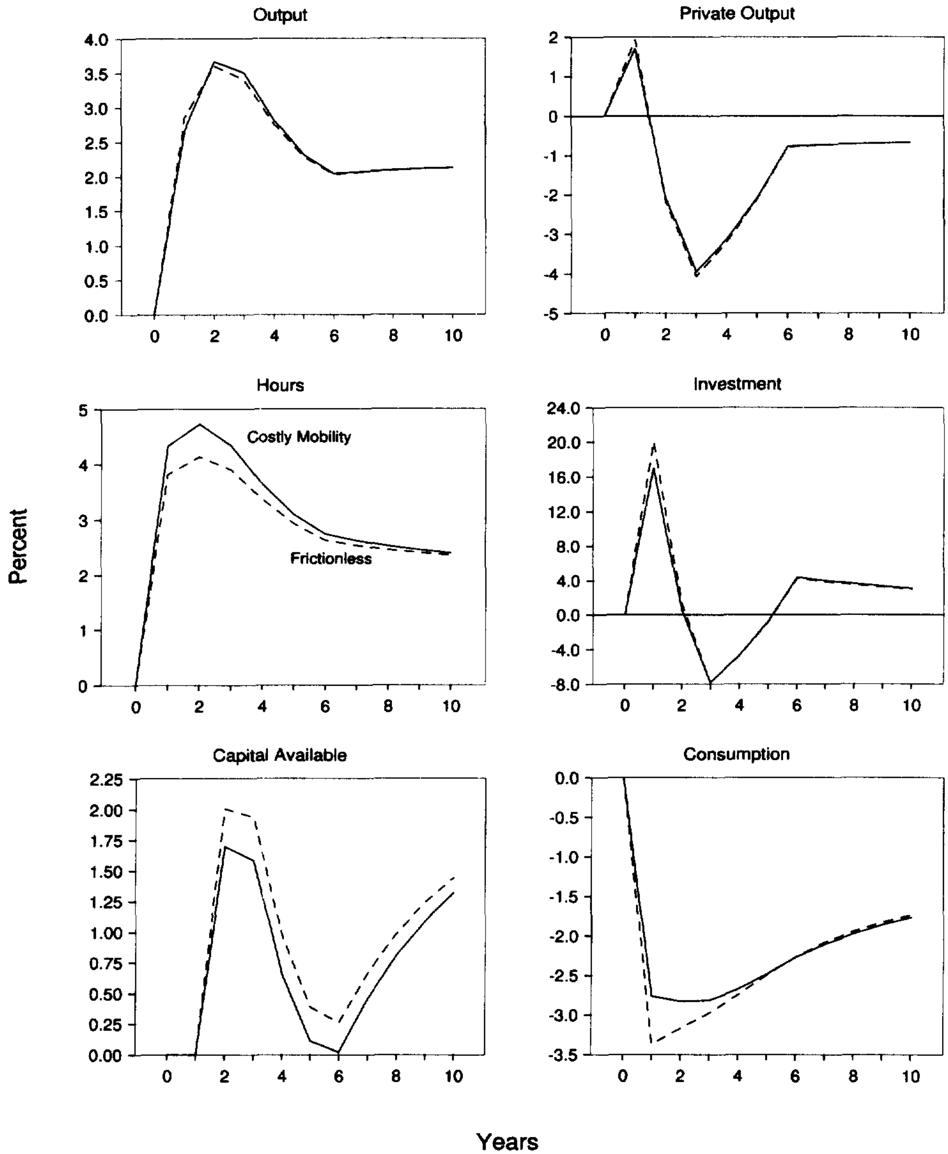
Variable	Value	Variable	Value
G_1	7	G_2	1
Y_1	35.847	Y_2	2.564
K_1	56.611	K_2	4.050
S_1	0.266	S_2	0.266
D_1	0	D_2	0
L_1	71.694	L_2	5.128
C_1	23.186	C_2	1.159
X_1	5.661	X_2	0.405
R_1	0	R_2	0
P_2/P_1	1		

Figure 1. Simulated Military Buildup:
Time Path of Government Purchases by Sector



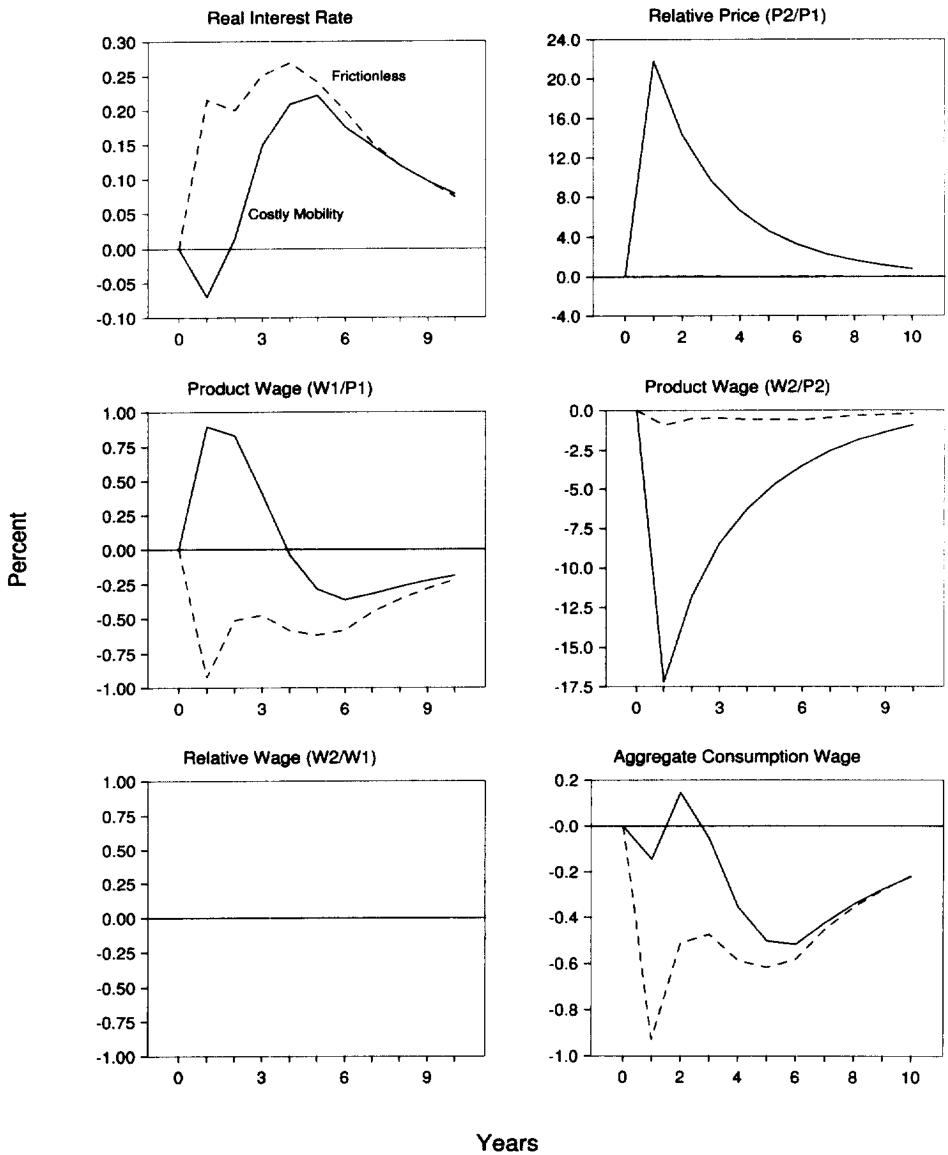
Note: The figure shows the time path of government purchases used in the simulations reported in Figures 2, 3 and 4.

Figure 2A. Simulated Response to a Military Buildup: Cobb-Douglas Technology, Frictionless versus High-Cost Capital Mobility



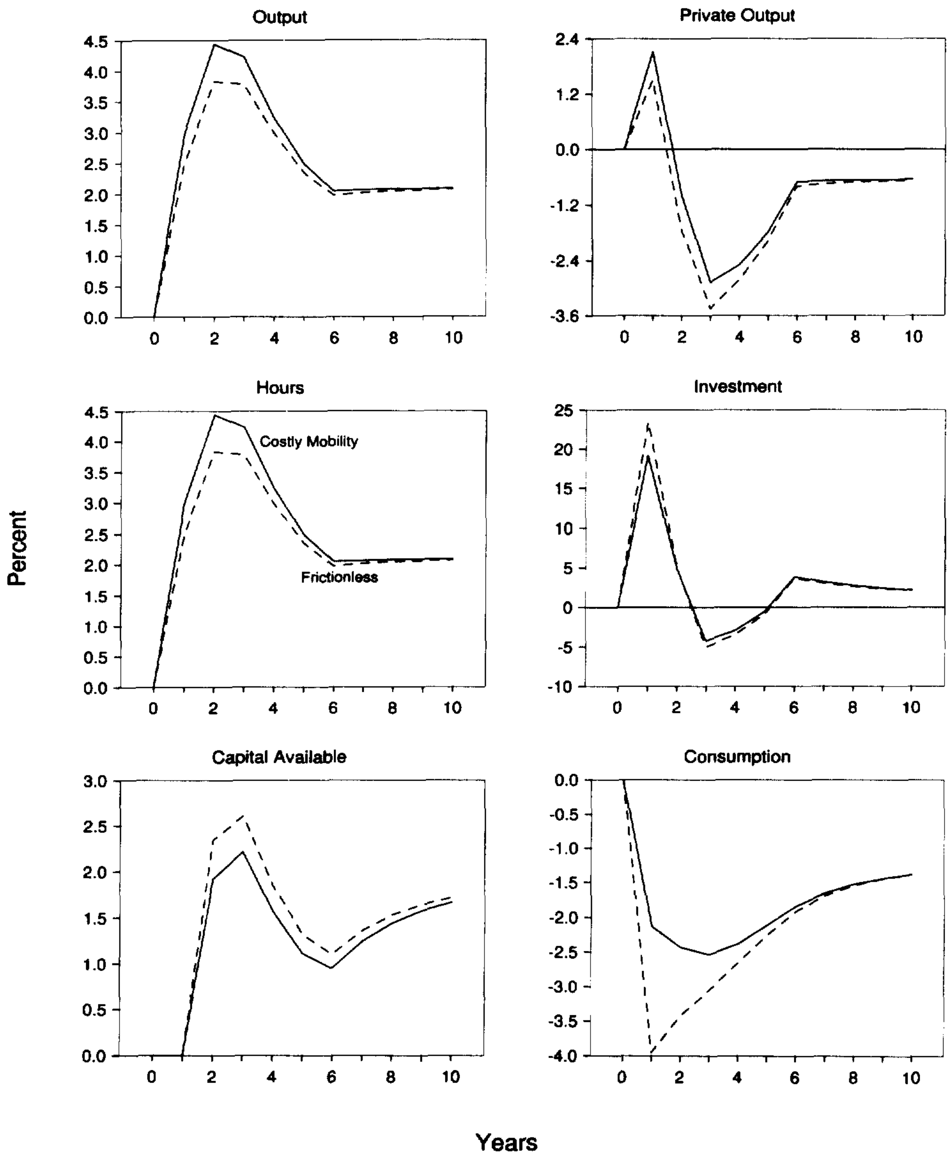
Note: Figure reports simulated response to the military buildup shown in Figure 1 assuming the Cobb-Douglas technology. The solid line shows simulations with high-cost capital mobility (γ=0.5). The dashed line shows simulations with frictionless capital mobility. See text for details.

Figure 2B. Simulated Response to a Military Buildup: Cobb-Douglas Technology, Frictionless versus High-Cost Capital Mobility



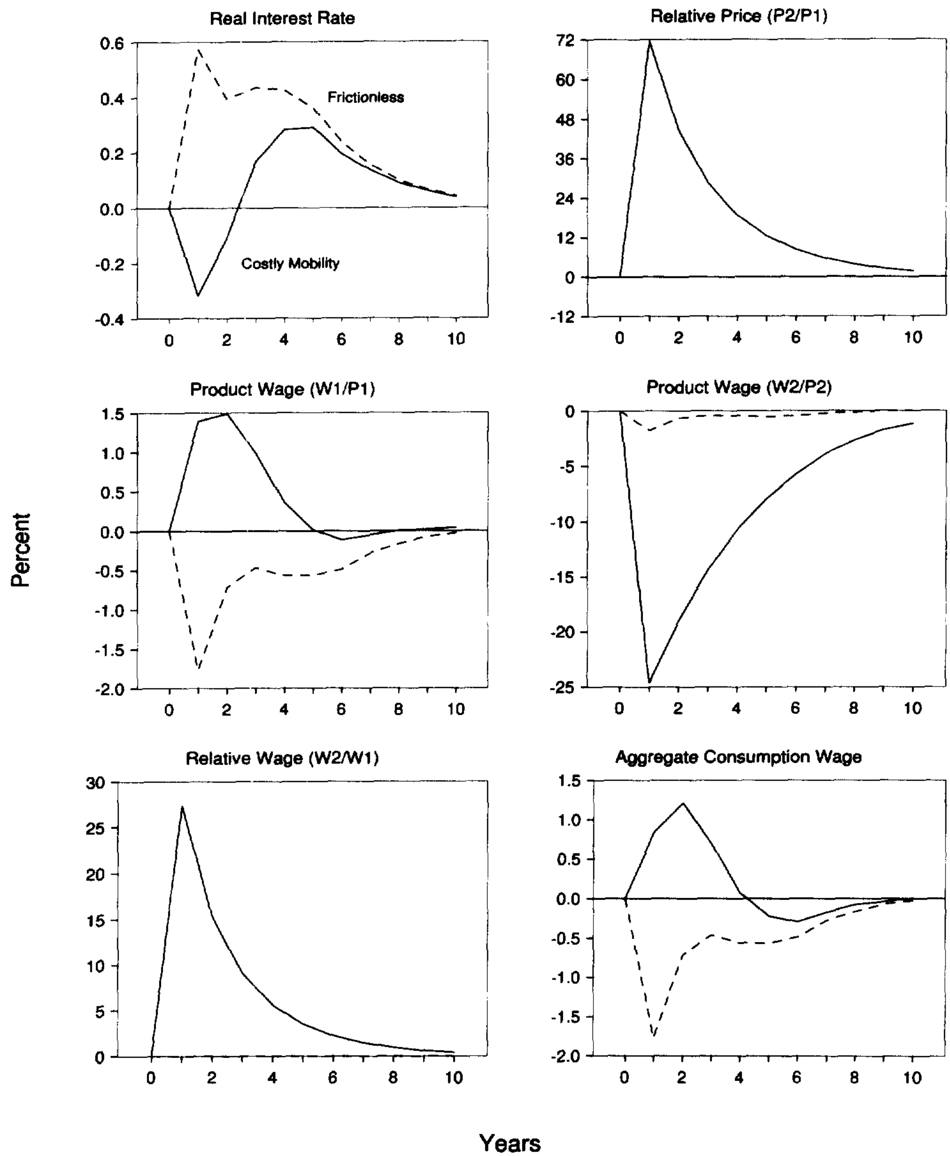
Note: Figure reports simulated response to the military buildup shown in Figure 1 assuming the Cobb-Douglas technology. The solid line shows simulations with high-cost capital mobility (γ=0.5). The dashed line shows simulations with frictionless capital mobility. See text for details.

Figure 3A. Simulated Response to a Military Buildup: Leontief Technology, Frictionless versus High-Cost Capital Mobility



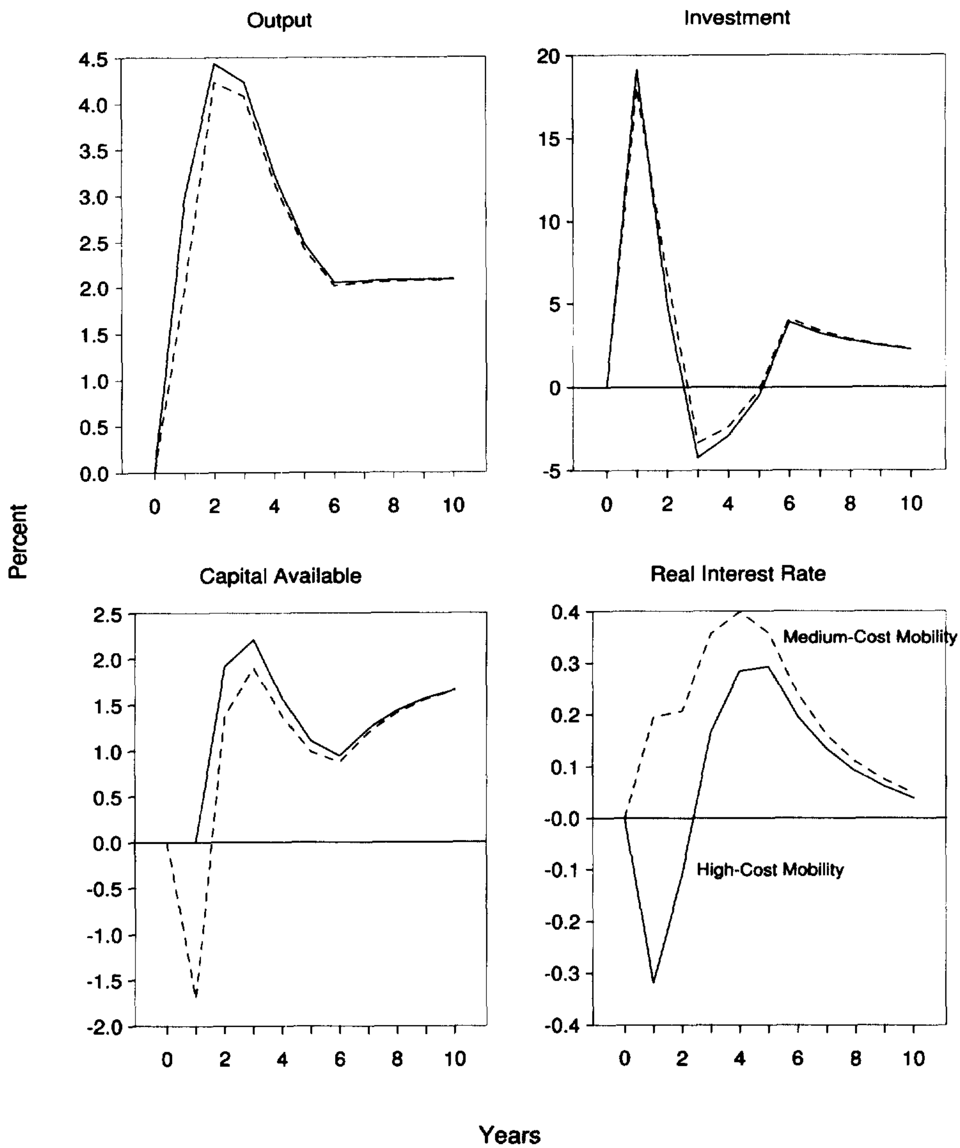
Note: Figure reports simulated response to the military buildup shown in Figure 1 assuming the Leontief technology. The solid line shows simulations with high-cost capital mobility (γ=0.5). The dashed line shows simulations with frictionless capital mobility. See text for details.

Figure 3B. Simulated Response to a Military Buildup: Leontief Technology, Frictionless versus High-Cost Capital Mobility



Note: Figure reports simulated response to the military buildup shown in Figure 1 assuming the Leontief technology. The solid line shows simulations with high-cost capital mobility (γ=0.5). The dashed line shows simulations with frictionless capital mobility. See text for details.

Figure 4. Simulated Response to a Military Buildup: Leontief Technology, Medium-Cost versus High-Cost Capital Mobility



Note: Figure reports simulated response to the military buildup shown in Figure 1 assuming the Leontief technology. The solid line shows simulations with high-cost capital mobility (γ=0.5). The dashed line shows simulations with medium-cost capital mobility (γ=0.25). See text for details.

Empirical Framework

Military Buildup Dates

Narrative (*Business Week*): Unanticipated geopolitical events that lead to forecasts of increased military procurement

Dates chosen:

June 25, 1950 North Korean invasion of South Korea

February 7, 1965 attack on the U.S. Army barracks in Vietnam

December 24, 1979 Soviet invasion of Afghanistan

Quarterly Dates: 1950:3 1965:1 1980:1

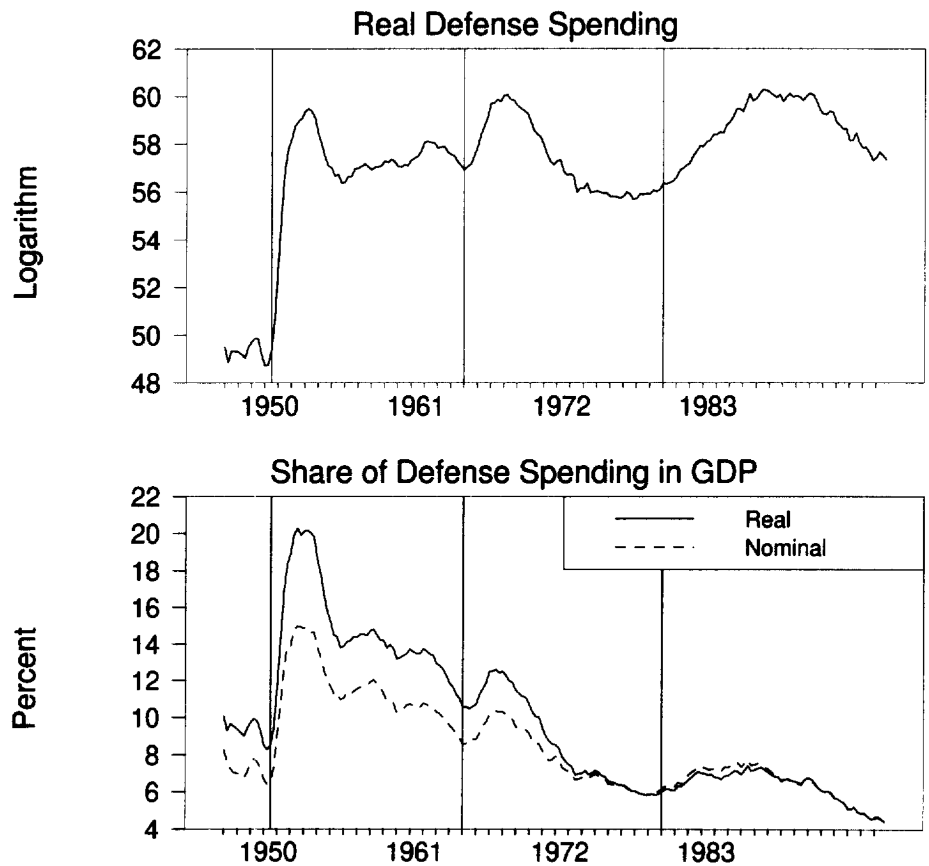
Estimation

We wish to estimate reduced-form impact of military buildup

Specification

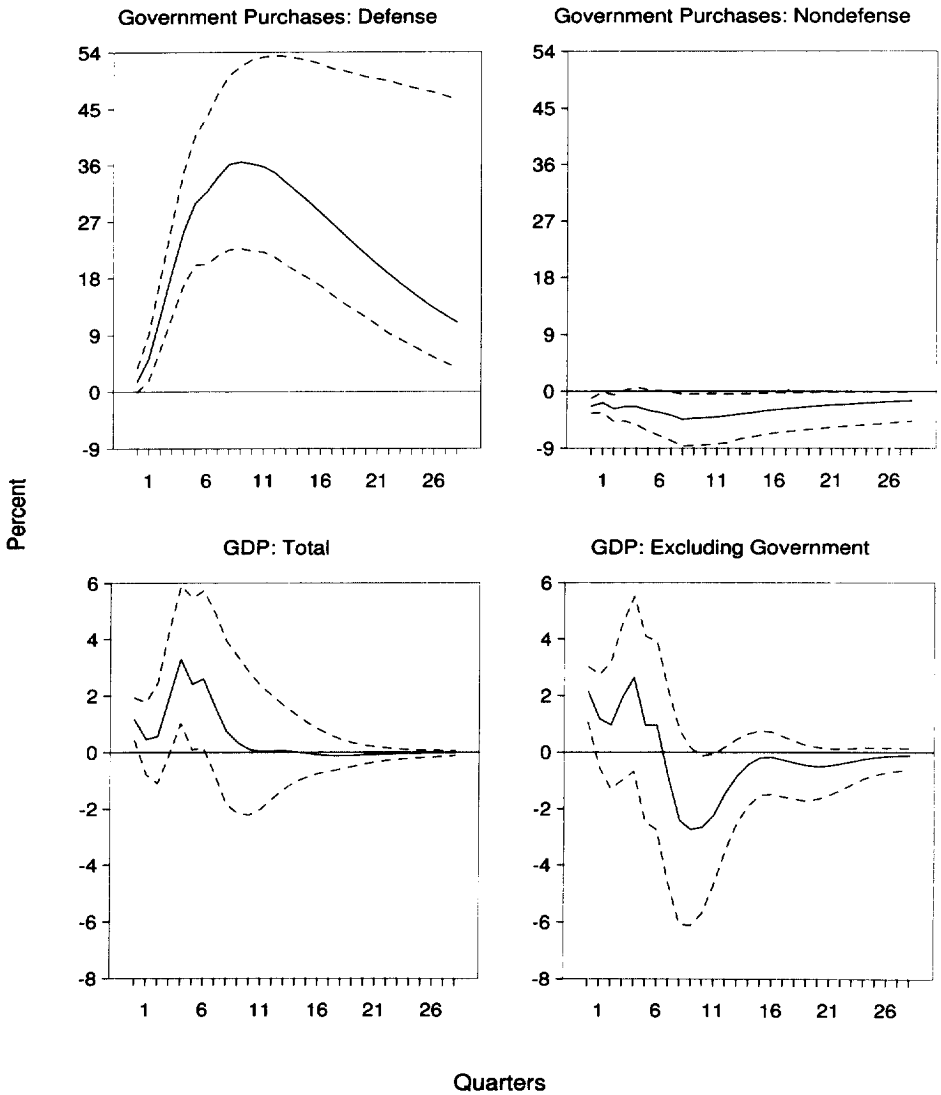
$$\log y_t = a_0 + a_1 t + a_2 (t \geq 1973{:}2) + \sum_{i=1}^{8} b_i y_{t-i} + \sum_{i=0}^{8} c_i D_{t-i} + \varepsilon_t$$

Figure 5. Defense Spending and Military Buildups



Note: Vertical lines are the dummies for military buildups. Real defense spending and real GDP are measured using the chain-weighted quantities.

Figure 6A. Estimated Response to a Military Buildup



Note: Solid lines are the estimated impulse response to a dummy variable that is equal to one with the onset of a military buildup. Dashed lines are the 10 and 90 percent bootstrap-within-bootstrap confidence bands. See text for details of the estimation procedure.

Figure 6B. Estimated Response to a Military Buildup

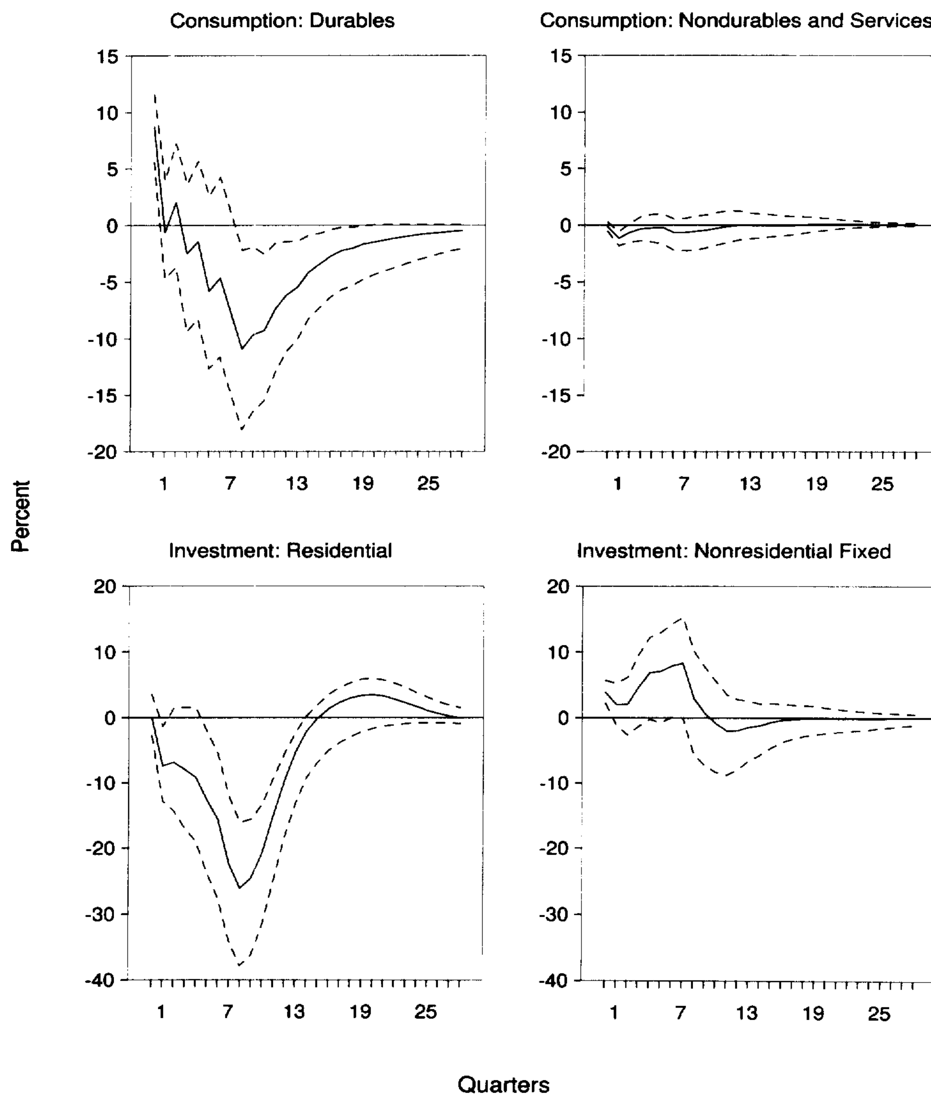


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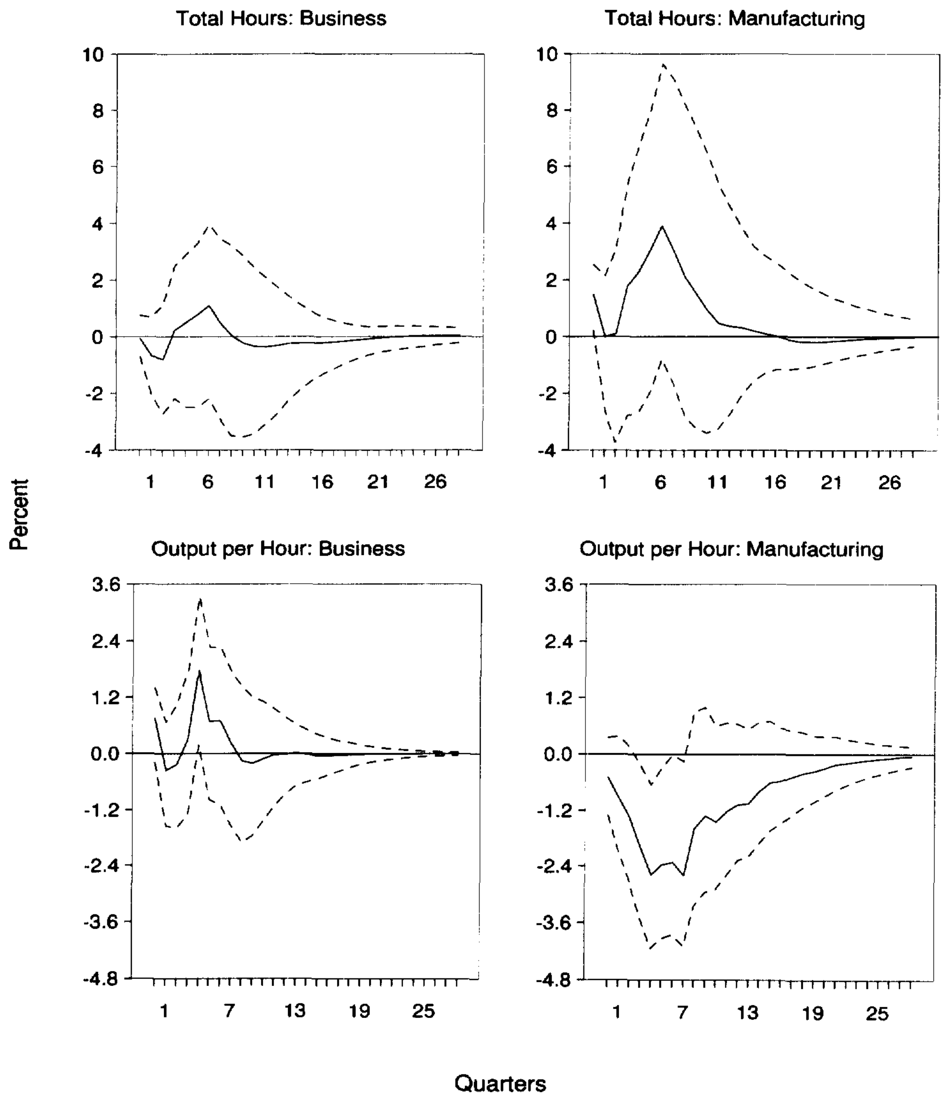
Figure 6C. Estimated Response to a Military Buildup



Note: Solid lines are the estimated impulse response to a dummy variable that is equal to one with the onset of a military buildup. Dashed lines are the 10 and 90 percent bootstrap-within-bootstrap confidence bands. See text for details of the estimation procedure.

Figure 6D. Estimated Response to a Military Buildup

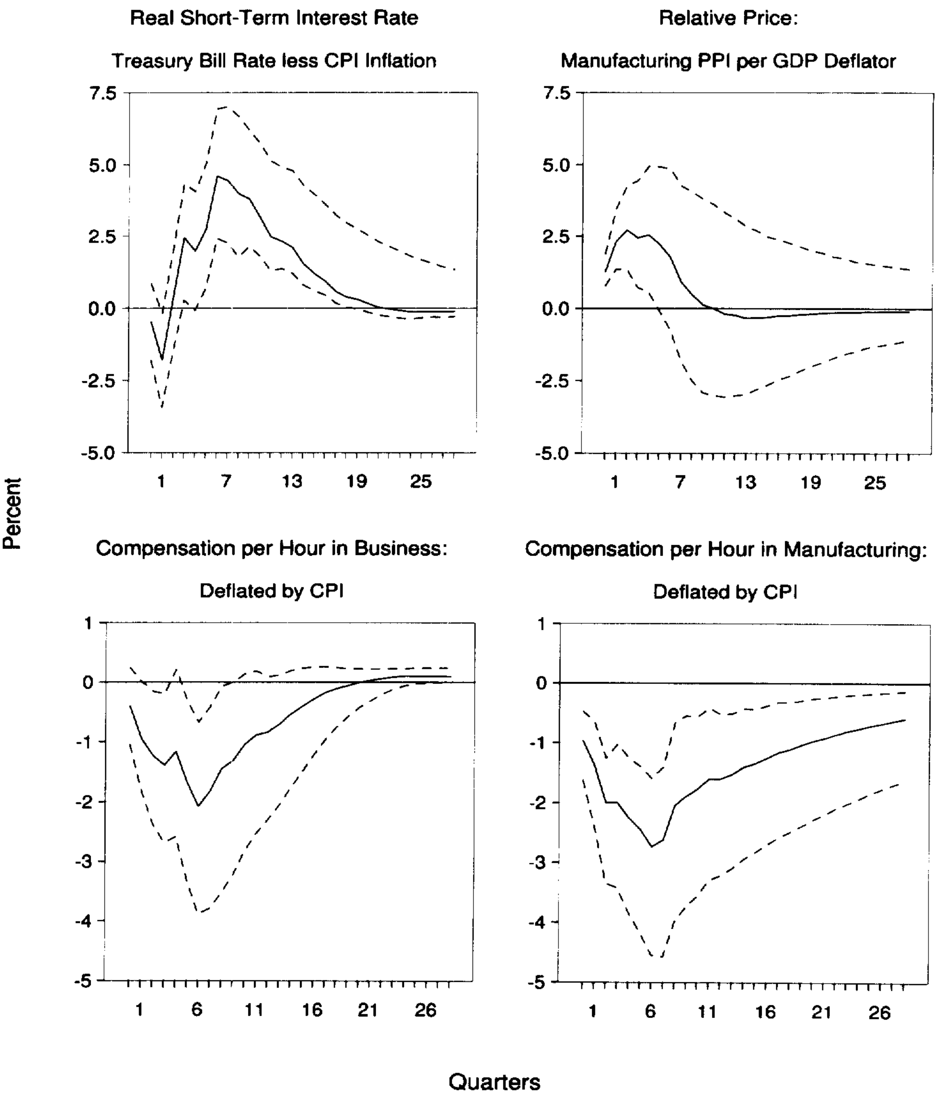


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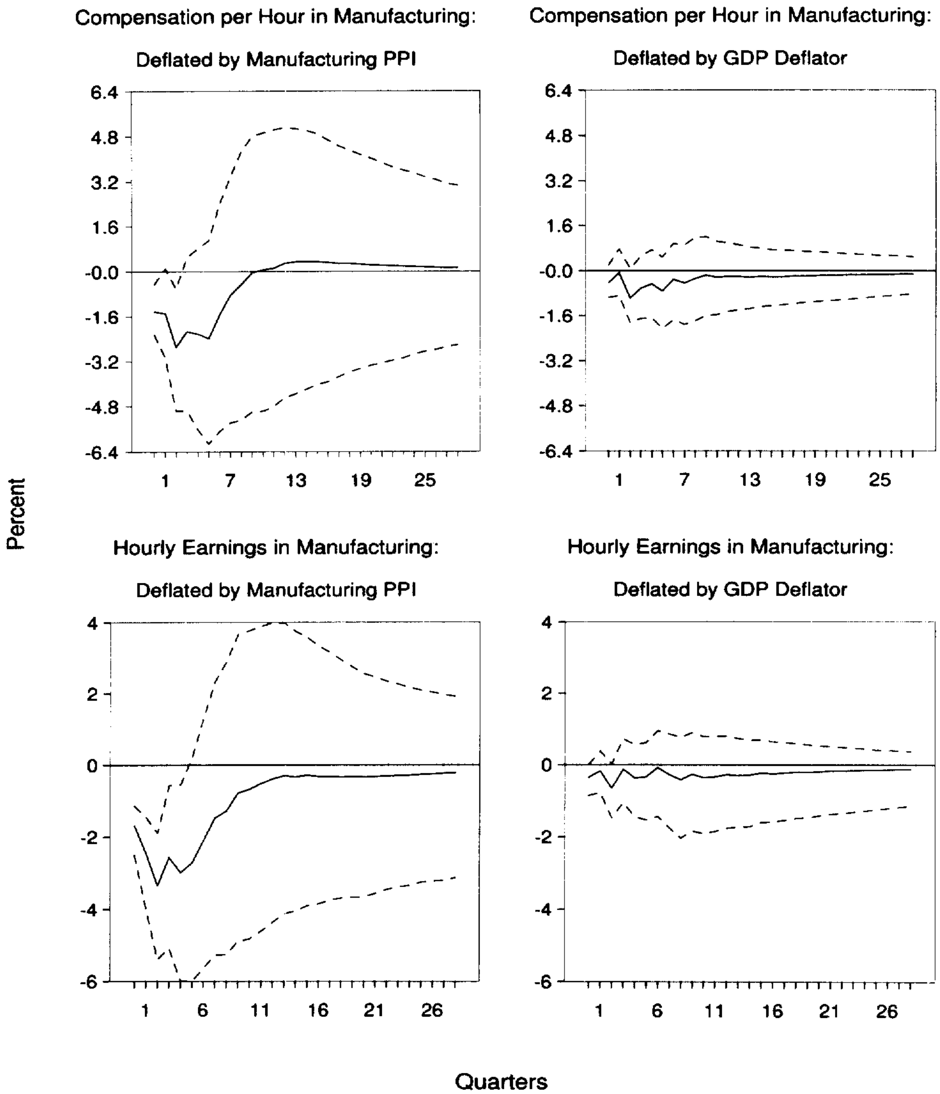
Figure 6E. Estimated Response to a Military Buildup



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