Long Live the Vacancy!

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Flow vacancies vs. long-lived vacancies

- MP Simplifying Assumption I: A vacancy must be "re-created" every period. Free Entry (Infinite elasticity of vacancy creation).
- "Long-lived vacancies" (LLV) arise if there is a setup-up cost. Once the cost is paid, the vacancy will exist until destroyed.

Very few papers use LLV:

- Fujita and Ramey (2007) suggests that LLV make it even harder to explain U fluctuations (smaller amplification)
- Shao and Silos (2013)
  - LLV generate realistic autocorrelation of vacancy stock.
  - LLV generate large U fluctuations
  - . . . in the context of a model with capital, too volatile investment

Constant vs. endogenous separations

- MP Simplifying Assumption II: constant separation rate.
- Motivated by Shimer (2012): U fluctuations mostly caused by variations in job finding rate, not variations in **separation rate**.
- Despite ample evidence of counter-cyclical **job destruction**.

Papers with time-varying separation rate:

- Mortensen and Pissarides (1994), den Haan, Ramey, and Watson (2000): endogenous separation; only small negative correlation between U and vacancies (Beveridge curve).
- Coles and Moghaddasi Kelishomi (2014): exogenous job destruction shocks.

LLV and endogenous separations

- Coles and Moghaddasi Kelishomi (2014)
  - LLV
  - Exogenous shocks to job separation: abrupt spikes, negatively correlated with productivity shocks ($\rho_{p,\sigma} = -0.6$)
  - Mechanism: spike in job separation increases unemployment, depletes the stock of vacancies, thereby reduces the job finding probability.
    Job separation explains job finding!
- Our methodological contribution:
  - Only one shock: labor productivity
  - Endogenous separation,
    explaining both job and match destruction
  - Clarify role of LLV vs. endogenous separation

Main results

- Both long-lived vacancies (LLV) and endogenous job separation, and their interaction, help to reconcile the labor market matching model with the data.
  - LLV reduce the need to generate large variability in new vacancy posting.
  - Endogenous job separation opens a second margin for productivity fluctuations to affect the labor market.
- Model with long-lived vacancies (LLV) and endogenous job separation matches a large set of moments very well.
- One-shock model explains almost all fluctuations in US labor market 1951-2014.

Aggregate shock

One aggregate shock: labor productivity

$$\ln y_t = \rho_y \ln y_{t-1} + \sigma_y \epsilon_t. \tag{1}$$

A worker-firm pair produces y_t.

Vacancies

- Every period there is a unit mass of potential vacancies.
- Firms that want to open a vacancy pay a one-time stochastic vacancy posting cost $\kappa_v \sim \mathcal{V}$ (Fujita and Ramey 2007; Coles and Moghaddasi Kelishomi 2014).
- Flow of new vacancies:

$$n_t = \mathcal{V}(V_t^V). \tag{2}$$

- A vacancy remains open until exogenously destroyed with probability δ_v, or filled with filling probability ϕ_t^f.

Value of Vacancy

- Value of a vacancy:

$$V_t^V = -\kappa_i + \phi_t^f V_t^C + (1 - \phi_t^f)\beta \mathbb{E}_t \left\langle (1 - \delta_v t + 1) V_{t+1}^V \right\rangle \quad (3)$$

where

- V_t^C: continuation value of being matched with a worker.
- κ_i: cost of idle capital

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  - V_t^C: continuation value of being matched with a worker.
  - κ_i: cost of idle capital

- When producing, firms pay

  - wage w_t
  - capital cost κ_k

Value of a filled job:

$$V_t^J = y_t - w_t - \kappa_k + V_t^C. \tag{4}$$

Separations

- Occasional costs need to be paid in order to maintain an employment relationship.
- Upon separation of an employment relationship, the job can either survive (match destruction) or be destroyed (job destruction).
- A job destruction event occurs with probability λ_j: firms draw a job maintenance cost κ_j from distribution $\mathcal{J}$. Firm pay cost and continue match if $\kappa_j \leq V_t^J$. Otherwise, match is destroyed, no vacancy.
  Hence, a job is destroyed with probability $\delta_{j_t} = \lambda_j \left(1 - \mathcal{J}\left(V_t^J\right)\right)$.

Separations, ctd.

- Similarly, a match destruction event occurs with probability λ_m.
- Upon arrival of a match destruction event, firms draw a match maintenance cost κ_m from distribution $\mathcal{M}$.
- If $\kappa_m \leq V_t^J - V_t^V$, firms pay the cost and continue the relationship. Otherwise the match dissolves and the vacancy enters the existing stock of vacancies to be refilled.
- Hence, a match is destroyed with probability $\delta_m = (1 - \lambda_j)\lambda_m \left(1 - \mathcal{M}\left(V_t^J - V_t^V\right)\right)$.
- The overall separation rate is consequently given by $\delta_t = \delta_{mt} + \delta_{jt}$.

Firm-continuation value of an employment relationship

$$
\begin{aligned}
V_t^C &= \beta \mathbb{E}_t \Big\{ (1-\lambda_j)(1-\lambda_m) V_{t+1}^J \\
&+ \lambda_j \left[\mathcal{J}\left(V_{t+1}^J\right) V_{t+1}^J - \int_{-\infty}^{V_{t+1}^J} \kappa_j \mathsf{d}\mathcal{J}(\kappa_j) \right] \\
&+ (1-\lambda_j)\lambda_m \Big[\left(1 - \mathcal{M}\left(V_{t+1}^J - V_{t+1}^V\right)\right)(1-\delta_v) V_{t+1}^V \\
&\quad + \mathcal{M}\left(V_{t+1}^J - V_{t+1}^V\right) V_{t+1}^J \\
&\qquad - \int_{-\infty}^{V_{t+1}^J - V_{t+1}^V} \kappa_m \mathsf{d}\mathcal{M}(\kappa_m) \Big] \Big\} \qquad (5)
\end{aligned}
$$

Workers

- Every worker who is employed in period t receives wage w_t,
- every searcher receives b.
- Searchers find jobs with probability ϕ_t^w

Values for being employed (V_t^E) and unemployed (V_t^U):

$$V_t^E = w_t + \beta \mathbb{E}_t \left\langle V_{t+1}^E - \delta_{t+1} \left(V_{t+1}^E - V_{t+1}^U \right) \right\rangle , \quad (6)$$

$$V_t^U = b + \beta \mathbb{E}_t \left\langle V_{t+1}^U + \phi_{t+1}^w (1 - \delta_{t+1}) \left(V_{t+1}^E - V_{t+1}^U \right) \right\rangle \quad (7)$$

Transitions

- CRS matching function in unemployment u_t and vacancies, v_t:

$$M(u_t, v_t) = A u_t^{\alpha} v_t^{1-\alpha}$$

- Job finding and filling probability:

$$\phi_t^w = \frac{M(u_t, v_t)}{u_t}, \quad \phi_t^f = \frac{M(u_t, v_t)}{v_t}.$$

- Dynamics of unemployment

$$\begin{aligned} u_t &= \delta_t e_{t-1} + \left(1 - \phi_{t-1}^w (1 - \delta_t)\right) u_{t-1} \\ e_t &= 1 - u_t. \end{aligned}$$

Vacancy dynamics

$$v_t \quad = \quad \left(1 - \delta_v t - \phi^f_{t-1}(1 - \delta_{mt})\right) v_{t-1} + \delta_{mt} e_{t-1} + n_t . \quad (8)$$

Vacancies in period t are

- surviving vacancies of the previous period
- less successful matches (those vacancies that were matched and not immediately separated by match destruction).
- plus inflow from employment relationships separated by match destruction
- plus newly formed vacancies, n,

Wages

Alternate-offer bargaining (Hall and Milgrom 2008)

- Threatpoint in bargaining is not separation, but delay; reduced effect of unemployment on wage bargaining.
- With probability δ_b negotiations break down, the worker returns to the unemployment pool
- Firm makes first offer; if worker accepts, they produce, if not:
- Worker makes counter offer in next period; if firm accepts, they produce,
  if not: firm makes counter offer next period, etc.

Data

- US: 1951 – 2003 for calibration
- US: 2003 – 2014 'out of sample'

Data sources: FRED, Business Dynamics Statistics, CPS, JOLTS.

Calibration targets

- Time period: one day (60th part of a quarter)
- Steady state wage of 64 percent of production,
- Discount factor β to 0.99 quarterly.
- Vacancy filling rate ϕ^f: 1/3 per week (Fujita and Ramey 2007; Coles and Moghaddasi Kelishomi 2014).
- Cost of an idle vacancy: 23 percent of average production (Hall and Milgrom 2008)
- Autocorrelation coefficient of labor productivity: $\rho_y = 0.92^{1/60}$,
- Unemployment replacement rate: 40 percent (Shimer 2005; Christiano, Eichenbaum, and Trabandt 2016).
- Firm profit: 2.255 percent (Hagedorn and Manovskii 2008).

Calibration

Parameter			Target
capital cost	κ_k	0.005	firm surplus
worker utility unemployed	b	0.004	replacement rate
worker utility disagreement	b_b	0.007	steady state wage
mean job maintenance cost	μ_j	0.062	mean job destr.
dispersion job maint. cost	σ_j	0.172	var. job destr.
mean job maintenance cost	μ_m	0.267	mean total sep.
dispersion job maintenance cost	σ_m	0.141	var. total sep.
probability break-up barg.	δ_b	0.006	variance U
elasticity matches w.r.t U	α	0.647	variability vacancies

Benchmark Results

Long Lived Vacancies:

	Urate		Vacancies		Finding rate		Sep. rate		real GDP	
Rel. stdev	7.27	(7.27)	7.39	(7.39)	5.18	(4.51)	2.87	(2.87)	1.00	(1.00)
Autocor.	0.95	(0.94)	0.95	(0.94)	0.95	(0.93)	0.87	(0.82)	0.93	(0.94)
Cor. GDP	-0.97	(-0.91)	0.97	(0.85)	0.97	(0.89)	-0.97	(-0.70)	1.00	(1.00)
Cor. U	1.00	(1.00)	-1.00	(-0.91)	-1.00	(-0.96)	0.88	(0.71)	-0.97	(-0.91)
WResponse	0.78									
ShimerCF	70.9									

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Cor. U	1.00	(1.00)	-1.00	(-0.91)	-1.00	(-0.96)	0.88	(0.71)	-0.97	(-0.91)
WResponse	0.78									
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Hall Milgrom:

	Urate		Vacancies		Finding rate		Sep. rate		real GDP	
Rel. stdev	7.27	(7.27)	7.39	(7.39)	7.92	(4.51)	0.00	(2.87)	1.00	(1.00)
Autocor.	0.92	(0.94)	0.80	(0.94)	0.89	(0.93)	-	(0.82)	0.91	(0.94)
Cor. GDP	-0.99	(-0.91)	0.94	(0.85)	1.00	(0.89)	-	(-0.70)	1.00	(1.00)
Cor. U	1.00	(1.00)	-0.89	(-0.91)	-0.97	(-0.96)	-	(0.71)	-0.99	(-0.91)
WResponse	0.79									
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Estimated parameter values, Intuition

	Model	Sep	RR	Pr	ξ	δ_v	δ_b/δ	DWR
1	Hall/Milgrom	c	71	1.1	∞	100.0	4.0	0.79

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2	HM,highRR	c	40	1.1	∞	100.0	2.7	0.79

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2 HM,highRR	c	40	1.1	∞	100.0	2.7	0.79
3 HM,highProf	c	40	2.3	∞	100.0	1.2	0.56

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2 HM,highRR	c	40	1.1	∞	100.0	2.7	0.79
3 HM,highProf	c	40	2.3	∞	100.0	1.2	0.56
4 HM,inelastic	c	40	2.3	1.0	100.0	0.1	0.20

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3 HM,highProf	c	40	2.3	∞	100.0	1.2	0.56
4 HM,inelastic	c	40	2.3	1.0	100.0	0.1	0.20
5 HMLLV	c	40	2.3	1.0	2.2	2.5	0.70

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4 HM,inelastic	c	40	2.3	1.0	100.0	0.1	0.20
5 HMLLV	c	40	2.3	1.0	2.2	2.5	0.70
6 LLVE,BM	e	40	2.3	1.0	2.2	3.9	0.78

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3 HM,highProf	c	40	2.3	∞	100.0	1.2	0.56
4 HM,inelastic	c	40	2.3	1.0	100.0	0.1	0.20
5 HMLLV	c	40	2.3	1.0	2.2	2.5	0.70
6 LLVE,BM	e	40	2.3	1.0	2.2	3.9	0.78
7 LLVE,elastic	e	40	2.3	∞	2.2	4.2	0.81
8 FVEndog	e	40	2.3	∞	100.0	0.6	0.36
9 FVlowProf	e	71	1.1	∞	100.0	3.3	0.70

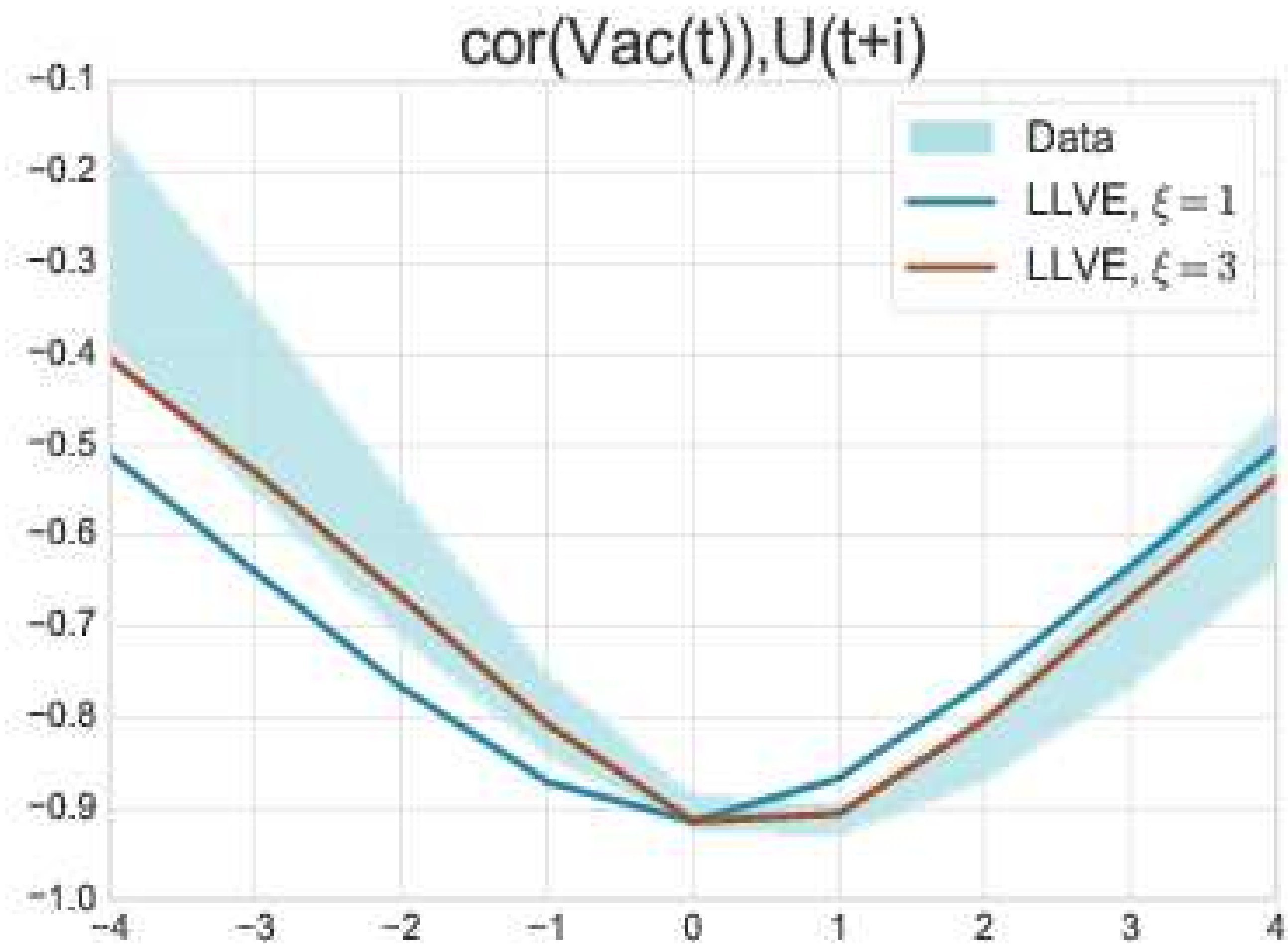
Estimated parameter values, Variable Opportunity Cost

	Model	Sep	RR	Pr	ξ	δ_v	δ_b/δ	DWR
6	LLVE,BM	e	40	2.3	1.0	2.2	3.9	0.78
21	LLVE,PropOut	e	40	2.3	1.0	2.2	2.3	0.82
1	Hall/Milgrom	c	71	1.1	∞	100.0	4.0	0.79
20	HM,PropOut	c	71	1.1	∞	100.0	1.8	0.79

Relative standard deviations, different models

		pueW	peuW	nMatch	nVac	VJ
	Data	4.46	2.74	3.22		
1	Hall/Milgrom	7.92	0.00	1.88	7.39	6.36
6	LLVE,BM	5.18	2.87	2.09	1.73	1.48
14	LLVE,Prof=9	5.42	2.87	1.92	0.59	0.24
16	LLVE,xi=2	5.08	2.87	2.22	2.41	1.80
19	LLVE,dV*10	5.05	2.87	2.26	1.56	3.51
21	LLVE,PropOut	5.14	2.87	2.13	1.74	1.38

Dynamic correlations



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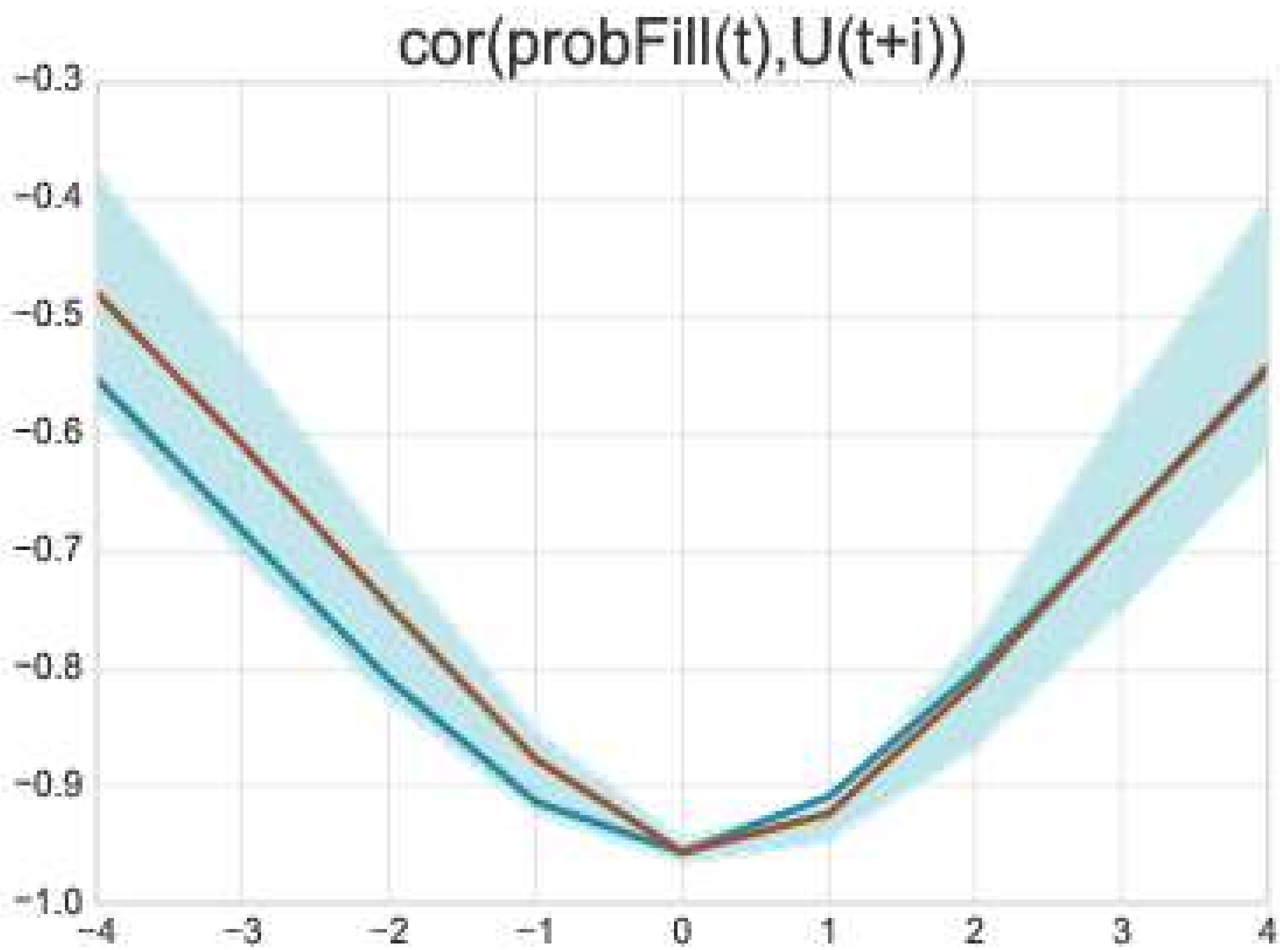

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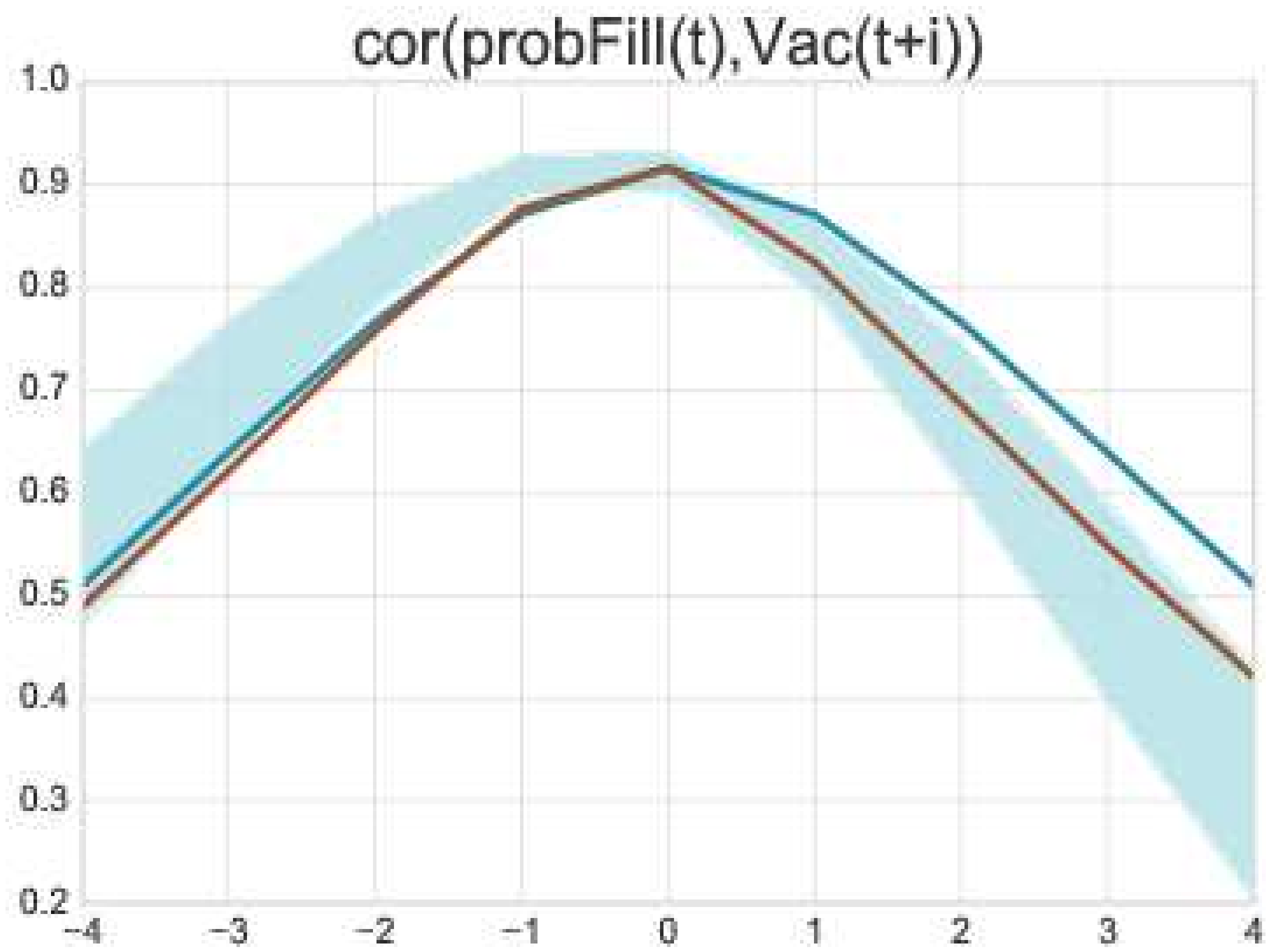

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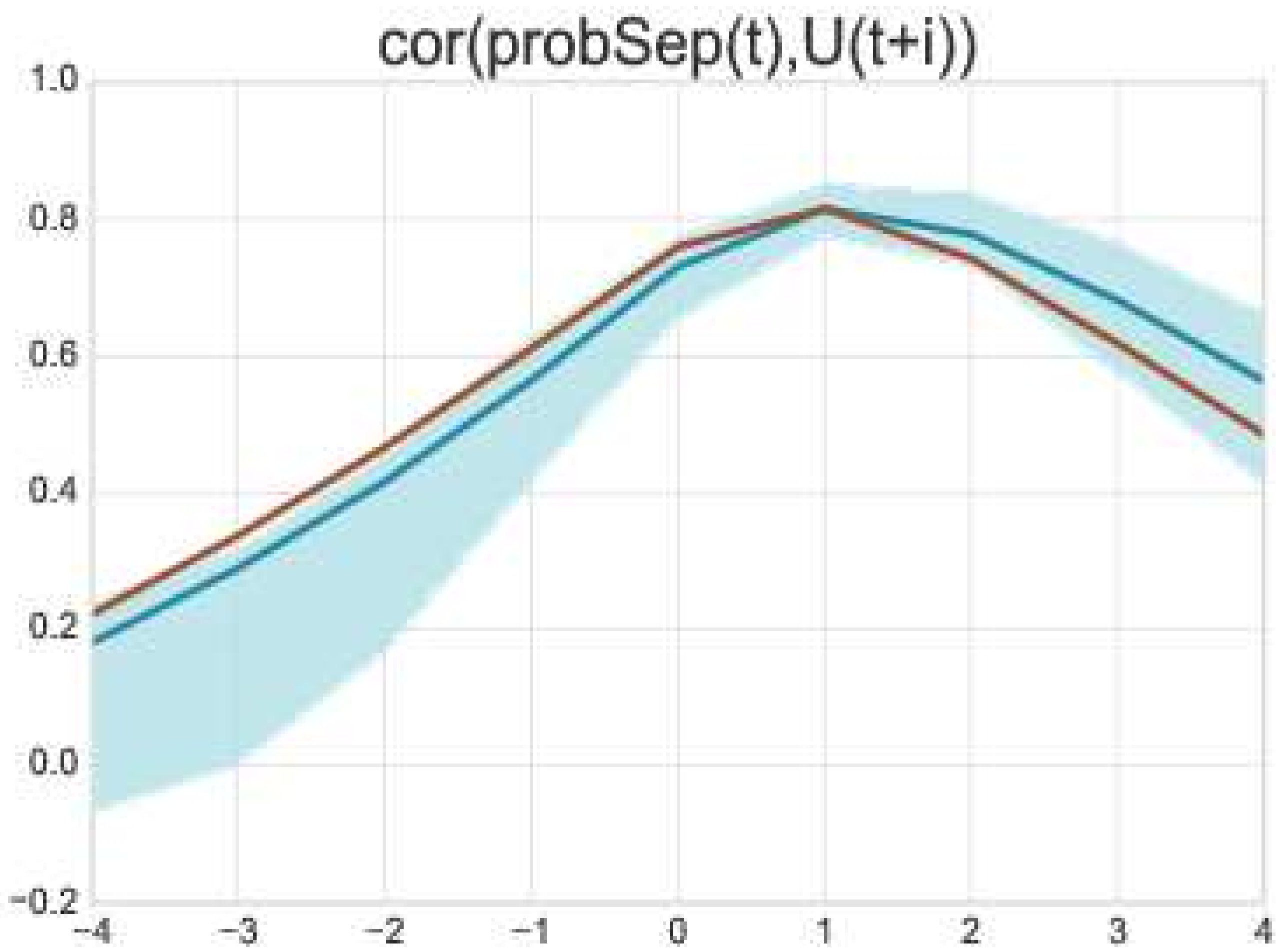

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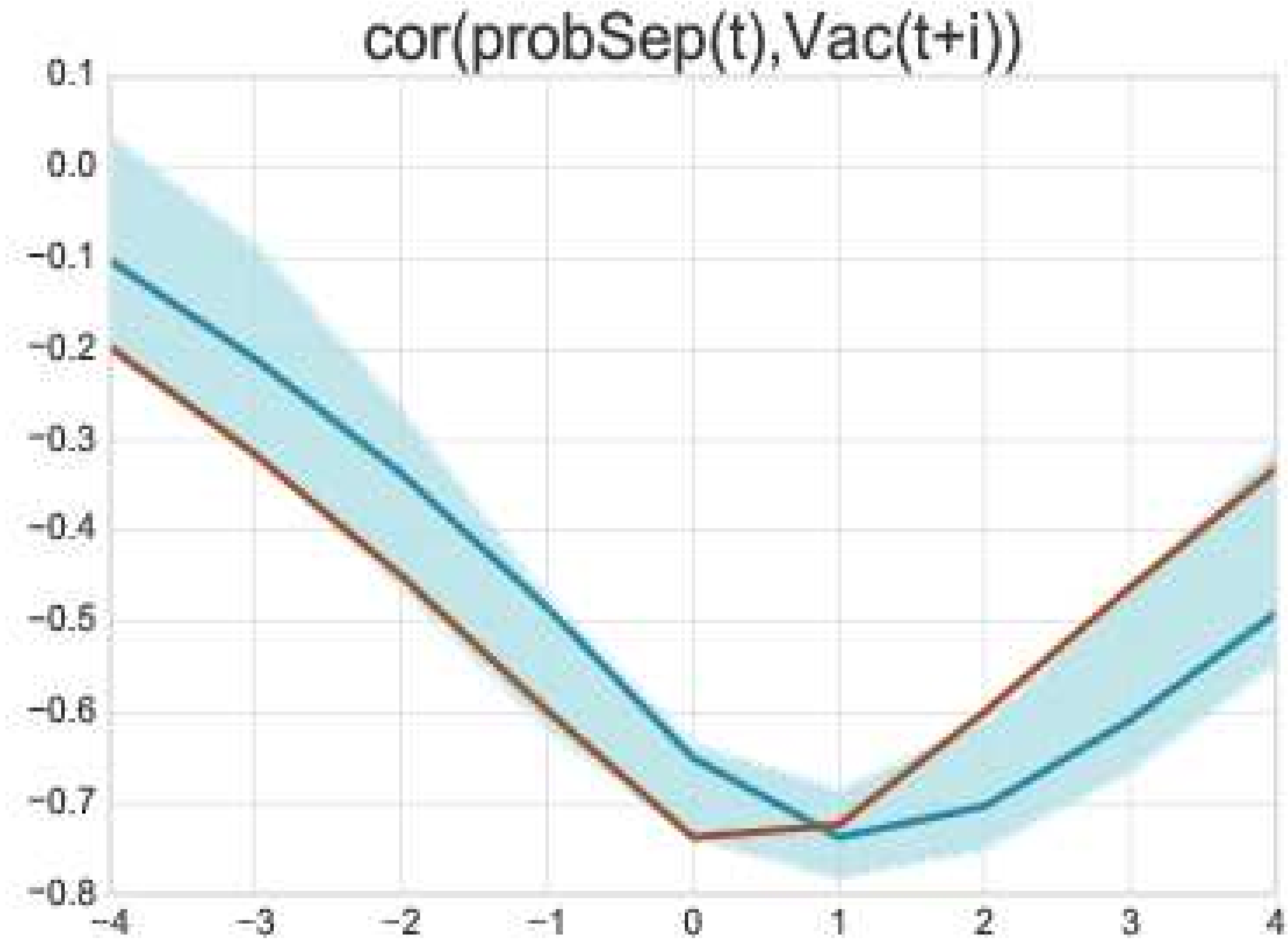

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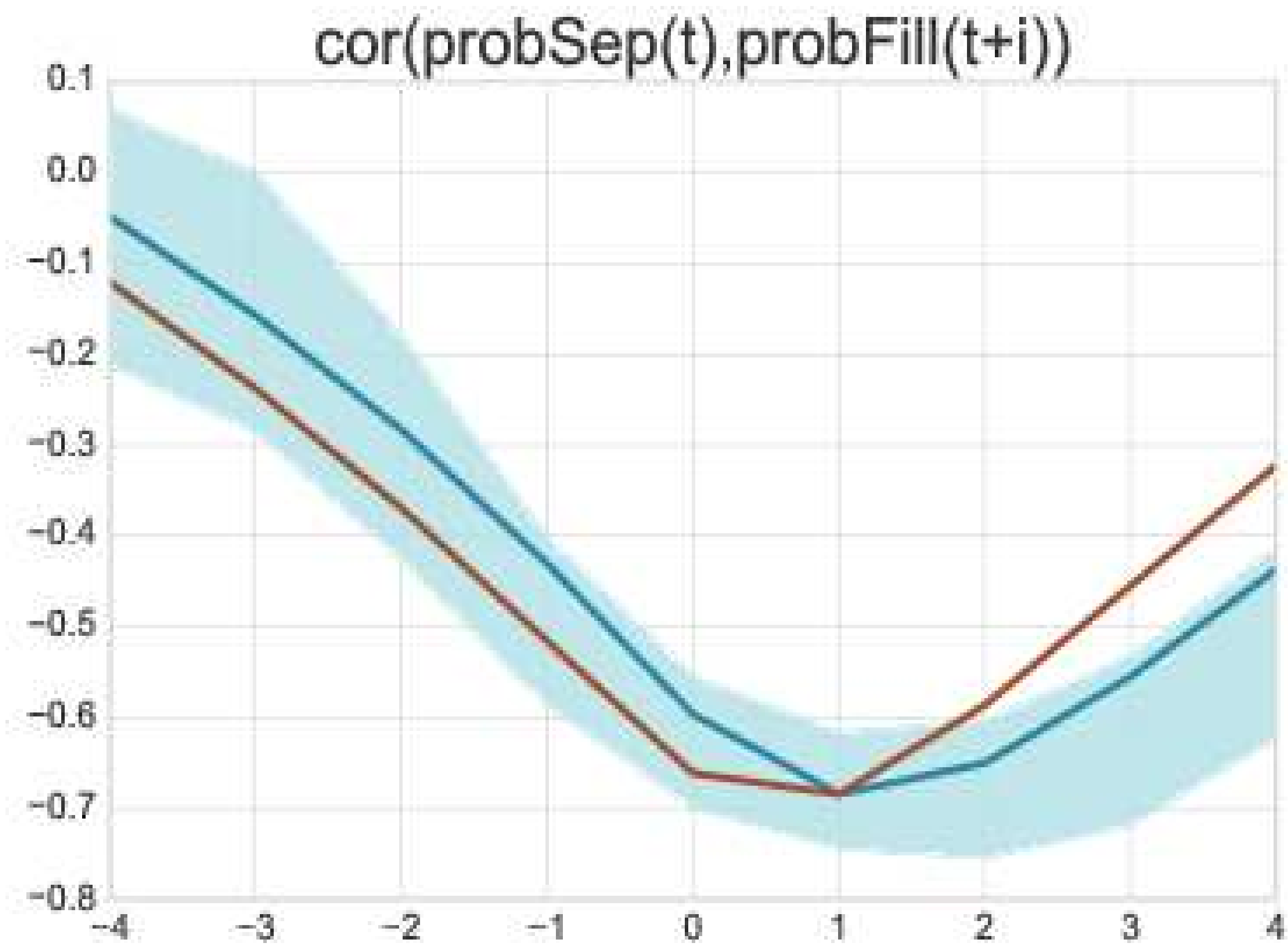
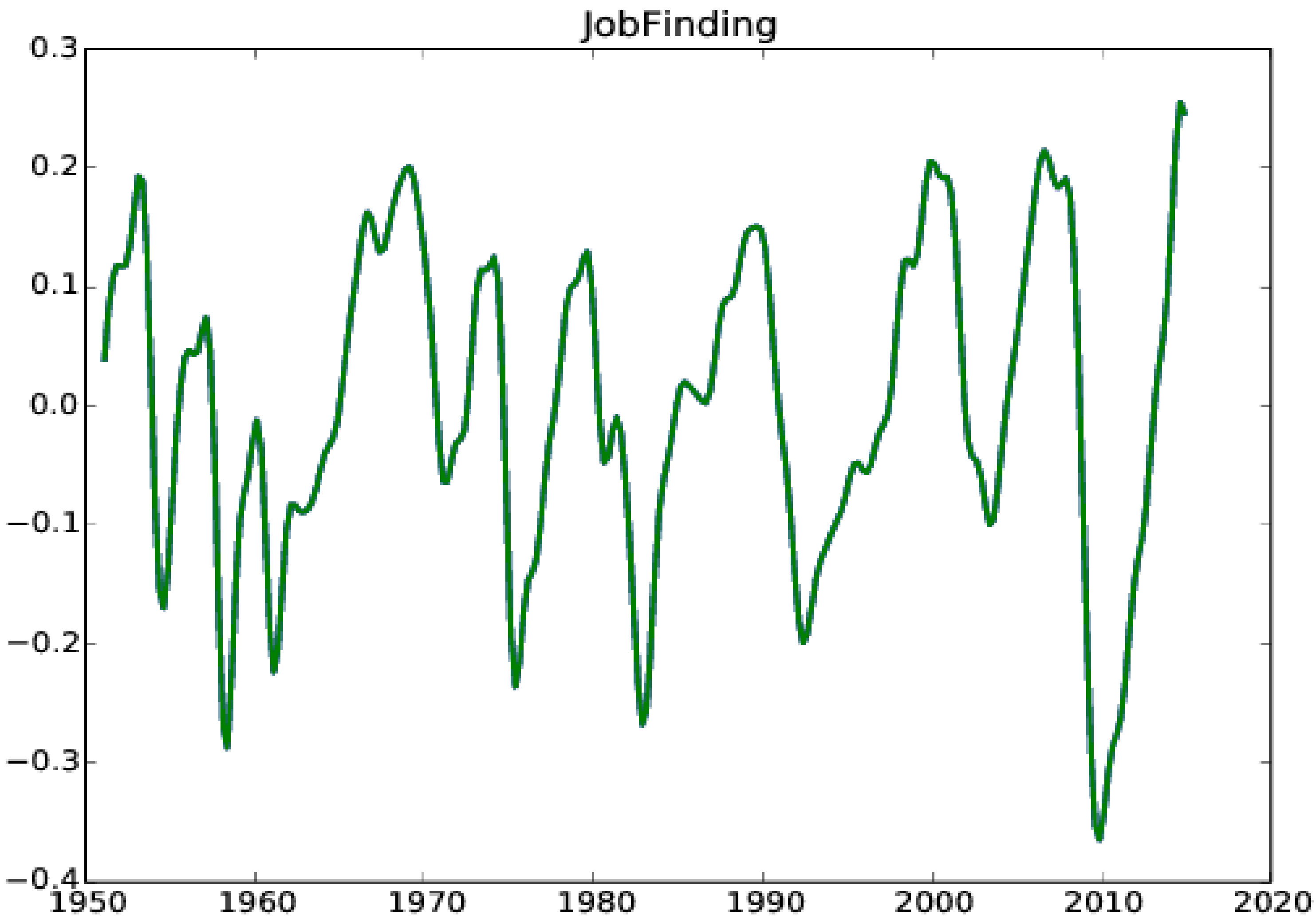


Key Labor Market Variables for Estimated Model



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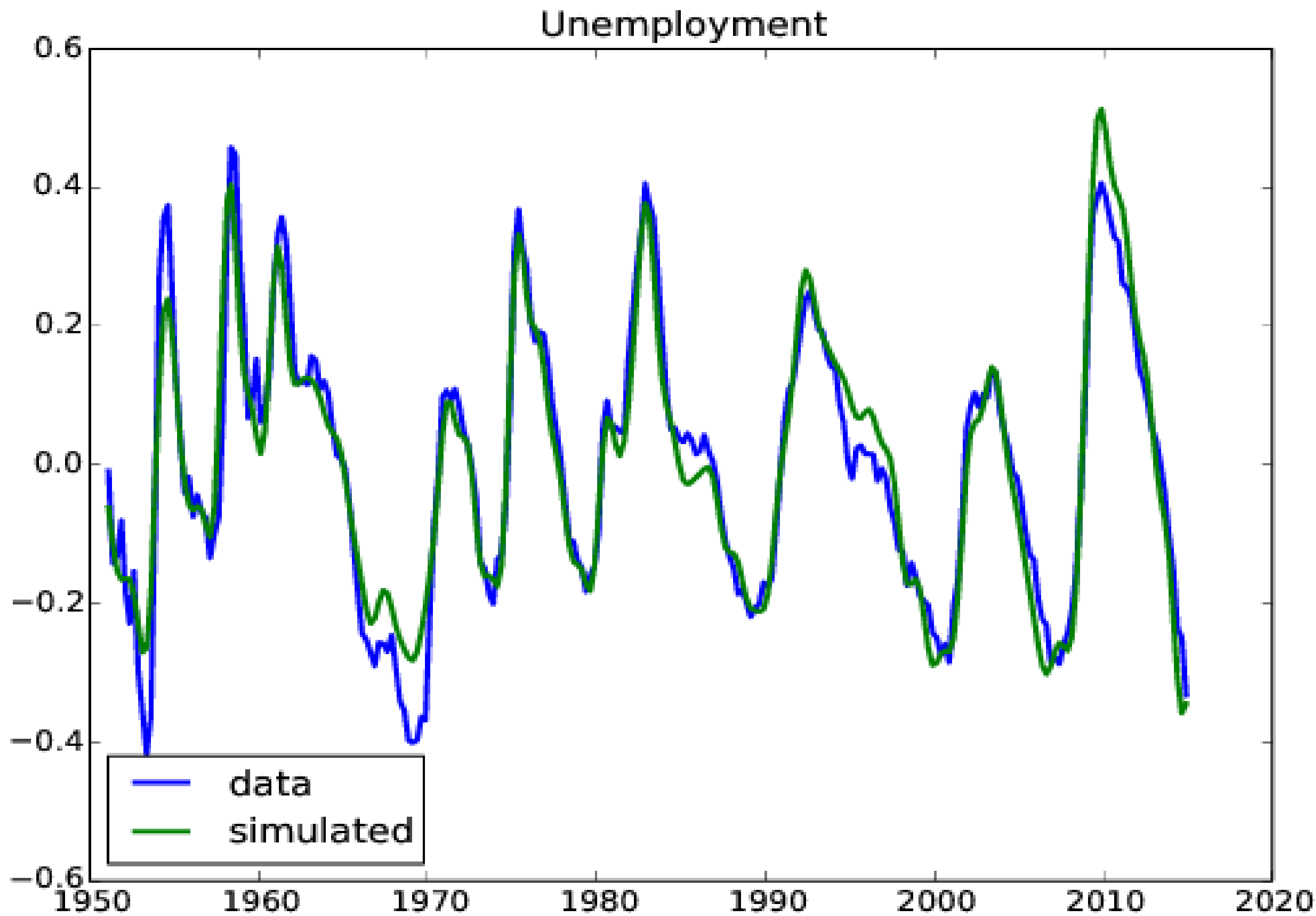

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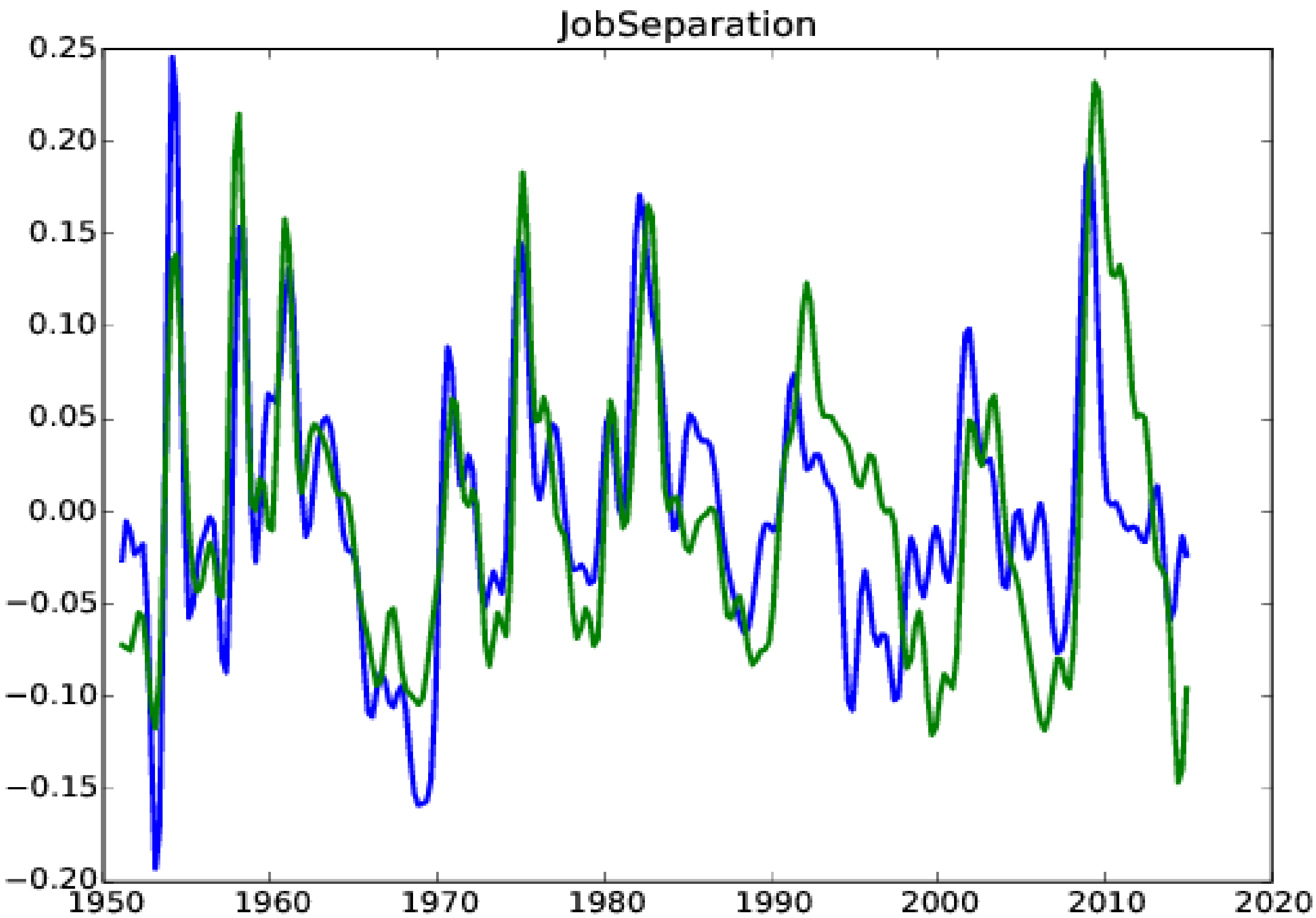

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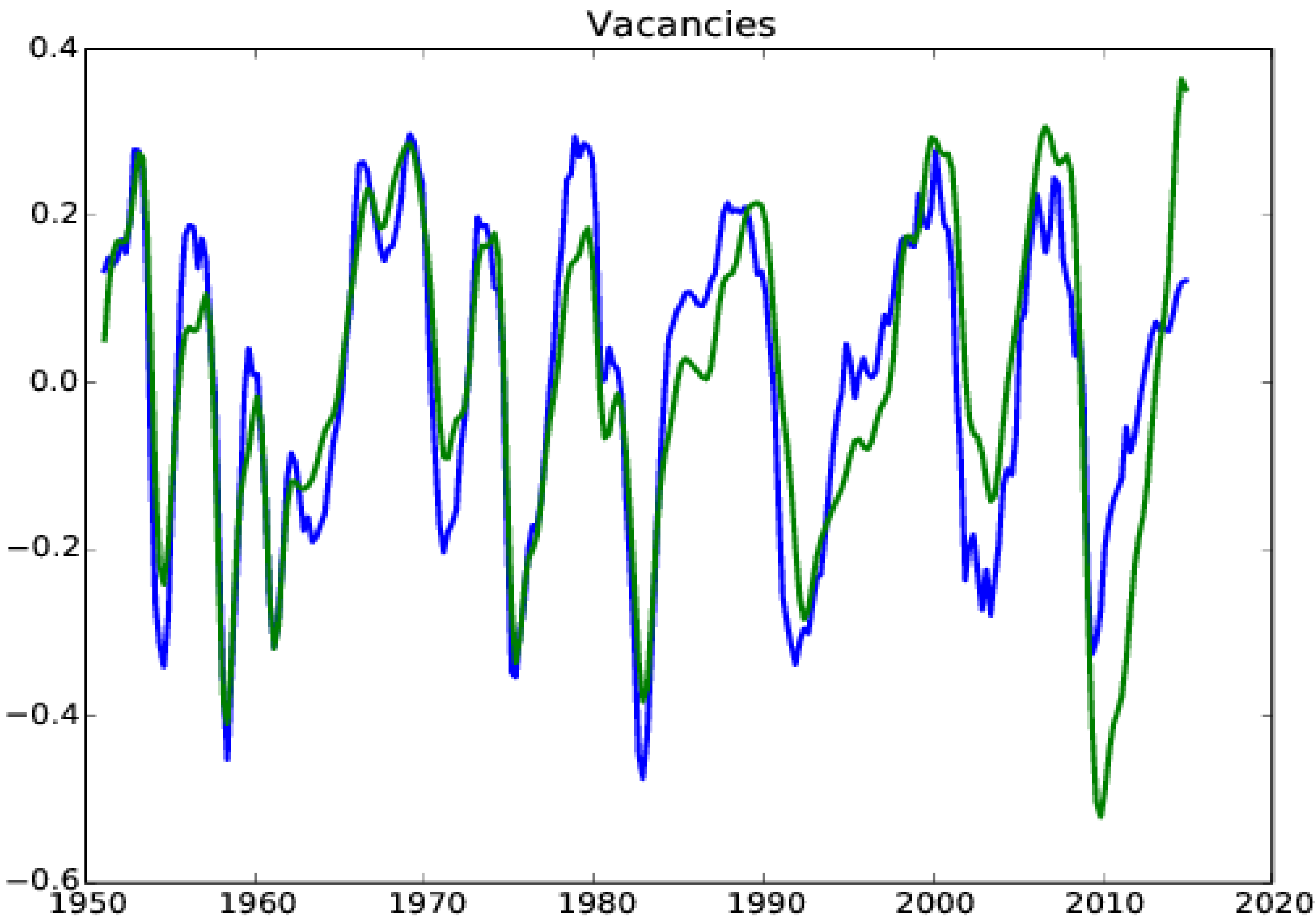

Conclusions

Key Features:

- Long-lived vacancies;
- Diamond Entry;
- no separation upon disagreement in wage bargaining;
- endogenous separations.

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- no separation upon disagreement in wage bargaining;
- endogenous separations.

Key Results

- reasonable model dynamics;
  - substantial endogenous persistence;
  - sizeable unemployment fluctuations;
  - robust to time varying opportunity cost of employment;
- one-shock model matches data well.

Thank You

… very much for your attention.

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den Haan, W., G. Ramey, and J. Watson (2000). Job destruction and propagation of shocks. *American Economic Review 90*, 482–498.

Fujita, S. and G. Ramey (2007). Job matching and propagation. *Journal of Economic Dynamics and Control 31*, 3671–3698.

Hagedorn, M. and I. Manovskii (2008). The cyclical behavior of equilibrium unemployment and vacancies revisited. *Amer-*

Contribution of job finding to unemployment fluctuations

- Shimer (2012) approximation:
  - $$u_t \approx \frac{\delta_t}{\delta_t + \phi_t^w} \tag{9}$$
  - Contribution of job finding: keep separations constant:
    $$u_t^{Find} \approx \frac{\bar{\delta}}{\bar{\delta} + \phi_t^w} \tag{10}$$
  - US data: job findings account for ≈ 75 % of U fluctuations; even more in last 20 years ("SCF")
- Contribution based on LLVE model:
  - Use constant separation rate
  - Use new vacancy postings from LLVE model solution

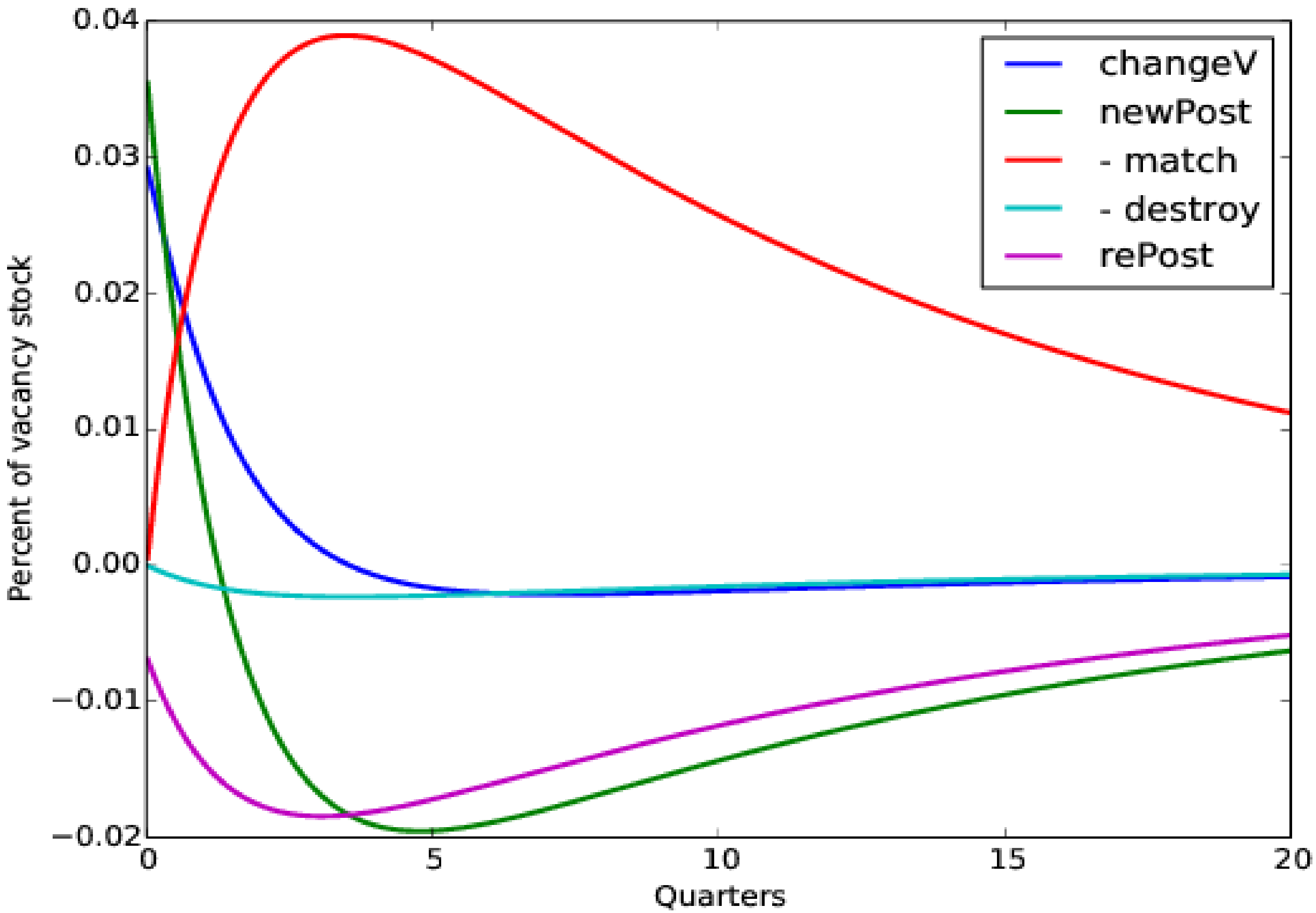
Relative standard deviations, different models

		pueW	peuW	nMatch	nVac	VJ
	Data	4.46	2.74	3.22		
1	Hall/Milgrom	7.92	0.00	1.88	7.39	6.36
2	HM,highRR	7.92	0.00	1.88	7.39	6.36
3	HM,highProf	7.92	0.00	1.88	7.39	6.36
4	HM,inelastic	7.88	0.00	1.69	7.39	11.73
5	HMLLV	7.78	0.00	1.15	2.34	2.92
6	LLVE,BM	5.18	2.87	2.09	1.73	1.48
7	LLVE,elastic	5.05	2.87	2.62	4.48	2.14
8	FVEndog	5.05	2.87	2.63	7.38	9.24
9	FVlowProf	5.05	2.87	2.63	7.38	9.24
10	HM,Prof=0.2	7.92	0.00	1.88	7.39	6.35
11	HM,Prof=0.5	7.92	0.00	1.88	7.39	6.35
12	HM,Prof=3	7.92	0.00	1.88	7.39	6.36
13	LLVE,Prof=5	5.35	2.87	1.96	0.93	0.48
14	LLVE,Prof=9	5.42	2.87	1.92	0.59	0.24
15	LLVE,xi=0.5	5.32	2.87	1.98	1.08	1.14
16	LLVE,xi=2	5.08	2.87	2.22	2.41	1.80

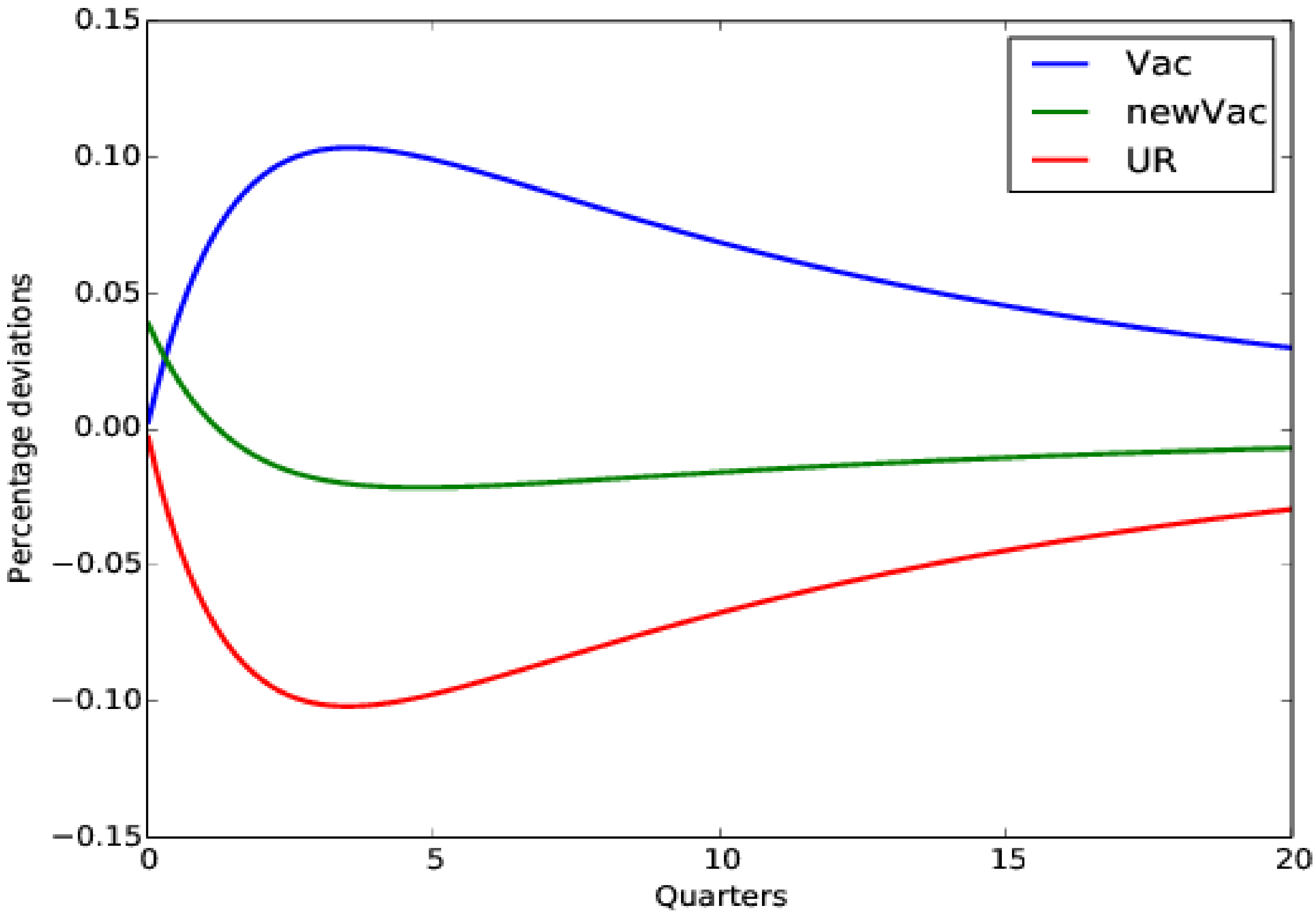
Correlation with U, different models

		Vac	pueW	peuW	nMatch	gdp	nV
	Data	-0.91	-0.96	0.74	0.93	-0.91	
1	Hall/Milgrom	-0.90	-0.97		-0.22	-0.99	-0
2	HM,highRR	-0.90	-0.97		-0.22	-0.99	-0
3	HM,highProf	-0.90	-0.97		-0.22	-0.99	-0
4	HM,inelastic	-0.92	-0.98		-0.25	-0.98	-0
5	HMLLV	-0.96	-0.99		-0.37	-0.92	-0
6	LLVE,BM	-1.00	-1.00	0.86	1.00	-0.97	0
7	LLVE,elastic	-0.91	-0.98	0.97	0.90	-0.99	0
8	FVEndog	-0.90	-0.98	0.97	0.89	-0.99	-0
9	FVlowProf	-0.28	-0.81	0.79	0.40	-0.87	-0
10	HM,Prof=0.2	-0.89	-0.97		-0.22	-0.99	-0
11	HM,Prof=0.5	-0.90	-0.97		-0.22	-0.99	-0
12	HM,Prof=3	-0.90	-0.97		-0.23	-0.99	-0
13	LLVE,Prof=5	-0.99	-1.00	0.78	0.98	-0.97	0
14	LLVE,Prof=9	-0.99	-1.00	0.75	0.96	-0.98	0
15	LLVE,xi=0.5	-0.99	-1.00	0.79	0.98	-0.97	0
16	LLVE,xi=2	-1.00	-1.00	0.90	0.99	-0.97	0

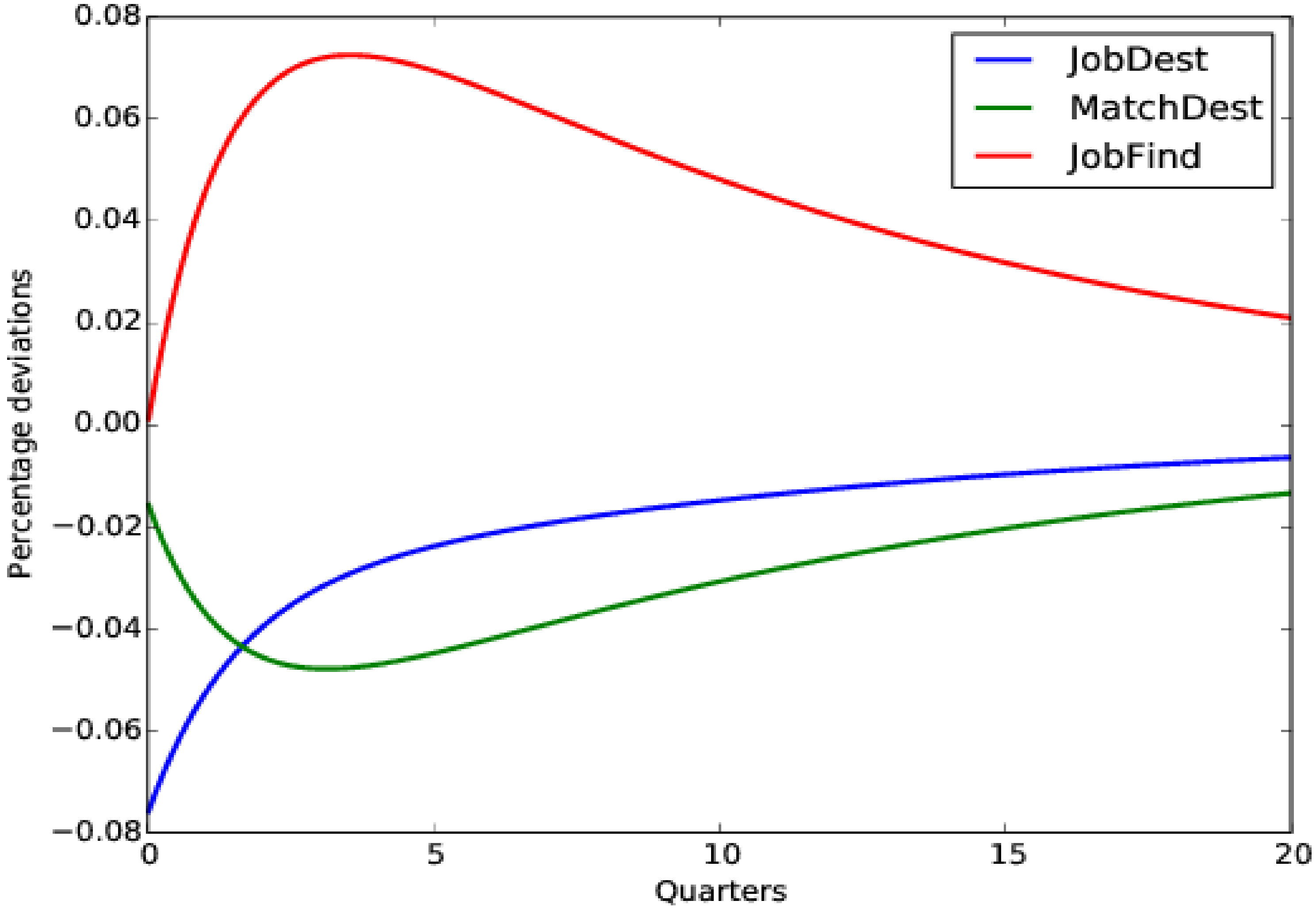
Impulse responses, benchmark



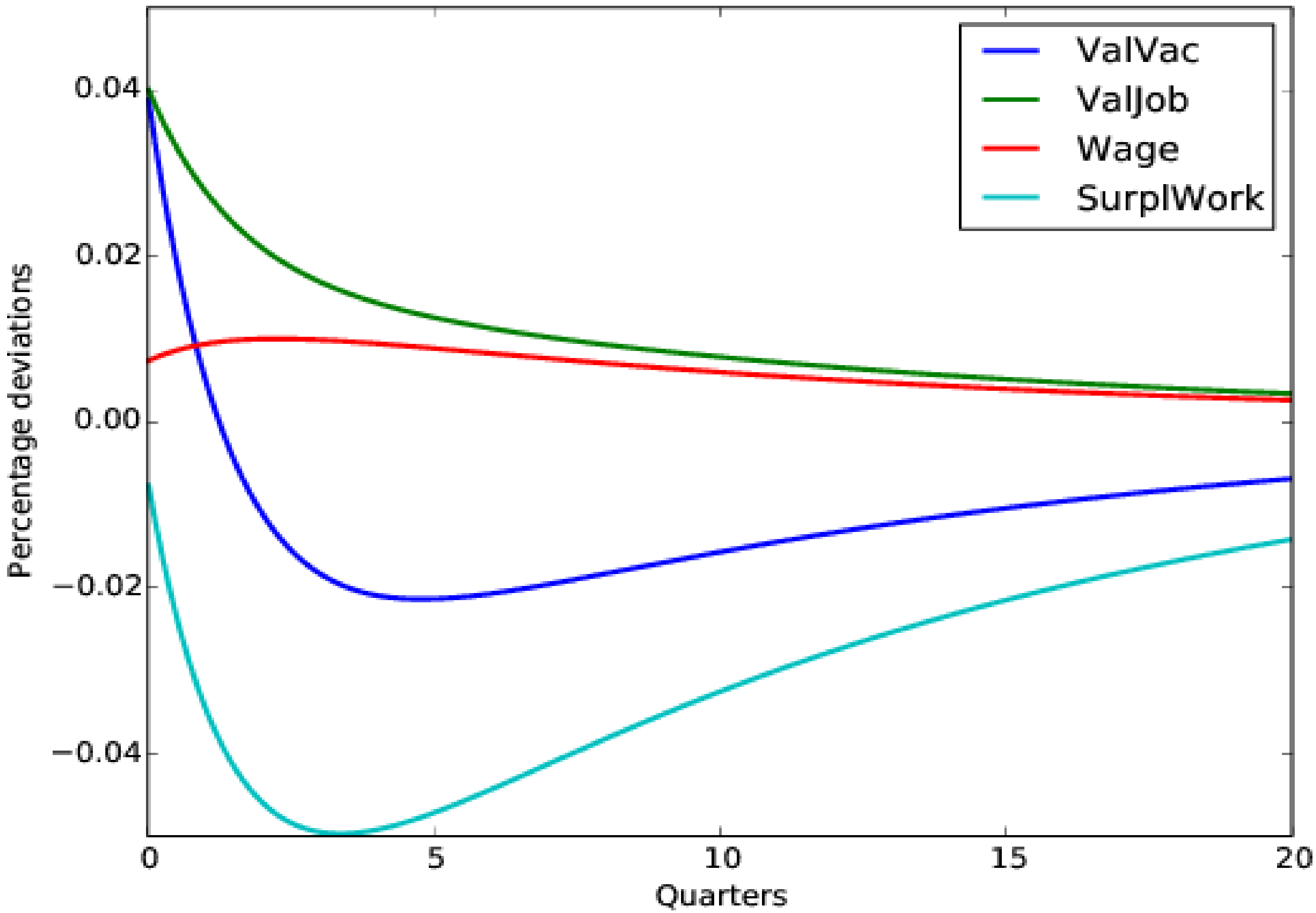
Impulse responses, benchmark



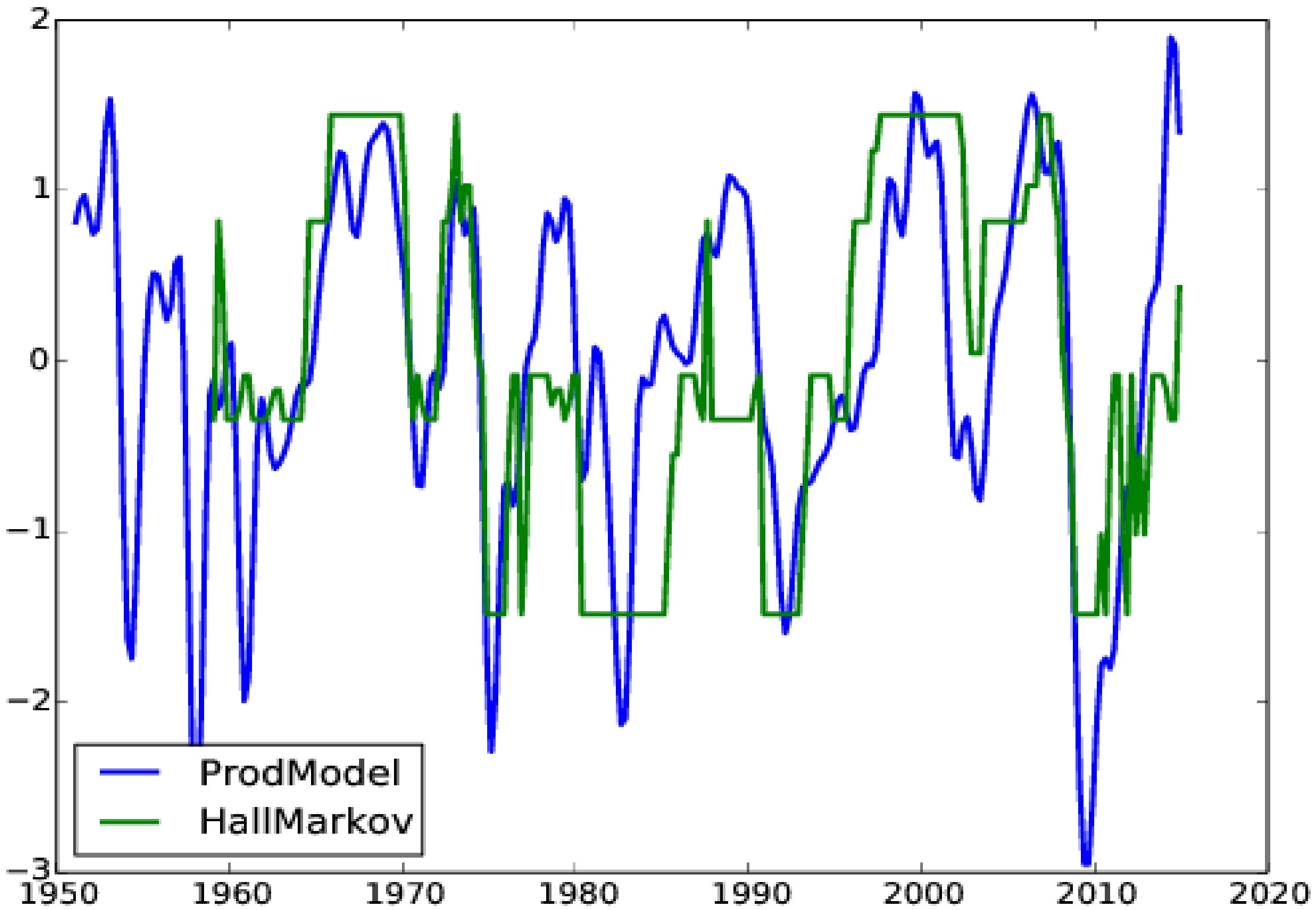
Impulse responses, benchmark



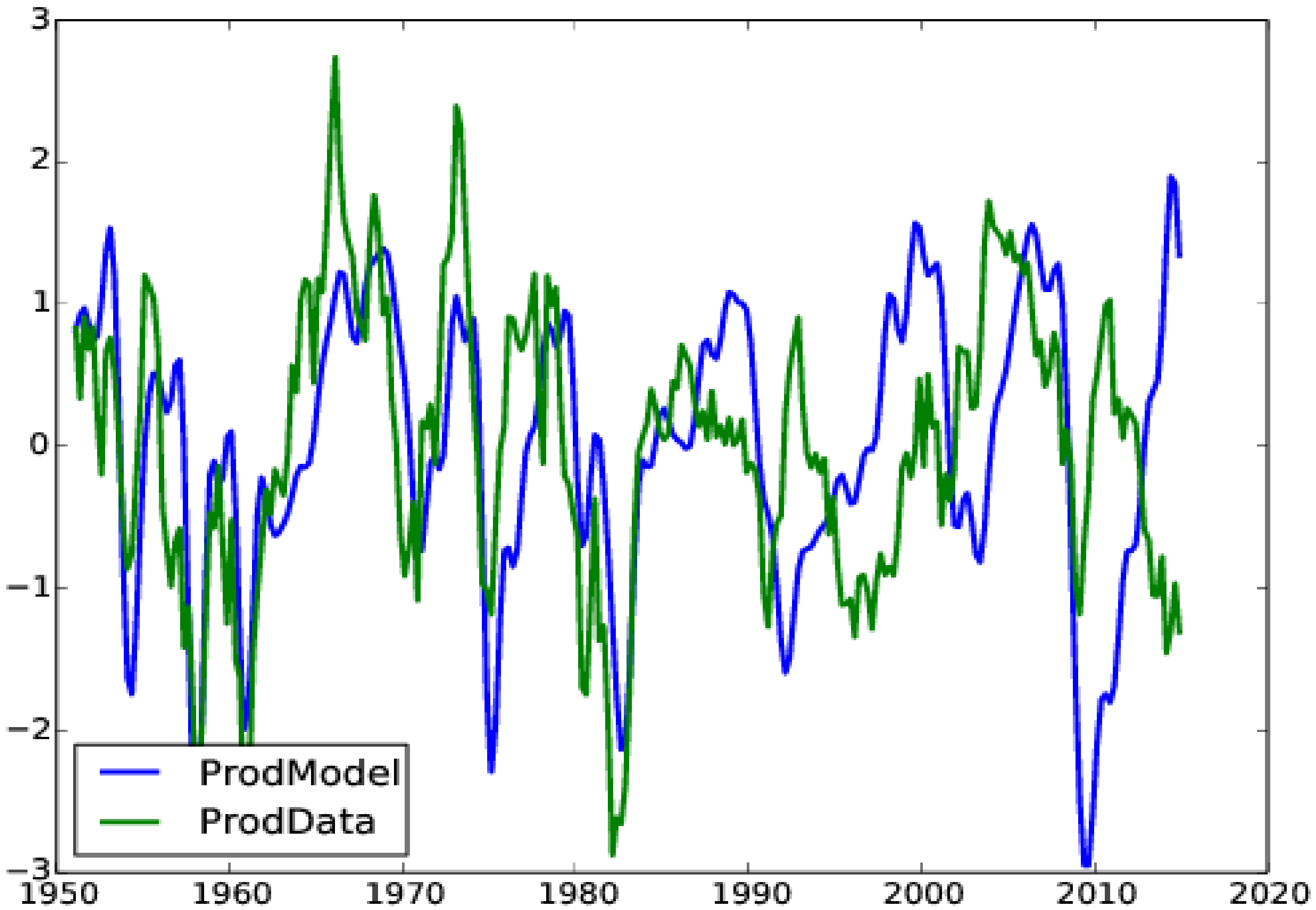
Impulse responses, benchmark



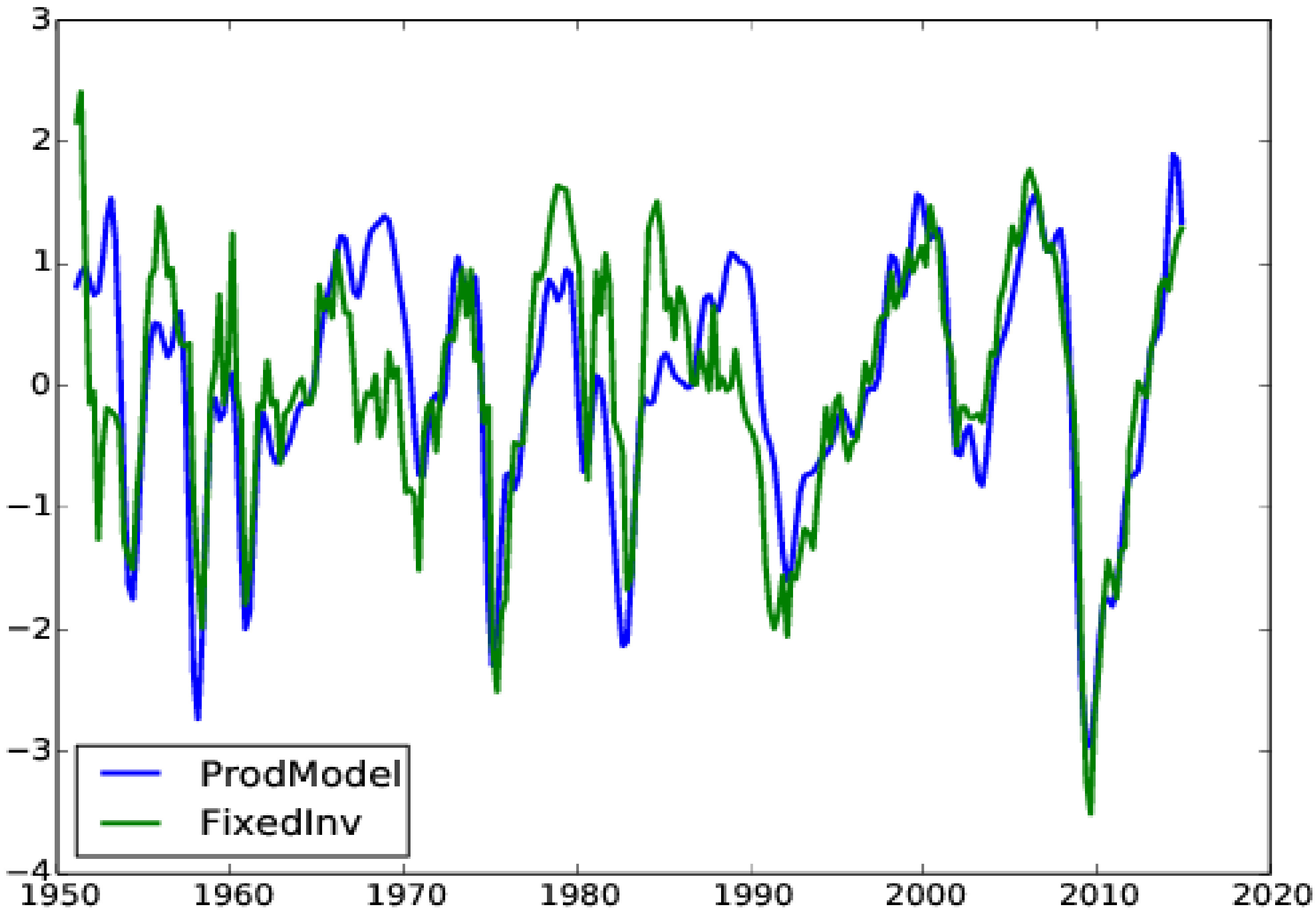
Implied Labor Productivity Shock vs. Various Suggested



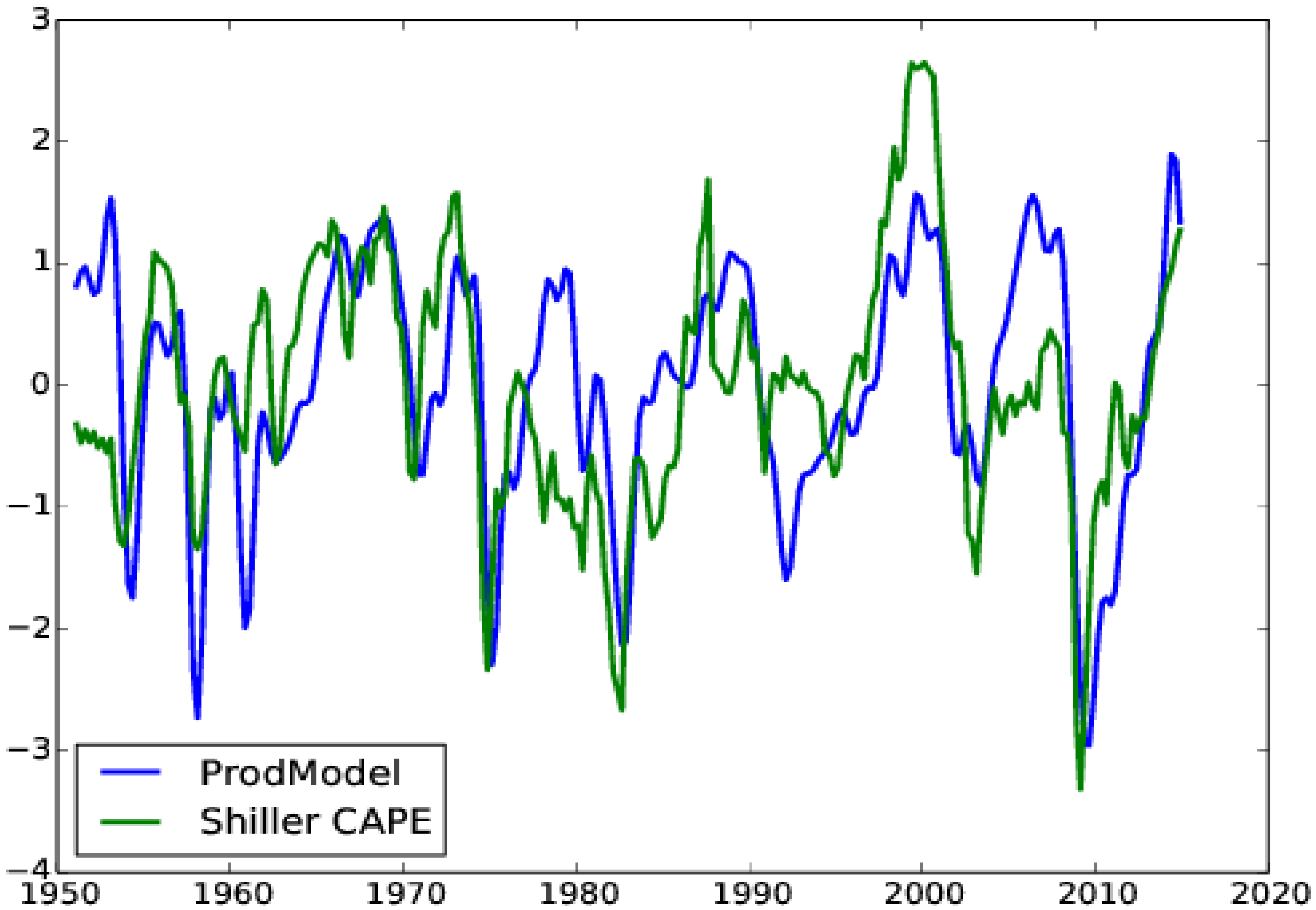
Implied Labor Productivity Shock vs. Various Suggested



Implied Labor Productivity Shock vs. Various Suggested



Implied Labor Productivity Shock vs. Various Suggested



Surplus

	Model	Sep	RR	Pr	ξ	δ_v	δ_b/δ	DWR
1	Hall/Milgrom	c	71	1.1	∞	100.0	4.0	0.79
6	LLVE,BM	e	40	2.3	1.0	2.2	3.9	0.78
10	HM,Prof=0.2	c	71	0.2	∞	100.0	10.2	0.96
11	HM,Prof=0.5	c	71	0.5	∞	100.0	7.0	0.90
12	HM,Prof=3	c	71	3.0	∞	100.0	0.6	0.41
13	LLVE,Prof=5	e	40	5.0	1.0	2.2	3.7	0.79
14	LLVE,Prof=9	e	40	9.0	1.0	2.2	3.5	0.79

ξ, δ_v

	Model	Sep	RR	Pr	ξ	δ_v	δ_b/δ	DWR
6	LLVE,BM	e	40	2.3	1.0	2.2	3.9	0.78
15	LLVE,xi=0.5	e	40	2.3	0.5	2.2	3.9	0.79
16	LLVE,xi=2	e	40	2.3	2.0	2.2	3.9	0.78
17	LLVE,xi=3	e	40	2.3	3.0	2.2	3.9	0.78
18	LLVE,dV*2	e	40	2.3	1.0	4.4	3.7	0.77
19	LLVE,dV*10	e	40	2.3	1.0	20.1	2.6	0.66