How Inefficient is Worker Reallocation?

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(*Preliminary*)

Introduction

- Ex-post wage bargaining together with search frictions can lead to inefficiencies, see Hosios (1990), Pissarides (2000)
- Debate on labor market business cycle volatility
  - Bargaining power
  - Wage rigidity
  - Job creation costs
- Implications for the dynamics of wages, hours, consumption, investment, and labor productivity and for welfare

- We estimate the welfare implications of these mechanisms in a business cycle model with several shocks, adjustment costs to capital and general non-separable preferences

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Preview of results

1. *Wage rigidity*: Steady state unemployment is almost identical to a world with bargaining power $\beta \simeq 0.5$, but over the business cycle wage rigidity is pervasive
2. *Source of business cycle fluctuations*: Shocks to neutral technology (stationary and stochastic trend) and to separation rate explain around 80 per cent of cyclical fluctuations
3. *Cost of unemployment*: Around 7 percent
4. *Welfare costs of search inefficiencies*: Small in steady state, large over business cycle (a novel cost of business cycle)

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Related literature

Many of you.....

and some more.....

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Outline

1. The model
2. Social planner problem
3. Estimation
4. Results
5. Welfare inefficiencies
6. Conclusions

The model

- Final output: $Y = F_t(K, N) = A_t Z_t K^{\alpha} N^{1-\alpha}$
  N : goods produced in *jobs* (sold at price p_t)
- A job produces goods h^{ϕ}, $\phi \in [0, 1]$
- Adjustment costs to capital
- Matching function: $n_t(u, v) = (M_t u)^{\eta} v^{1-\eta}$
- Free entry by firms. Unitary cost of a recruiting service is

$$r_t = p_t^{\kappa} X_t^{1-\kappa}$$

Required recruiting services:

$$\bar{R}(n, v) = \overline{r} n^{\gamma_1} v^{\gamma_2}, \qquad \gamma_1 \geq 0, \gamma_2 > 0, \qquad \gamma_1 + \gamma_2 = 1$$

which can also be written as

$$R_t(u, n) = \overline{r} \left(M_t u\right)^{-\eta_0} n^{\eta_1}, \qquad \eta_0 = \frac{\eta \gamma_2}{1-\eta}, \qquad \eta_1 = \gamma_1 + \frac{\gamma_2}{1-\eta}$$

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The model II

- There are two types of jobs. At the start of relationship:
  1. with prob. $1-\theta$: Nash bargaining with workers' power β
  2. with prob. θ: candidate wage $\omega \sim G$, actual wage in bargaining set
     Randomness avoids discontinuities (in estimation and to shocks)
     The worker buys out the firm (Coase theorem)
- A Representative household. Utility of an unemployed worker is $U^u(C_t) = \frac{C_t^{1-\chi}}{1-\chi}, \ \chi > 0$. Utility of an employed is:

$$U_t^e(C_t^e, h_t) = \frac{(C_t^e)^{1-\chi}\left[S_t(h_t)\right]^{\chi}}{1-\chi}, \ \chi > 0$$

where

$$S_t(h_t) = 1 + (\chi - 1)\left(\Psi_0 + \Psi_{1,t}\frac{h_t^{1+\nu}}{1+\nu}\right), \quad \nu > 0$$

- Aggregate resource constraint: $Y_t = I_t + C_t + D_t + L_t$

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Shocks

1. Two shocks to neutral technology: $Y = A_t Z_t K^{\alpha} N^{1-\alpha}$
2. Two shocks to investment specific technology: $e^{q_t + \varphi_t} I$
3. Shock to matching technology: $n_t(u, v) = (M_t u)^{\eta} v^{1-\eta}$
4. Preference shocks: $S_t(h) = 1 + (\chi - 1)\left(\Psi_0 + \Psi_{1,t} \frac{h^{1+\nu}}{1+\nu}\right)$
5. Shock to discount factor: B_t stochastic
6. Shock to aggregate demand: $Y_t = C + I + D_t$
7. Shocks to separation rate $\frac{1}{1+e^{\lambda_t}}$:

$$\lambda_t = \rho_\lambda \lambda_{t-1} + \sum_{i \in \{z,a,q,\varphi,\psi,m,d,b,\lambda\}} \pi_i \varepsilon_{it}$$

important for persistence; Den Haan, Ramey, and Watson (2000)

Timing

Timing convention:

i. Aggregate shocks are realized

ii. Old jobs are destroyed (probability Λ_t). New jobs (matches at time $t-1$) start producing

iii. Decisions about job creation, consumption and investment are taken

iv. Output, income pooled, invested and consumed. Next period begins

Equilibrium conditions I

1. The job net surplus:

$$V_t = \pi_t p_t h_t^{\phi} + U_t^e(C_t^e, h_t) - \pi_t C_t^e - H_t + B_t E_t\left(H_{t+1}\right) + B_t E_t\left[(1-\Lambda_{t+1})\, V_{t+1}\right]$$

2. Value of unemployment:

$$H_t = U^u(C_t) - \pi_t C_t + B_t E_t\left\{H_{t+1} + f_t\left[(1-\theta)W_{t+1}^b + \theta W_{t+1}^r\right]\right\}$$

3. Splitting of surplus with bargaining: $W_t^b = \beta V_t$ and $P_t^b = (1-\beta)\, V_t$
4. Splitting of surplus in a rigid wage job (two thresholds $\overline{\omega}_t$ and $\underline{\omega}$):

$$W_t^r(\omega) = \min\left[\max\left(0),\ \overline{W}_t^r(\omega)\right), V_t\right] \quad \text{and} \quad P_t^r = V_t - W_t^r$$

5. Free entry condition:

$$\frac{\pi_t r_t R(u_t, n_t)}{n_t} = B_t E_t\left[(1-\theta)P_{t+1}^b + \theta P_{t+1}^r\right]$$

Equilibrium conditions II

6. Optimal consumption choice: $\pi_t = \frac{1}{C_t^{\chi}} = \left[\frac{S_t(h_t)}{C_t^e}\right]^{\chi}$
7. The price of a labor intensive intermediate good: $p_t = \frac{\partial F(K_t, N_t)}{\partial N_t}$
8. The evolution for the marginal value of capital
9. The Euler equation for investment
10. Stochastic trend: $X_t \equiv e^{\frac{z_t}{1-\alpha}} \; e^{\frac{\alpha q_t}{1-\alpha}}$

Social planner problem

The social net value of a job is:

$$\begin{aligned} V_t^* &= \pi_t^* p_t^* h_t^{*\phi} + U_t^e\left(C_t^{e*}, h_t^*\right) - U^u\left(C_t^*\right) - \pi_t^*\left(C_t^{e*} - C_t^*\right) \\ &\quad + \pi_t^* r_t^* \frac{\partial R_t(u_t, n_t)}{\partial u_t} + B_t E_t\left[\left(1 - \Lambda_{t+1}\right) V_{t+1}^*\right] \end{aligned}$$

Optimal job creation solves:

$$\pi_t^* r_t^* \frac{\partial R_t(u_t, n_t)}{\partial n_t} = B_t E_t\left(V_{t+1}^*\right)$$

Two differences: $H_t \neq \frac{\partial R_t(u_t,n_t)}{\partial u_t}$ and $\frac{R_t(u_t,n_t)}{n_t} \neq \frac{\partial R_t(u_t,n_t)}{\partial n_t}$

Hosios benchmark: Workers should appropriate less than the Hosios' benchmark: under Hosios $u > u_t^*$ if $\gamma_1 > 0$

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Proposition The decentralized equilibrium is socially efficient if the Hosios condition holds ($\beta = \eta$), there are no appropriability problems ($\gamma_1 = 0$), and wages are flexible ($\theta = 0$)

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Hall' two factor model

In Hall (2009a) there are only two factors that drive consumption, productivity, hours per worker and unemployment ($\widehat{u}_t = \frac{s_t}{s_t + f_t}$):

$$\begin{aligned} \varkappa_{1t} &= A_t \left(\frac{\widetilde{K}_t}{N_t} \right)^{\alpha} h_t^{\phi-1} && \text{(Labour productivity)} \\ \varkappa_{2t} &= \widetilde{\pi}_t && \text{(Marginal value of wealth)} \end{aligned}$$

In our model, there are four additional factors: i) separation rate Λ_t; ii) the matching technology M_t; iii) the discount factor B_t; and iv) the marginal value for leisure Ψ_{1t}. Only the first one will matter

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Data

We start with quarterly data (but plans to refine it)

1. Unemployment rate
2. Average hours per worker (weekly)
3. Finding rate: f_t, from monthly data $1 - f_t = (1 - f_t^m)^3$
4. Separation rate: s_t , from monthly data $1 - s_t = (1 - s_t^m)^3$
5. Vacancies (help wanted index spliced to JOLTS in 2000)
6. Labor share
7. Labor productivity growth
8. Consumption growth
9. Investment growth

Measurement error in vacancies, unemployment, find. and sep. rate

Sample period: 1967:I–2009:IV

Data detrended, 5th order polynomial $\sim$ HP filter 1e5 as H09

See raw data

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Selected priors

Parameters Priors	Distri.	Mean	SD	Min	Max
u (%)	N	5.25	0.25	1.00E-02	50
λ	B	0.045	0.01	0.005	0.5
y_l	B	0.67	0.05	1.00E-02	0.99
$\frac{L}{Y}$ (%)	G	0.8	0.5	0.00001	99
γ_1	U	0.5	0.28	0.001	0.998
β	U	0.5	0.28	0.001	0.998
θ	U	0.5	0.28	0.001	0.998
τ	N	0.97	0.04	0.1	5
κ	U	0.5	0.28	0.001	0.998
η	B	0.6	0.1	0.001	1
$\overline{r}$	U	15	8.66	0.001	30
χ	G	1.75	0.25	0.99	30
$\frac{C}{C^e}$	B	0.85	0.05	0.5	0.99
ν	G	1.6	0.2	0.01	20

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Remaining priors

Parameters estimates and some steady state quantities

u	4.69	f	0.88	λ	0.04
y_l	0.62	$\frac{L}{Y}$	3.00	$\frac{L^e+L}{Y}$	4.25
$\frac{C}{Y}$	0.59	$\frac{I}{Y}$	0.23	τ	1.00
β	0.06	γ_1	0.61	θ	0.43
κ	0.28	η	0.71	$\overline{r}$	2.39
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More estimates, more information

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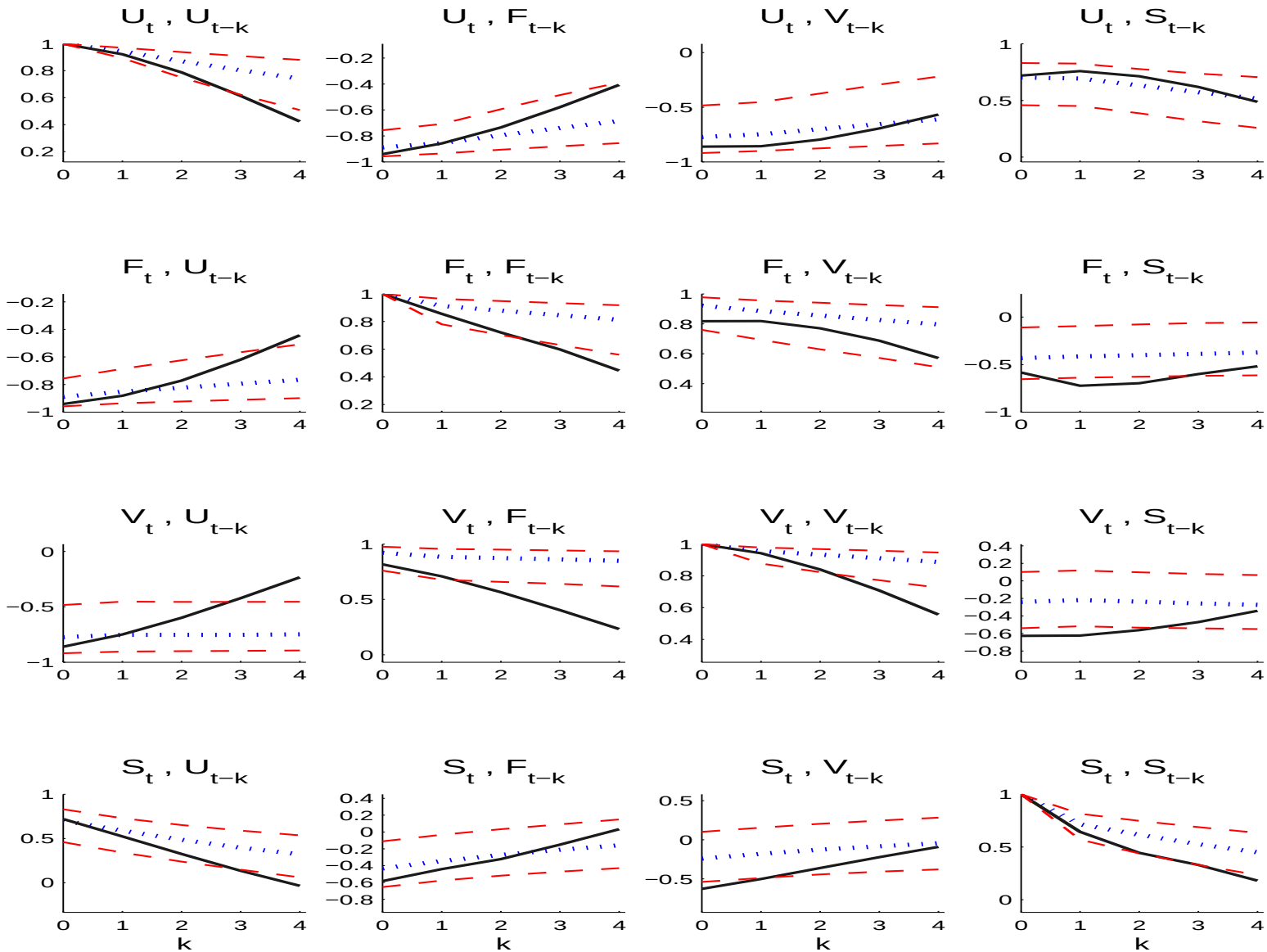
Key labour market correlations



Note: Data (solid), model median (dotted) and [5,95] posterior bands (dashed)

Variance covariance decomposition

Percentage of variance explained by each shock: periodicity 6-32 quarters

	a	dz	φ	ψ	λ	b	d	m	m_u	m_f	$m_{s/v}$
u	70.7	12.2	1.6	0.3	9.7	3.6	0.1	1.4	0.3	0	0
f	65.1	9.4	2.2	0.3	0.1	3.5	0.4	10.9	0	8.1	0
s	61.5	11.9	1.2	0.2	20.9	4.0	0	0.2	0	0	0
v	54.3	5.9	6.6	0.4	17.4	4.7	1.4	9.0	0	0	0
y	84.2	12.0	0.30	0.3	1.9	0.9	0.1	0.2	0	0	0
c	28.9	14.9	10.6	0.3	0.3	33.1	12.0	0.0	0	0	0
i	63.9	0.1	3.9	0.1	1.9	23.7	6.2	0.2	0	0	0
n	57.2	11.3	2.2	0.2	24.5	3.4	0.0	1.2	0	0	0

See impulse responses: a, z, λ, φ, ψ, d, m, b

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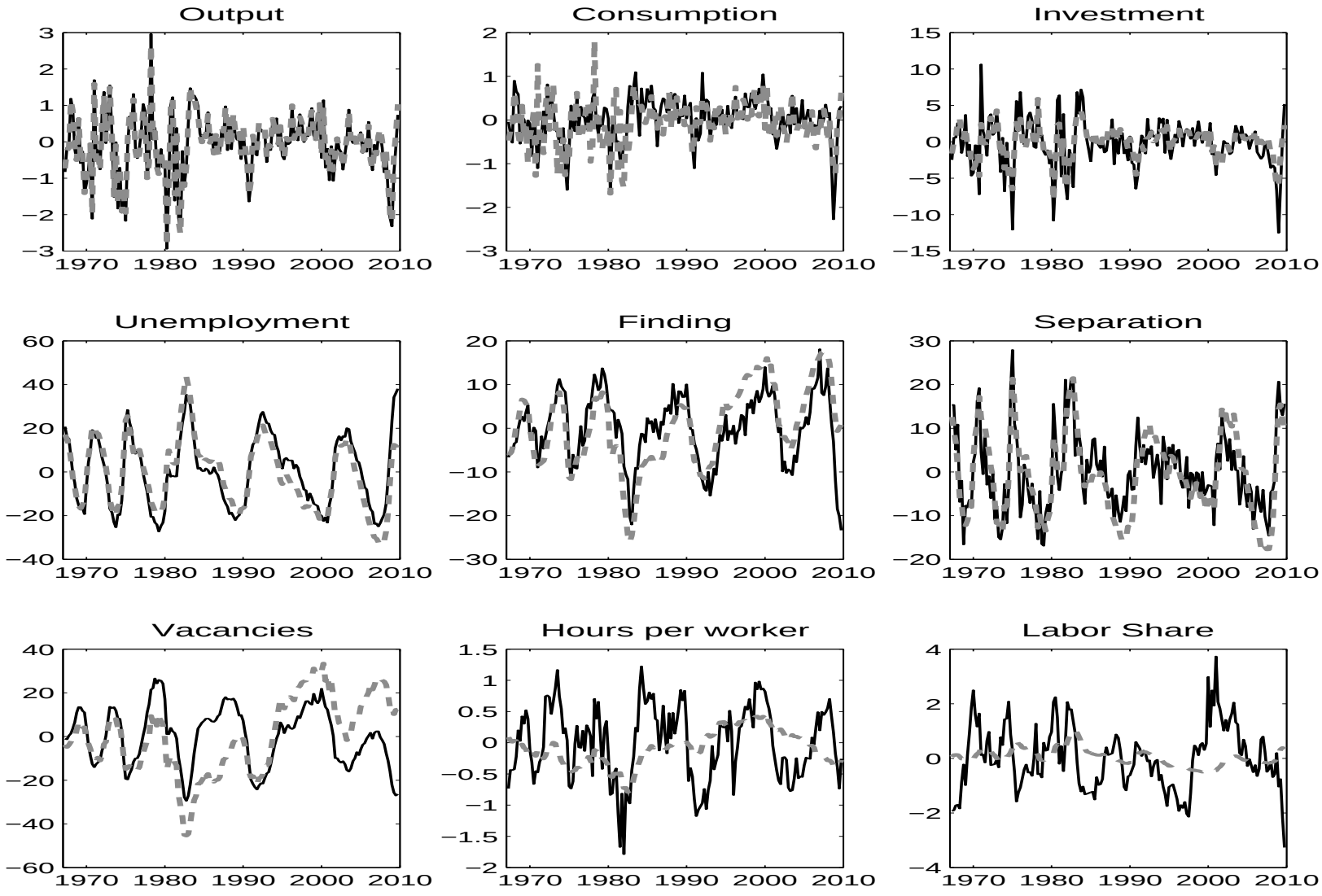
Percentage of variance explained by each shock: periodicity 6-32 quarters

	a	dz	φ	ψ	λ	b	d	m	m_u	m_f	$m_{s/v}$
u	70.7	12.2	1.6	0.3	9.7	3.6	0.1	1.4	0.3	0	0
f	65.1	9.4	2.2	0.3	0.1	3.5	0.4	10.9	0	8.1	0
s	61.5	11.9	1.2	0.2	20.9	4.0	0	0.2	0	0	0
v	54.3	5.9	6.6	0.4	17.4	4.7	1.4	9.0	0	0	0
y	84.2	12.0	0.30	0.3	1.9	0.9	0.1	0.2	0	0	0
c	28.9	14.9	10.6	0.3	0.3	33.1	12.0	0.0	0	0	0
i	63.9	0.1	3.9	0.1	1.9	23.7	6.2	0.2	0	0	0
n	57.2	11.3	2.2	0.2	24.5	3.4	0.0	1.2	0	0	0

See impulse responses: a, z, λ, φ, ψ, d, m, b

Model fit with three shocks: a_t, z_t, λ_t



Data (solid black) and counterfactual (grey dashed)

Contribution of remaining shocks

Welfare comparison: steady state (percentage)

Statistic	Decentralized (%)	Efficient (%)
u	4.69	5.85
f	87.6	69.3
Λ	4.00	4.00
L^*/Y	4.25	3.37
C/Y	58.7	58.8
I/Y	23.3	23.2
C	136.6	136.7
C^e	146.7	146.8

Welfare comparison: volatility

Median Standard deviation

Statistic	Decentralized (%)	Efficient (%)	SD(E)/SD(D)
u-rate	15.3	8.50	0.38
Finding	11.3	3.60	0.20
Separation	8.90	8.90	1.00
Vacancies	24.6	6.90	0.18
Hours per worker	1.56	1.54	0.99
Consumption	0.87	0.87	1.00
Investment	2.76	2.97	1.08

Efficient allocation: there is a positive correlation between

1. vacancies and unemployment
2. vacancies and separation

Comparison in impulse responses (decentralized vs efficient): a_t, z_t, φ_t, λ_t

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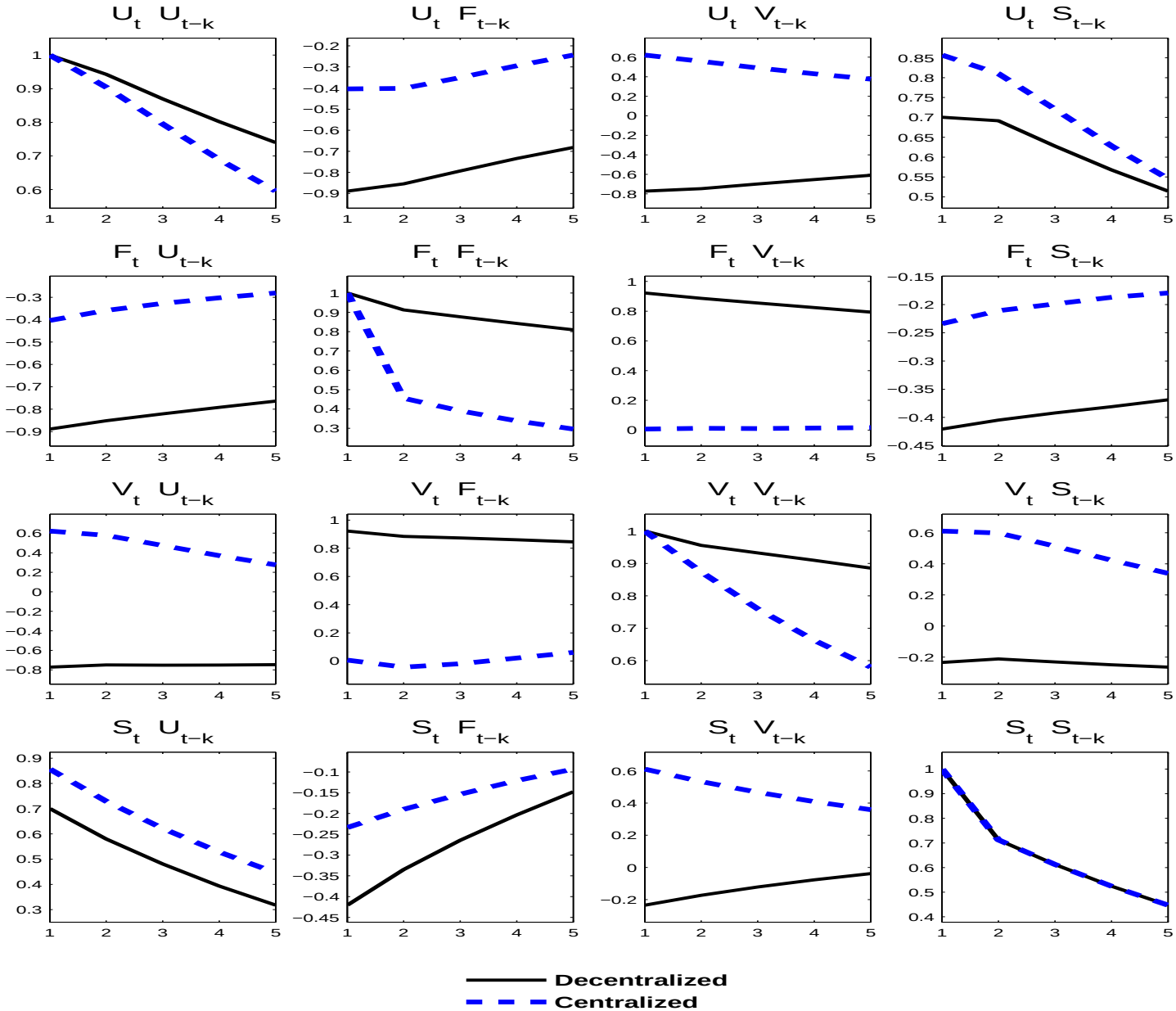
Labour market correlations: decentralized vs efficient



Contribution of shocks: efficient vs decentralized

Percentage of variance explained by each shock: periodicity 6-32 quarters

	a	dz	φ	ψ	λ	b	d	m
u	59	12	5	0	18	3	0	3
	71	12	2	0	10	4	0	1
f	7	2	15	0	0	0	0	44
	65	9	2	0	0	4	0	11
v	39	6	14	0	23	5	0	12
	54	6	7	0	17	5	1	9
y	86	11	0	0	0	1	0	0
	84	12	0	0	2	1	0	0
c	34	14	10	0	0	29	13	0
	29	15	11	0	0	33	12	0
i	65	1	4	0	0	22	6	0
	64	0	4	0	2	24	6	0

1. Mitigated responses to neutral shocks (but consumption and investment respond more); see a_t
2. Matching and investment specific shocks more relevant; see φ_t, m_t

Contribution of shocks: efficient vs decentralized

Percentage of variance explained by each shock: periodicity 6-32 quarters

	a	dz	φ	ψ	λ	b	d	m
u	59	12	5	0	18	3	0	3
	71	12	2	0	10	4	0	1
f	7	2	15	0	0	0	0	44
	65	9	2	0	0	4	0	11
v	39	6	14	0	23	5	0	12
	54	6	7	0	17	5	1	9
y	86	11	0	0	0	1	0	0
	84	12	0	0	2	1	0	0
c	34	14	10	0	0	29	13	0
	29	15	11	0	0	33	12	0
i	65	1	4	0	0	22	6	0
	64	0	4	0	2	24	6	0

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Conclusions

- We estimate a business cycle search model with inefficiencies due to 1) failure of the Hosios (1990) condition; 2) appropriability problems in creation costs; 3) wage rigidity
- We show that search inefficiencies are small in steady state but potentially large at business cycle frequencies (a new dimension to evaluate the costs of business cycles)
- Quantify welfare gains
- Investigate sub-sample stability
- We could endogenize the separation rate along the lines of Mortensen and Pissarides (1994, 1998)
- Other sources of inefficiencies (financial frictions, nominal rigidity, market power, distortionary taxation) but any of these would generate welfare costs also due to the inefficiencies emphasized here

Conclusions

- We estimate a business cycle search model with inefficiencies due to 1) failure of the Hosios (1990) condition; 2) appropriability problems in creation costs; 3) wage rigidity
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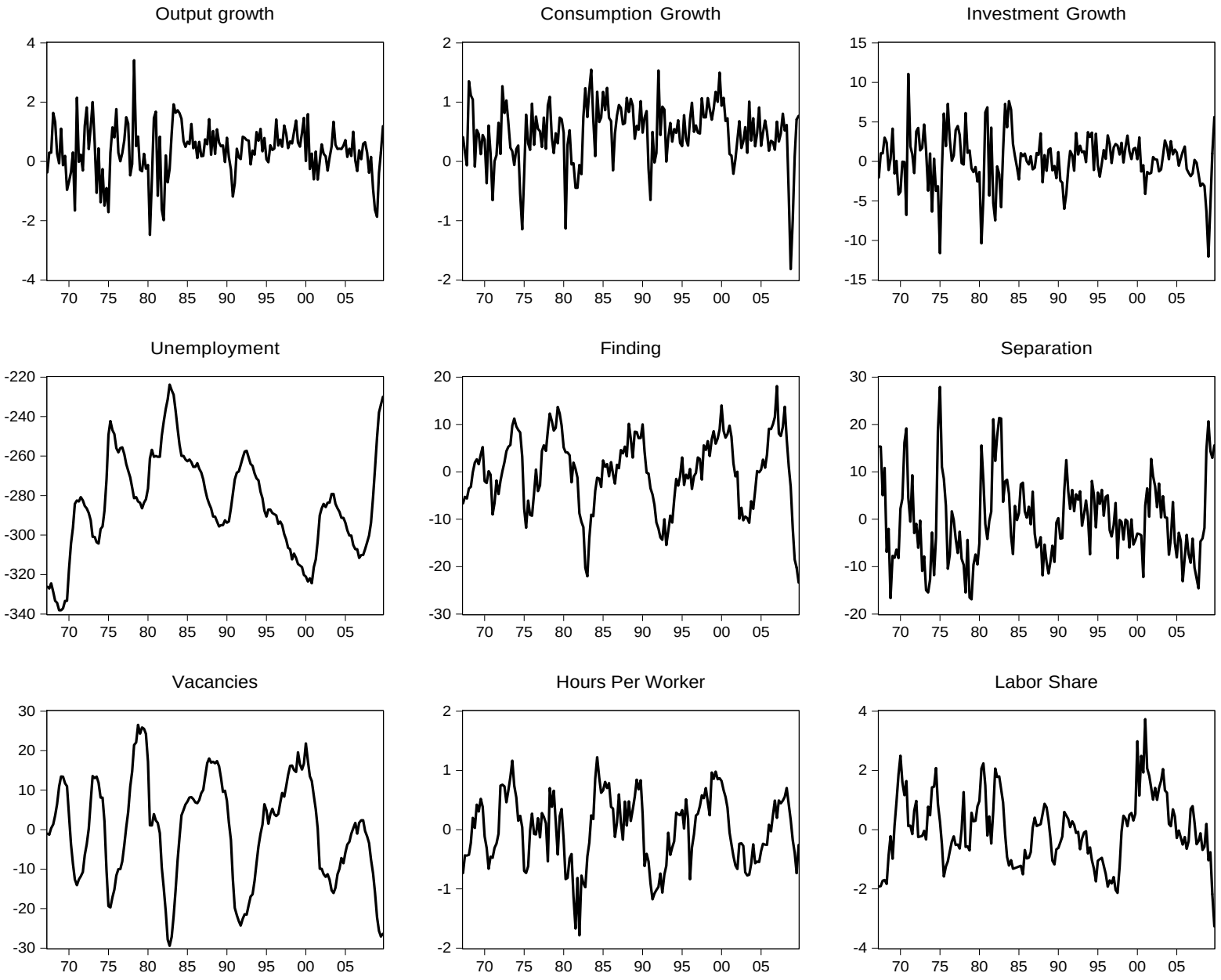
Thanks for your attention !

Raw data


Output growth
Consumption Growth
Investment Growth
Unemployment
Finding
Separation
Vacancies
Hours Per Worker
Labor Share
70 75 80 85 90 95 00 05

Remaining priors

Parameters Priors	Distri.	Mean	SD	Min	Max
ς	G	1.5	1	0.001	20
f_{ss}	G	0.2	0.1	0.001	2
α	N	0.4	0.05	0.01	1
δ	C	0.025	0	0.02	0.03
ϕ	U	0.5	0.28	0	1
T''	U	2.5	1	0.001	100
μ_z (%)	N	0.3	0.025	0.01	1
μ_q (%)	C	0.01	0	0.01	1
g_{ss}	C	0.18	0	0.18	0.22
h_{ss}	B	0.37	0.02	0.05	1
$\pi_i,\ i \in \{z, a, q, \varphi, \psi, m, d, b, \lambda\}$	N	0	10	-80	80
$\rho_i, i \in \{a, \varphi, \psi, m, d, b, \lambda\}$	B	0.6	0.2	0.01	0.99
σ_a (%)	U	12.505	7.214	0.01	10
σ_z (%)	U	12.505	7.214	0.01	10
σ_q (%)	C	0.01	0	0	10
σ_φ (%)	I	1.5	100	0.01	200
$\sigma_i\ i \in \{\psi, m, d, b, \lambda\}$ (%)	U	12.505	7.214	0.01	10
$\sigma_u^{me}\ i \in \{u, f, s, v\}$ (%)	B	0.3	0.1	0.01	0.99

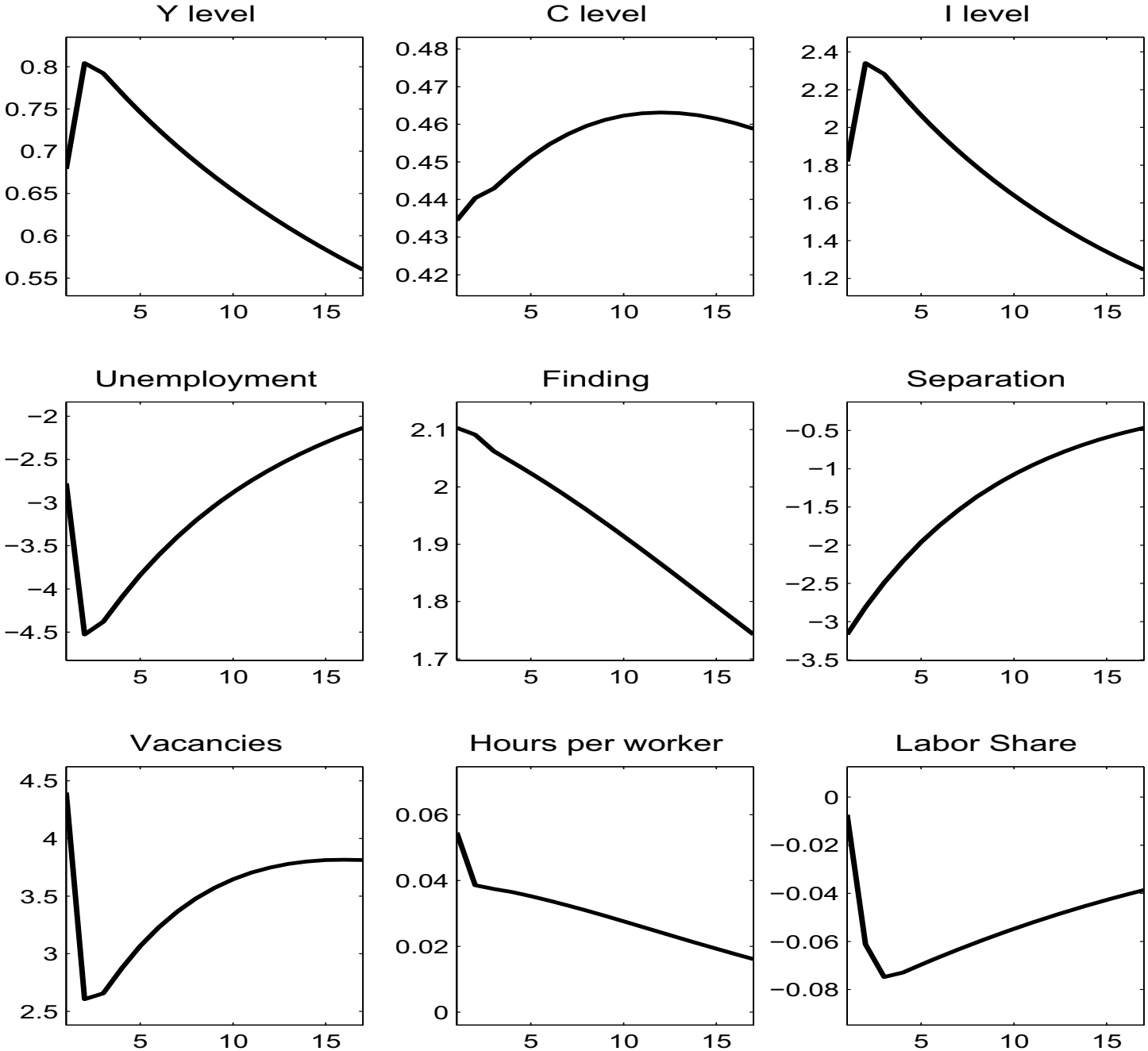
Parameters estimates, complete list

χ	4.04	τ	1.00	ρ_m	0.81
$\frac{c}{c^e}$	0.93	ς	0.85	ν	2.1
fss	0.41	α	0.37	π_a	5.48
δ	0.03	π_z	-3.68	σ_a (%)	0.60
ϕ	0.16	π_q	0.00	σ_z (%)	0.39
T''	0.03	π_{var}	-0.01	σ_q (%)	0.01
μ_z (%)	0.29	π_ψ	-0.19	σ_φ (%)	32.81
μ_q (%)	0.01	π_b	9.45	σ_ψ (%)	1.11
g_{ss}	0.18	π_d	-0.01	σ_λ (%)	1.93
λ	0.04	π_m	-0.12	σ_b (%)	0.09
h_{ss}	0.38	ρ_a	0.95	σ_d (%)	1.93
η	0.71	ρ_φ	0.68	σ_m (%)	1.65
$\overline{r}$	2.39	ρ_ψ	0.99	σ_u^{me} (%)	0.26
κ	0.28	ρ_λ	0.89	σ_f^{me} (%)	0.61
γ_1	0.61	ρ_b	0.99	σ_s^{me} (%)	0.92
β	0.06	ρ_d	0.97	σ_v^{me} (%)	0.14
θ	0.43				
logPost	-1469.44				
logLikel	-1348.50				

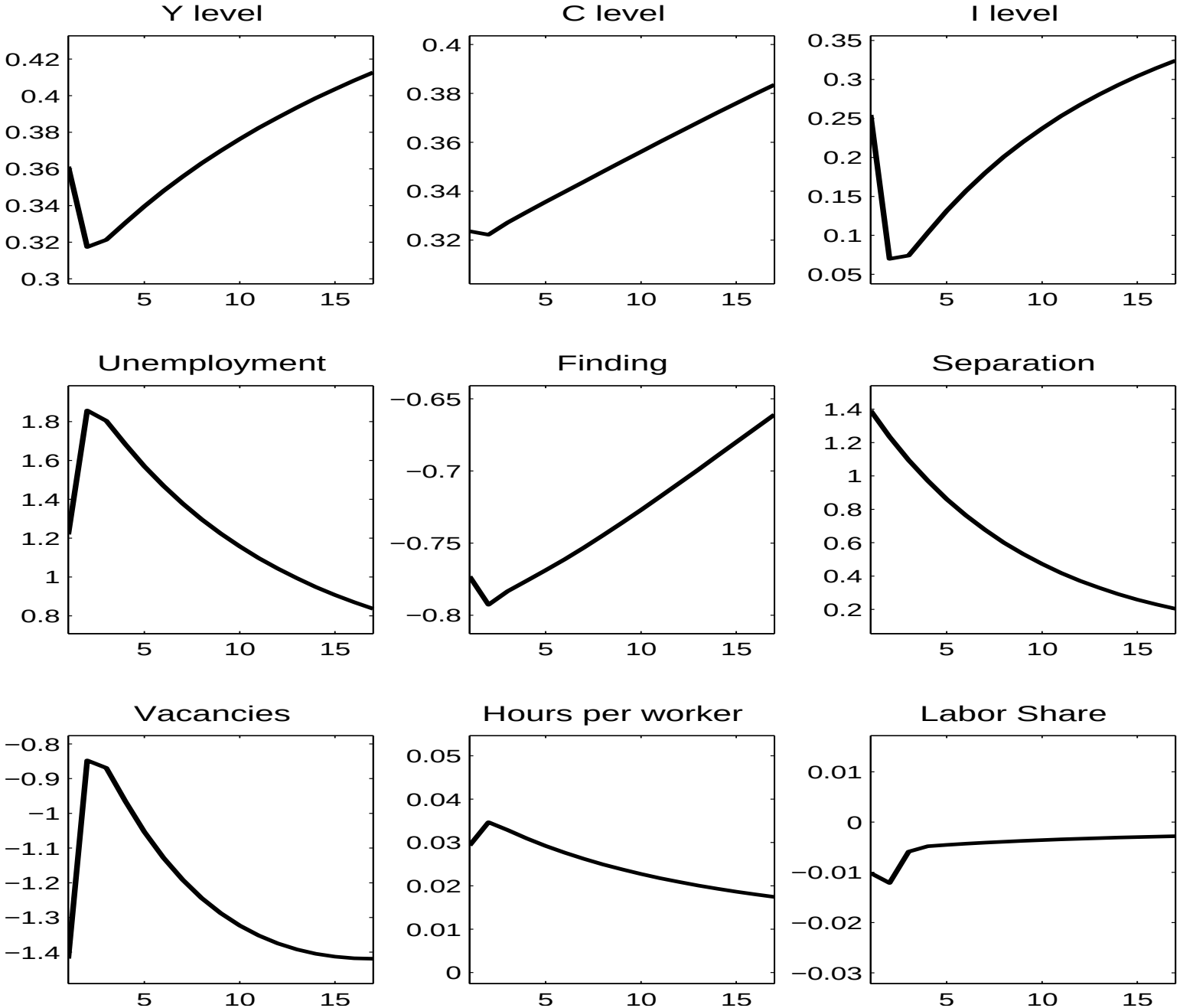
Steady state quantities, complete list

C	1.37	W^r	0.99	$\frac{C}{C^e}$	0.93
f	0.88	$\overline{\omega}$	1.76	$\frac{L}{Y}$	0.04
$\underline{\omega}$	-1.74	μ_ω	1.74	L^*	0.69
V	0.99	$G(\underline{\omega})$	0.00	$\frac{K}{Y}$	7.86
u	0.05	$G(\overline{\omega})$	0.94	ν	2.10
n	0.04	P^b	0.93	Ψ_0	0.01
N	0.80	P^r	0.01	Ψ_1	1.06
$S(h)$	1.07	H	-6.65	w^b	1.55
Y	2.57	Ω	0.28	w^r	1.74
C^e	1.47	π	0.28	y_l	0.62
I	0.58	p	2.04	u (%)	4.69
L	0.08	r	1.22	$\frac{L^e+L}{Y}$	4.25
D	0.45	$\frac{C}{Y}$	0.59	$\frac{L}{Y}$	0.03
K	19.59	$\frac{I}{Y}$	0.23	$\frac{L^e}{Y}$	0.01
W^b	0.06				

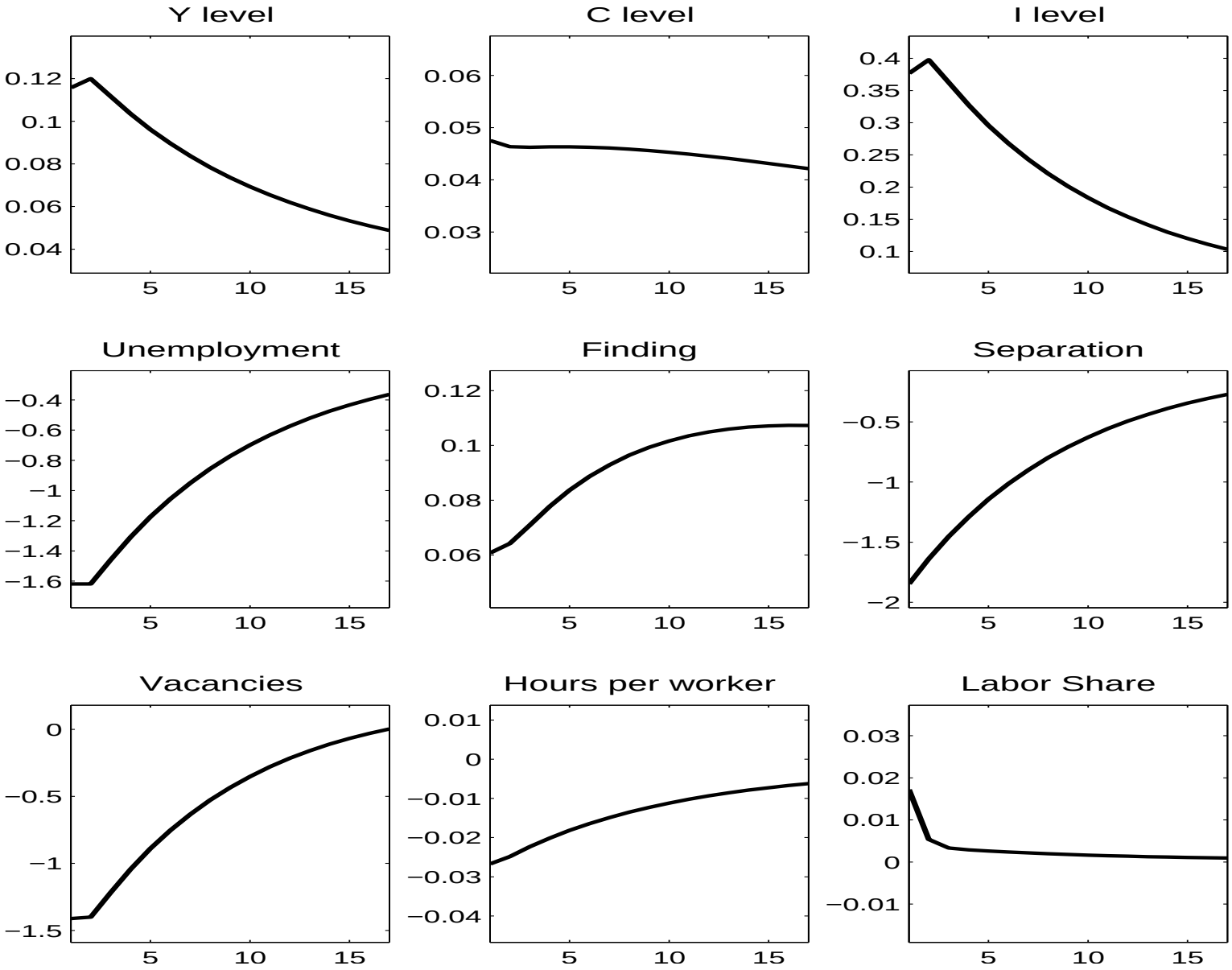
Impulse response: one SD increase in a_t



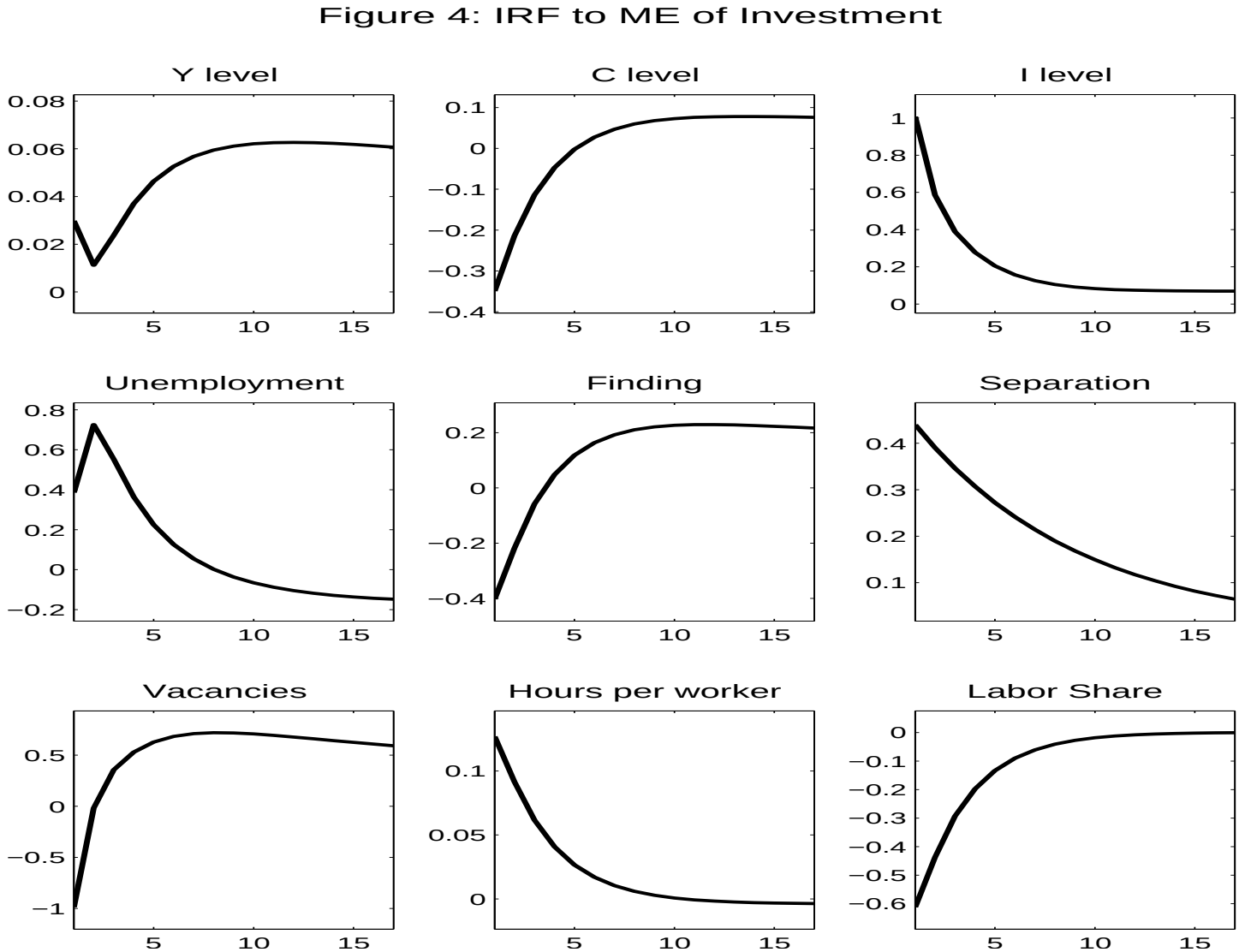
Impulse response: one SD increase in z_t



Impulse response: one SD increase in λ_t

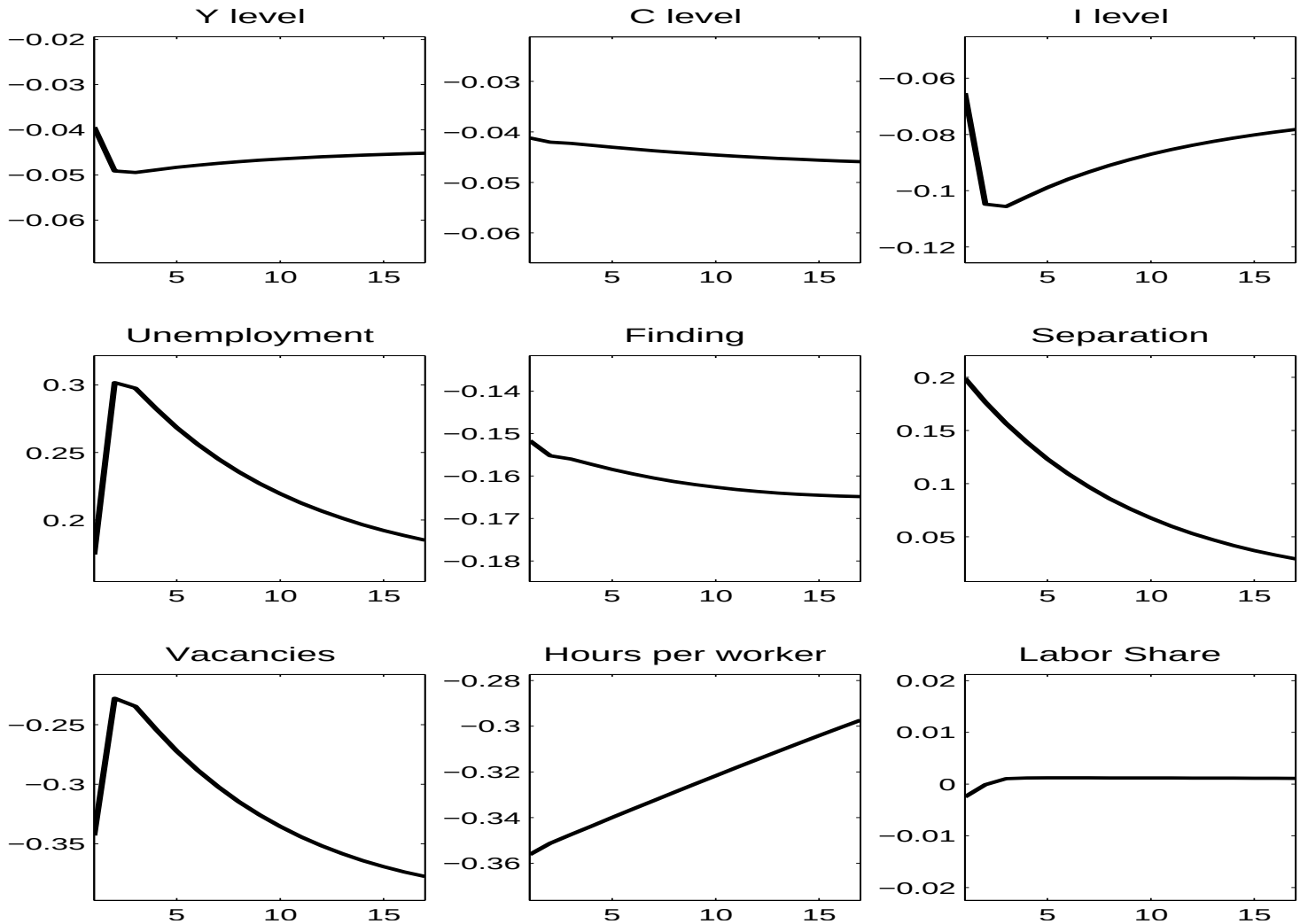


Impulse response: one SD increase in φ_t



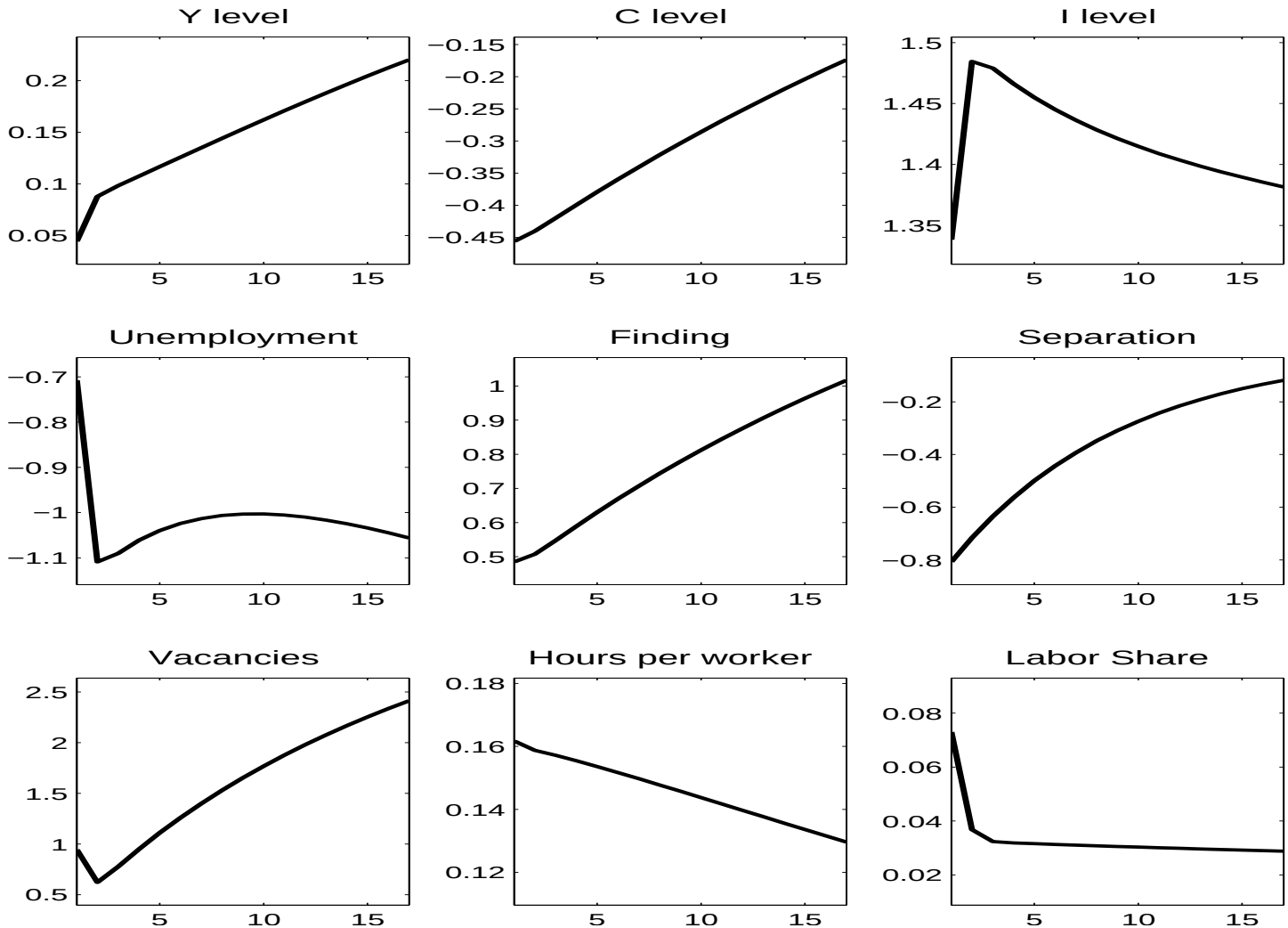
Impulse response: one SD increase in ψ_t

Figure 5: IRF to Labor Preference



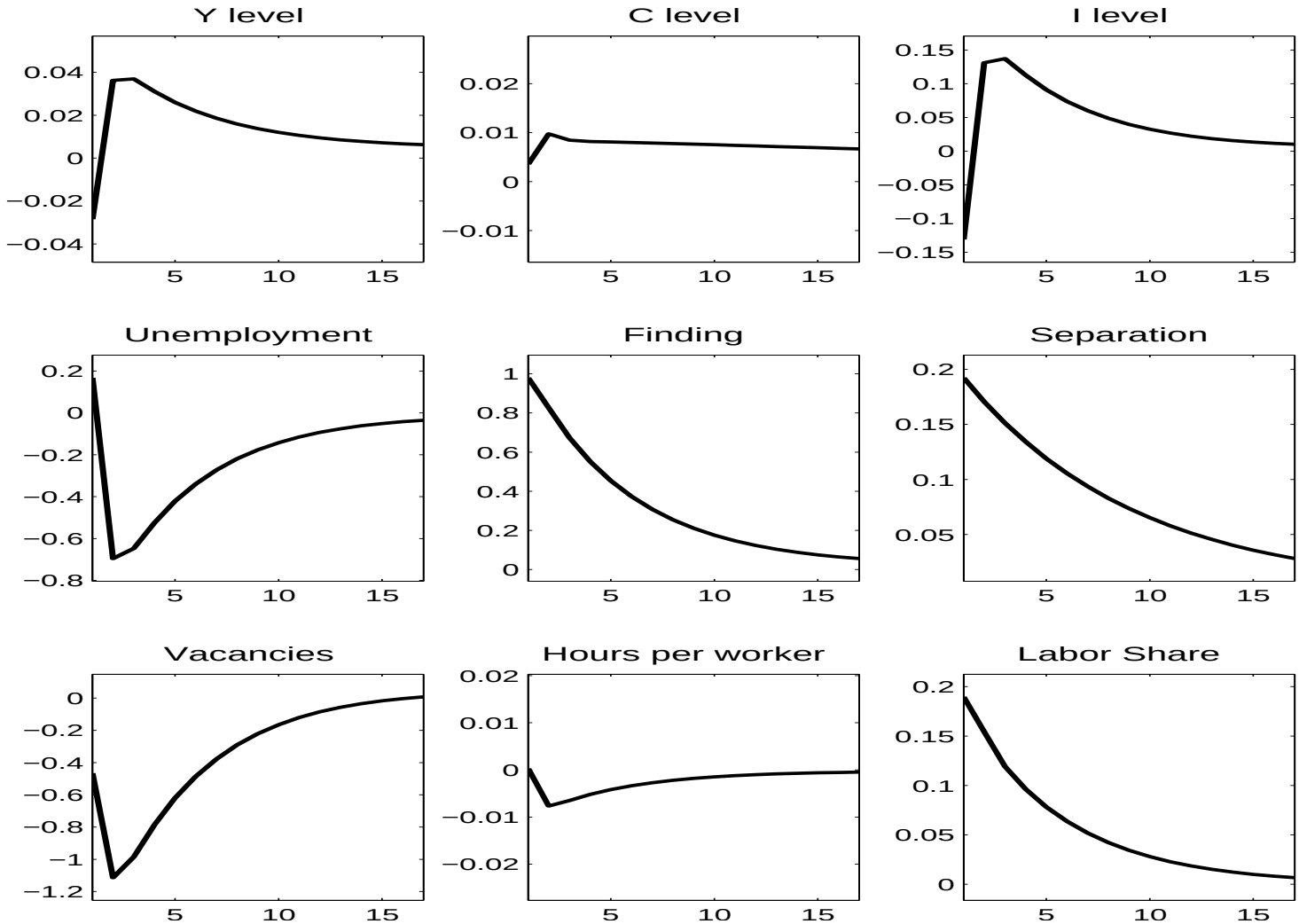
Impulse response: one SD increase in b_t

Figure 7: IRF to Discount Factor



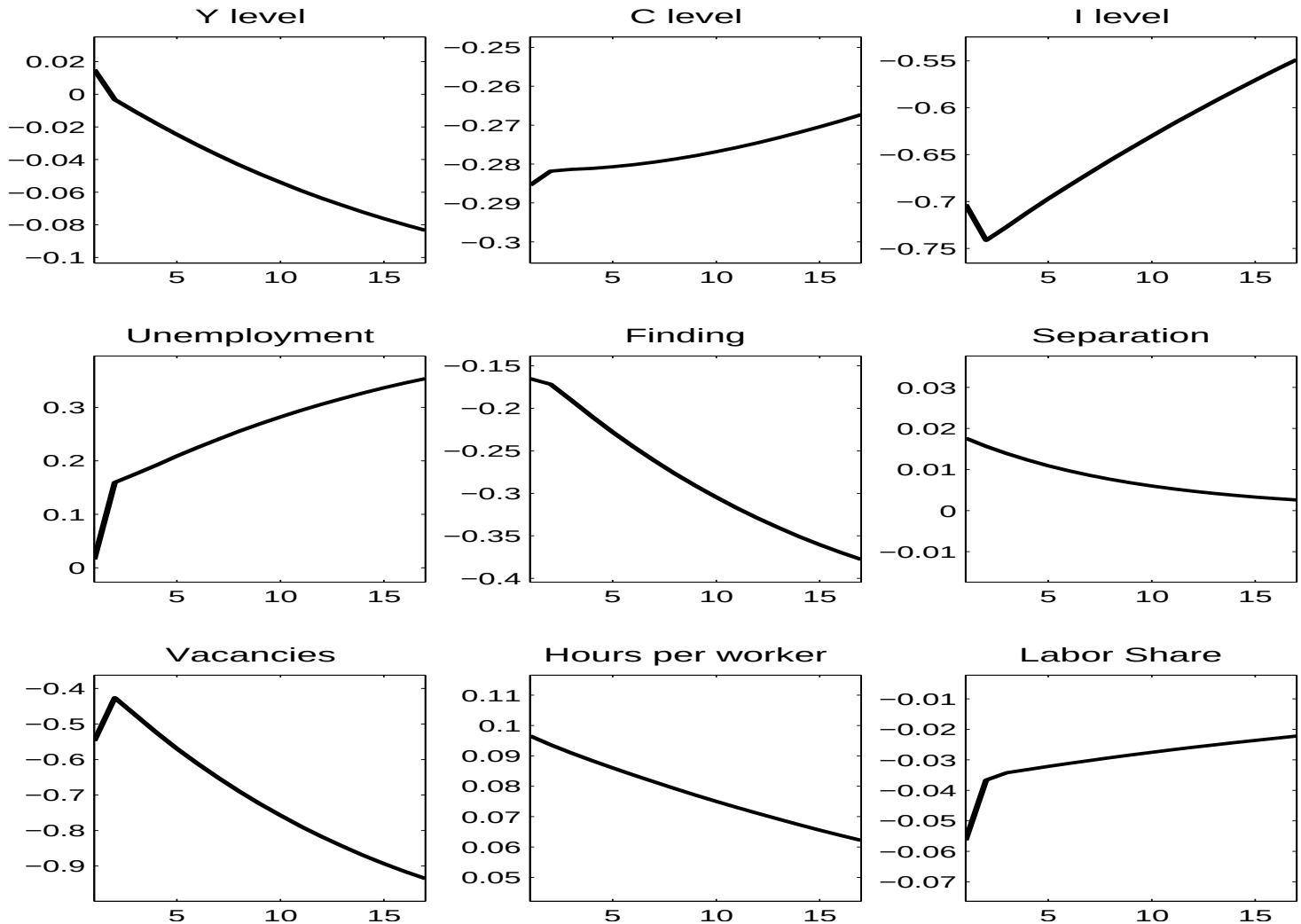
Impulse response: one SD increase in m_t

Figure 9: IRF to Matching

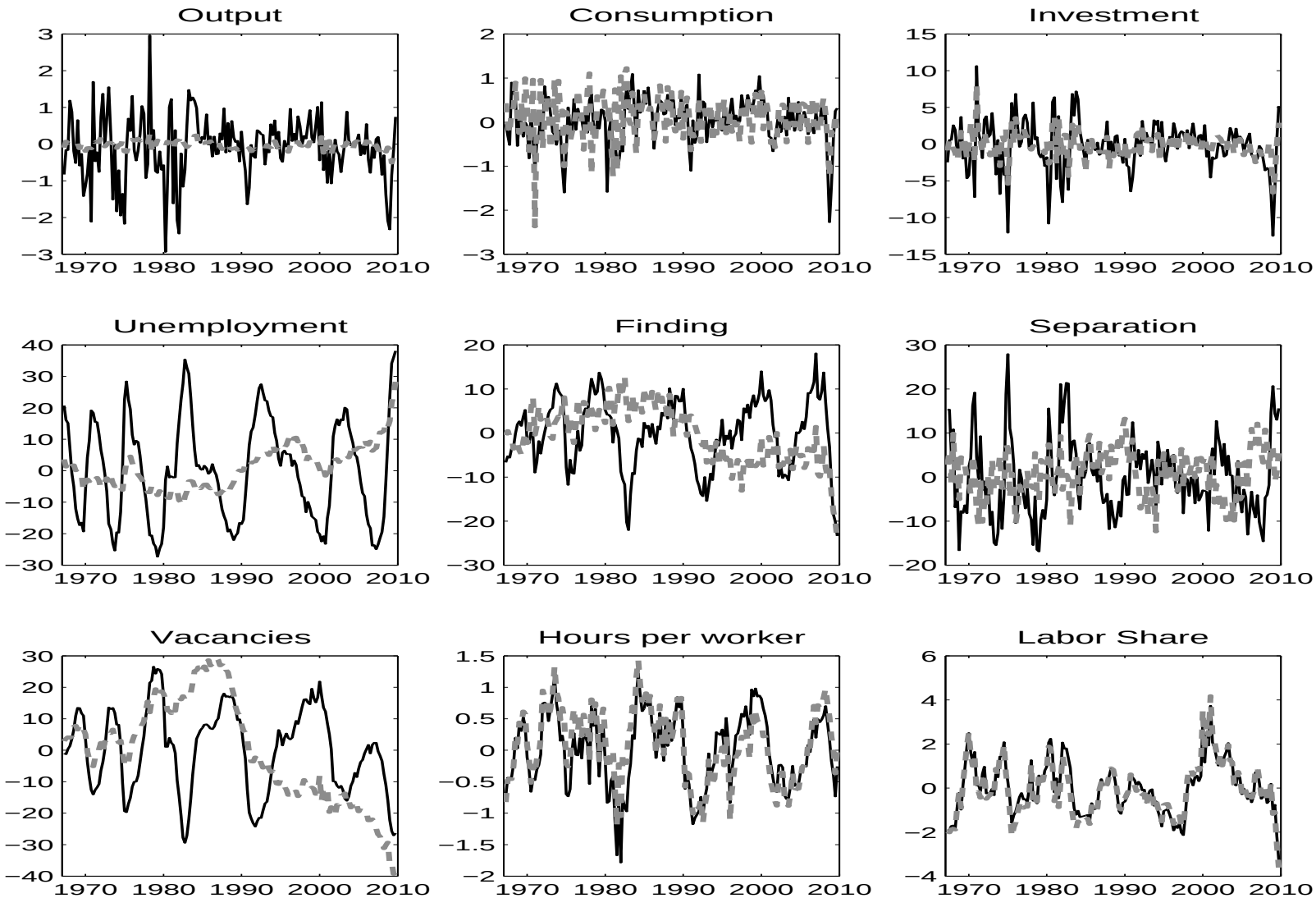


Impulse response: one SD increase in d_t

Figure 8: IRF to Aggregate Demand

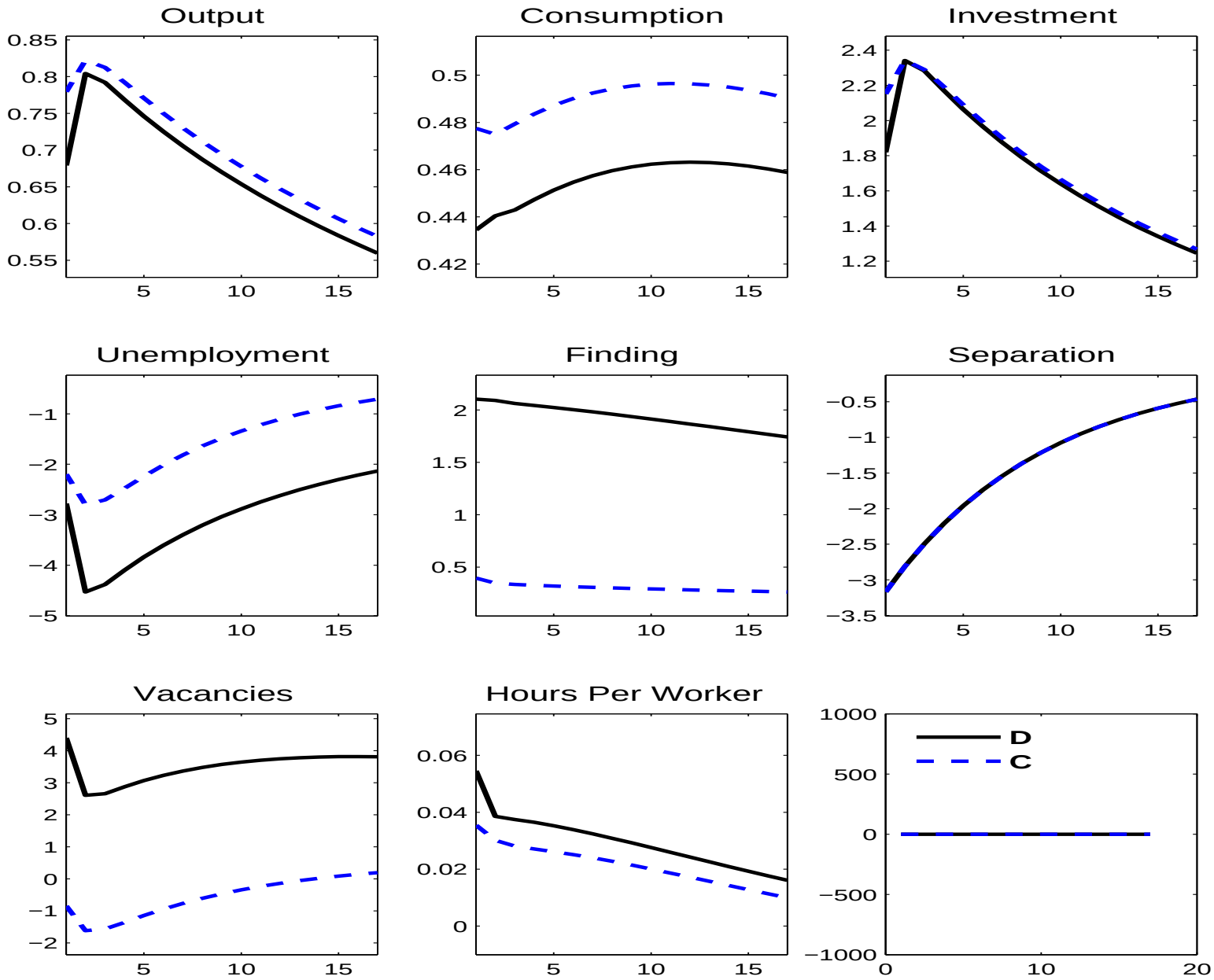


Contribution of all other shocks

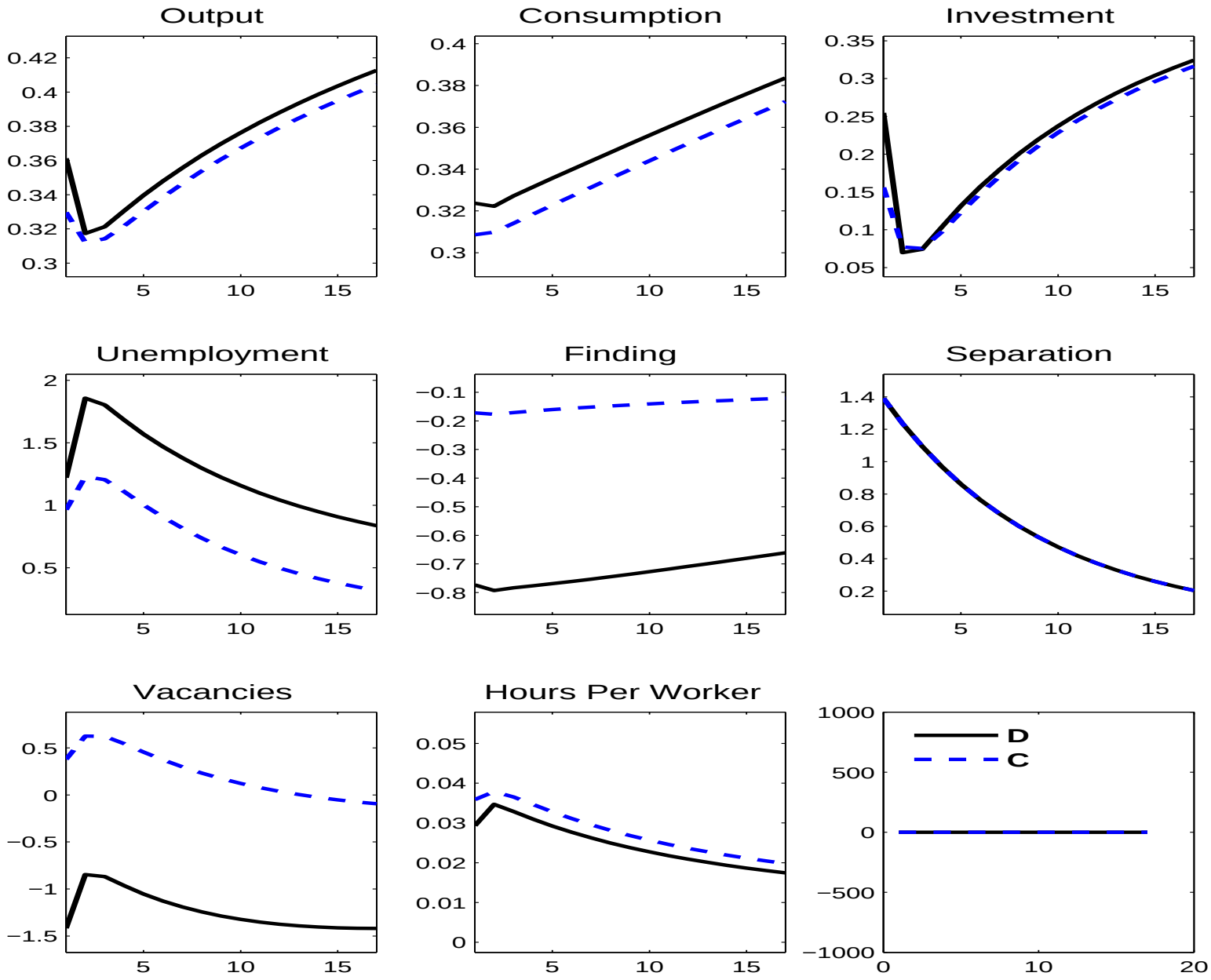


Data (solid black) and counterfactual (grey dashed)

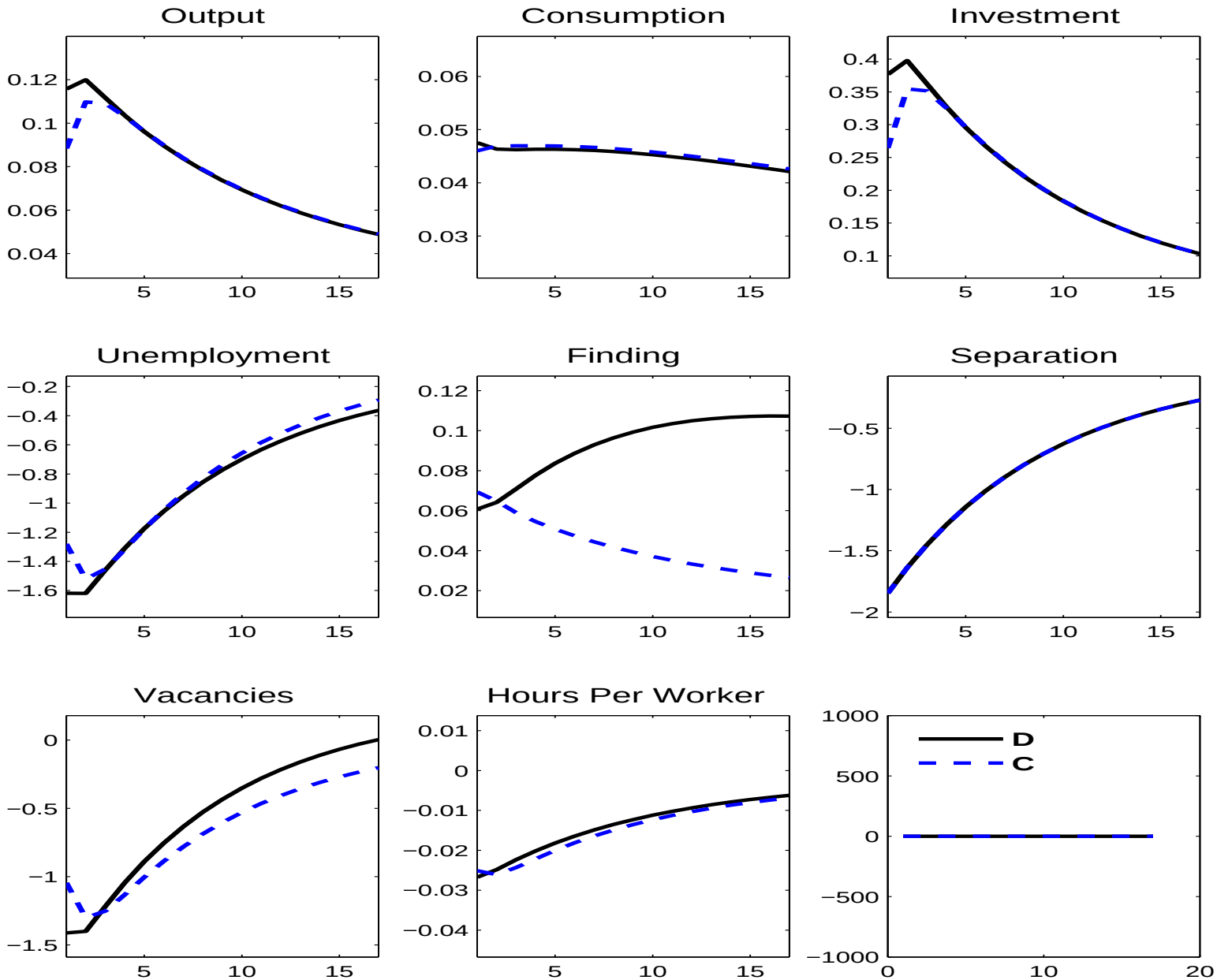
Impulse response: Decentralized vs efficient a_t



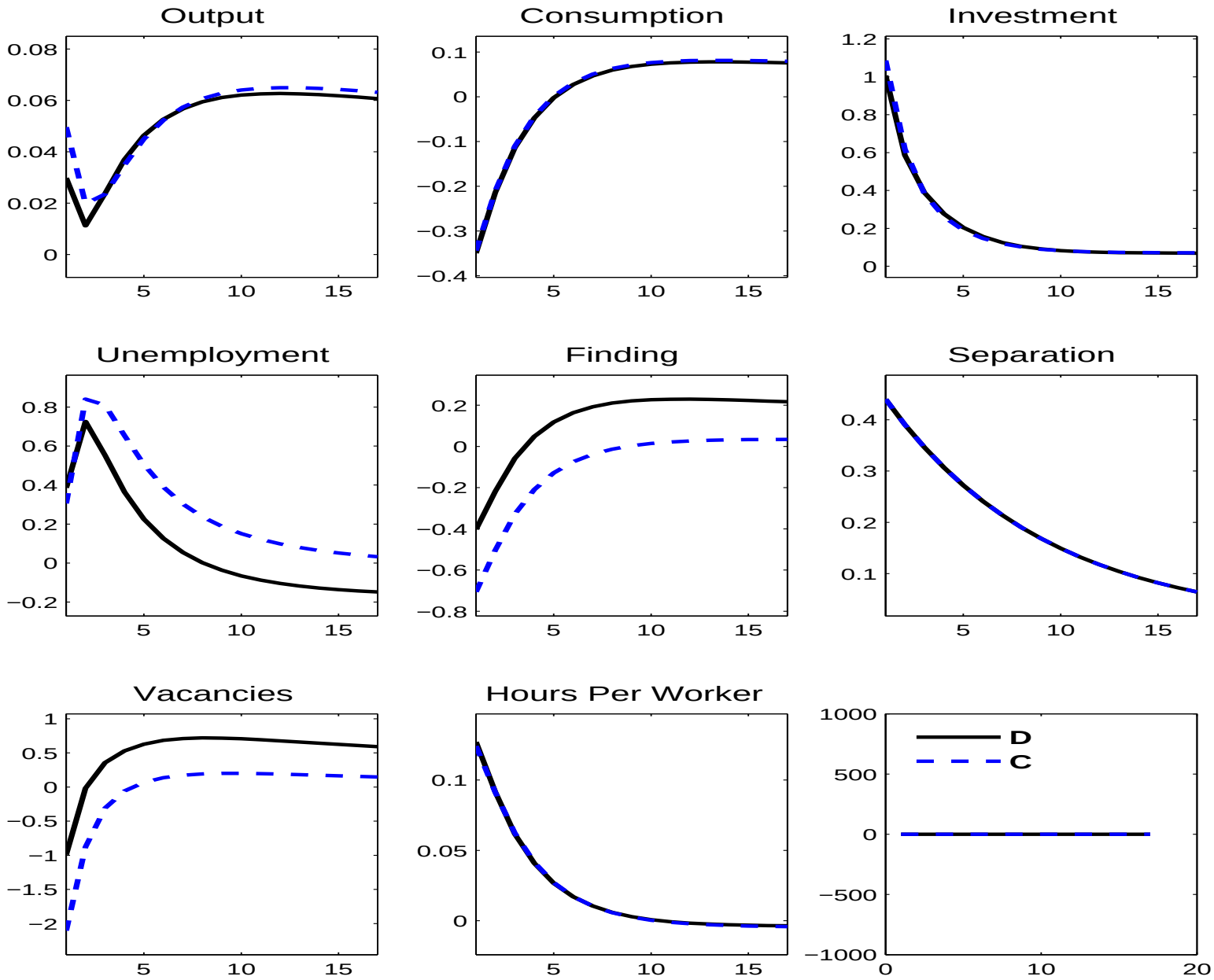
Impulse response: Decentralized vs efficient z_t



Impulse response: Decentralized vs efficient in λ_t



Impulse response: Decentralized vs efficient φ_t



Impulse response: Decentralized vs efficient m_t