Redistributive Shocks and Productivity Shocks

José-Víctor Ríos-Rull   Raul Santaeulalia-Llopis

Penn, CAERP, CEPR, NBER

Penn

London School of Economics
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Introduction

1. Business Cycle Research (almost) always assumes Cobb-Douglas technology.
2. Which implies constant factor shares.
3. Yet they are not.
4. Does it matter for fluctuations questions?
5. We answer this with a silly theory of factor share movements.

Our thing is to pose not one but two technology shocks

1. The standard technology

A multiplicative shock to productivity

$$Y_t = e^{z_t^0} K_t^{\theta} N_t^{1-\theta}$$

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A multiplicative shock to productivity

$$Y_t = e^{z_t^0}\ K_t^{\theta}\ N_t^{1-\theta}$$

2. We will explore the following technology

A shock to factor shares and another to total productivity

$$Y_t = e^{z_t^1}\ K_t^{\theta - z_t^2}\ N_t^{1-\theta+z_t^2}$$

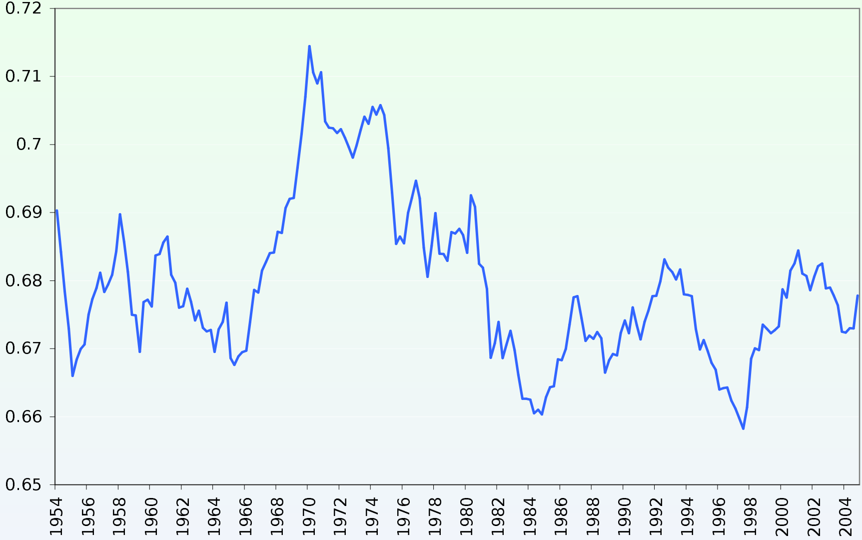
Our Finding is that it matters so much that changes our assessment of previous findings

1. Our process matches both the cyclical behavior of
   - Solow Residuals
   - Factor Shares
2. The induced behavior of hours is that it is three (13%) times less volatile than in the standard model, and 13% (2%) than in the data.
3. So the standard claim in the RBC literature that shocks to productivity account for 2/3 of hours volatility is just not right. Agents do not want to move their hours as much. Prices do not induce them to do so.
4. Our findings hold independently of the elasticity of hours.

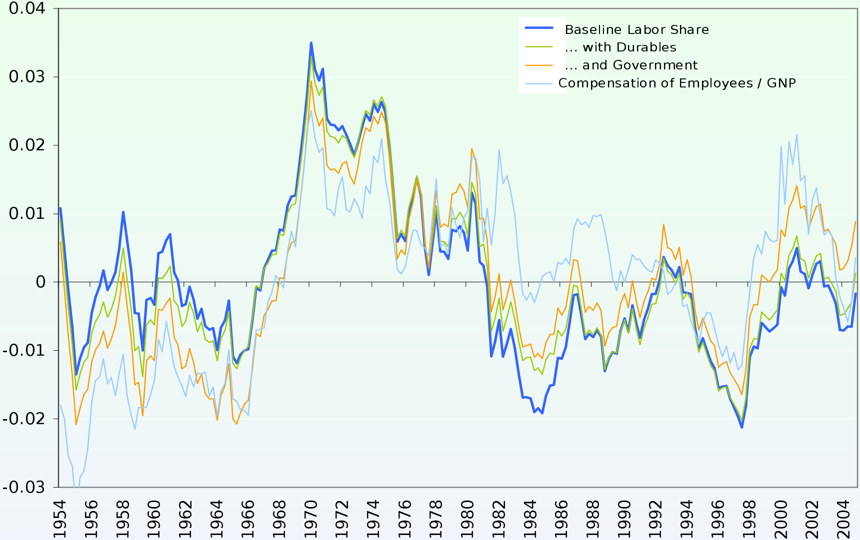
Literature

1. Cyclical allocation of risk and optimal labor contracts: either Labor share has no information. Gomme and Greenwood (1995) or there are differences in risk attitudes The Boldrin and Horvath (1995) Donaldson, Danthine, and Siconolfi (2005) .
2. Models with occasionally binding capacity constraints. Hansen and Prescott (2005) variable capacity utilization. labor share moves some.
3. Explicit role for markups. Hornstein (1993) Ambler and Cardia (1998)
4. More directly shocks to labor share. Castañeda, Díaz-Giménez, and Ríos-Rull (1998) Young (2004).

We want to replicate the dynamic patterns of labor share.



The Labor Share, U.S. 1954.I-2002.IV



Deviations of Labor Share, Various measures U.S. 1954.I-2002.IV

Properties of Labor Share

1. **Labor Share is quite volatile: Table 1** The standard deviation of the baseline definition of labor share is 43% that of output (65% of the variance) and 80% of that of the Solow residual (89% of the variance)
2. **Labor Share is countercyclical**. Correlatation of -.24. Solow residual -.47.
3. **Labor Share is highly persistent**. Autocorrelation of .78
4. **Labor Share lags output by about a year**. Look at phase shift Table 2.
5. **Labor Share overshoots**. Figure 1

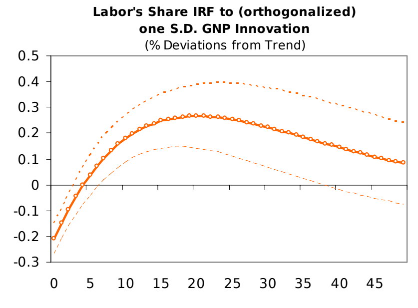
	σ_x	σ_x/σ_{GNP}	$\rho(x, GNP)$	$\rho(x, s^0)$	$\rho(x_t, x_{t-1})$
GNP	1.59	1.00	1.00	$.74^a$	$.85^a$
Solow Residual: s^0	.85	.53	$.74^a$	1.00	$.71^a$
Baseline Labor Share	.68	.43	$-.24^a$	$-.47^a$	$.78^a$

Note: All variables are *logged* and HP-filtered. Let a and b denote respective significance at 1 and 5%

Table: Standard deviation and correlation with output of Labor Share, U.S. 1954.I-2004.IV

	Cross-correlation of GNP_t with										
	x_{t-5}	x_{t-4}	x_{t-3}	x_{t-2}	x_{t-1}	x_t	x_{t+1}	x_{t+2}	x_{t+3}	x_{t+4}	x_{t+5}
Baseline Labor Share	-.20	-.26	-.32	-.34	-.33	-.24	.03	.25	.40	.47	.44

Table: Phase-Shift of the Labor Share, U.S. 1954.I-2004.IV



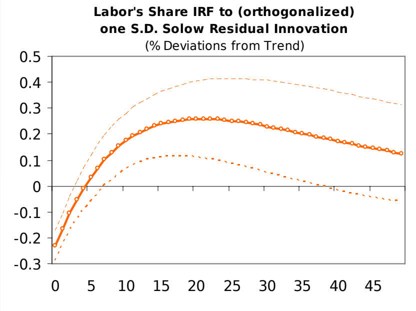


Figure: Labor's Share IRFs to GNP (left panel) and Solow Residual (right panel) Innovations

The standard specification: Solow residuals as shocks

- Linearly detrend variables X_t

$$\ln X_t = \chi_x + g_x t + \widetilde{x}_t.$$

- Apply it to $\{Y_t, K_t, N_t\}$ yielding $\{\widetilde{y}_t, \widetilde{k}_t, \widetilde{n}_t\}$.

- Then define $$s_t^0 = \widetilde{y}_t - \zeta\, \widetilde{k}_t - (1-\zeta)\, \widetilde{n}_t.$$

A structural interpretation of the Solow residual

- With Cobb-Douglas, the Solow residual is the shock to productity:

$$Y_t = e^{z_t^0} A\, K_t^{\theta} \left[(1+\lambda)^t\, \mu\, N_t\right]^{1-\theta} = e^{z_t^0} A\, K_t^{\theta} \left[(1+\lambda)^t\, \mu\, (1+\eta)^t\, h_t\right]^{1-\theta}$$

λ and η are productivity and population growth rates. A and μ just units parameters. Under CRRA, there is a balanced growth path. Rewrite

$$Y^*\, e^{\widetilde{y}_t} = e^{z_t^0}\, A\, [K^*\, e^{\widetilde{k}_t}]^{\theta}\, [\mu\, h^*\, e^{\widetilde{h}_t}]^{1-\theta}$$

$$z_t^0 \;=\; \widetilde{y}_t - \theta \widetilde{k}_t - (1-\theta)\widetilde{h}_t + \ln \frac{Y^*}{AK^{*\theta}\,(\mu h^*)^{\theta}} \;=\; \widetilde{y}_t - \theta \widetilde{k}_t - (1-\theta)\widetilde{h}_t$$

- If we use model data (with share parameter θ), we obtain

$$s_t^0 = \widehat{y}_t - \theta\, \widehat{k}_t - (1-\theta)\, \widehat{h}_t = z_t^0$$

- Recall: Cobb-Douglas (and competition) imply constant factor shares.

A Structural Interpretation of two shocks: the Redistributive Shock

- Define the folliwing residual

$$\ln s_t^1 = \ln Y_t - (1 - \frac{W_t N_t}{Y_t}) \ln K_t - \frac{W_t N_t}{Y_t} \ln N_t = \ln Y_t - \zeta_t \ \ln K_t - (1 - \zeta_t) \ \ln N_t$$

- Now Pose

$$Y_t = e^{z_t^1} \ A \ K_t^{\theta - z_t^2} \ \left[\mu \ (1+\lambda)^t \ (1+\eta)^t \ h_t\right]^{1-\theta+z_t^2}$$

- Under competitive markets

$$\frac{W_t N_t}{Y_t} = \frac{\frac{\partial Y_t}{\partial N_t} N_t}{Y_t} = (1-\theta) + z_t^2$$

- So the deviation from mean labor share is THE shock z_t^2.

A Structural Interpretation: the Multiplicative Shock

Detrending

$$Y^* \, e^{\widehat{y}_t} = e^{z_t^1} \, A \, \left(K^* \, e^{\widehat{k}_t}\right)^{\theta - z_t^2} \, \left(\mu \, h^* \, e^{\widehat{h}_t}\right)^{1-\theta+z_t^2},$$

taking logs and using $\qquad Y^* = A K^{*\theta} \left(\mu h^*\right)^{\theta}.$

$$z_t^1 = \widehat{y}_t - (\theta - z_t^2)\widehat{k}_t - (1-\theta+z_t^2)\widehat{h}_t + z_t^2 \ln\left(\frac{K^*}{\mu h^*}\right)$$

- So we have $\qquad s_t^1 = z_t^1 - z_t^2 \ln\left(\frac{K^*}{\mu h^*}\right)$

- Units matter.

- We choose units in the model so that $K^* = \mu h^*$ and then $s_t^1 = z_t^1$, so the redistributive shock z^2 has no effects on productivity.

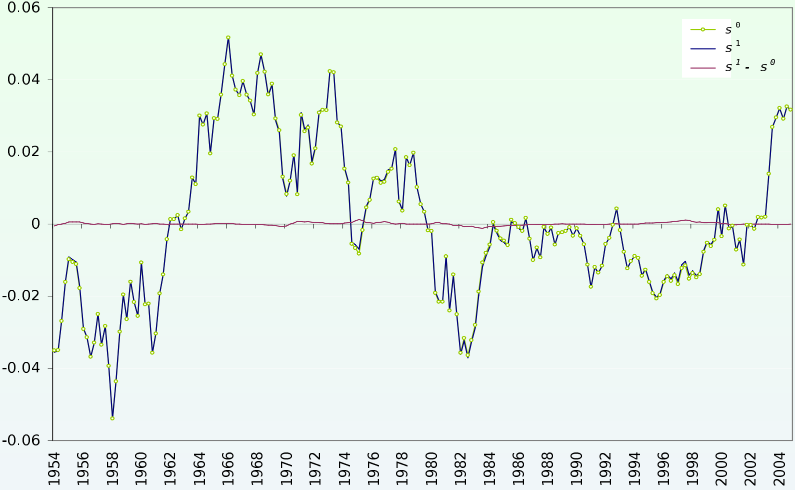


Figure: The two sets of productivity residuals s_t^0 and s_t^1, U.S. 1954.I-2004.IV

Let's estimate processes for the shocks (Full ML)

1. z^0 is an AR(1). $\rho^0 = .954$, $\sigma_{\epsilon_0} = .00668$. Standard. (.02, .000)

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1. z^0 is an AR(1). $\rho^0 = .954$, $\sigma_{\epsilon_0} = .00668$. Standard. (.02, .000)

2. To model $\{z_t^1, z_t^2\}$. We use a VAR(1).

Lags	Akaike's	Schwartz's Bayesian	Hannan and Quinn
1	-16.207*	-16.167*	-16.108*
2	-16.204	-16.137	-16.039
3	-16.197	-16.104	-15.966
4	-16.190	-16.070	-15.893

$$z_t = \Gamma z_{t-1} + \epsilon_t \qquad \begin{pmatrix} \epsilon_t^1 \\ \epsilon_t^2 \end{pmatrix} \sim N\left(0, \Sigma^2\right)$$

$$\widehat{\Gamma} = \begin{pmatrix} .946 & .001 \\ .050 & .930 \end{pmatrix} \qquad \widehat{\Sigma}^2 = \begin{pmatrix} .0068^2 & -.1045e-04 \\ -.1045e-04 & .00304^2 \end{pmatrix}$$

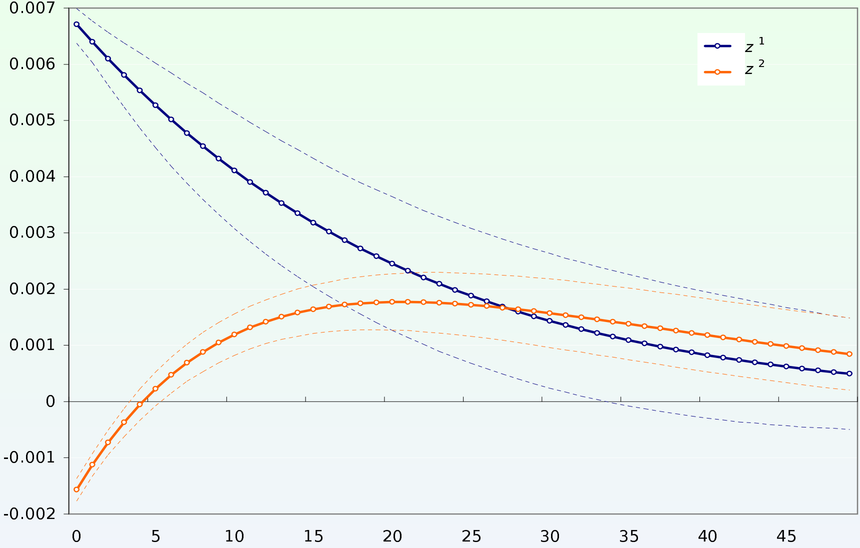
- Statiscally siginificant except γ_{12}, but no big deal.

Orthogonalization of Residuals

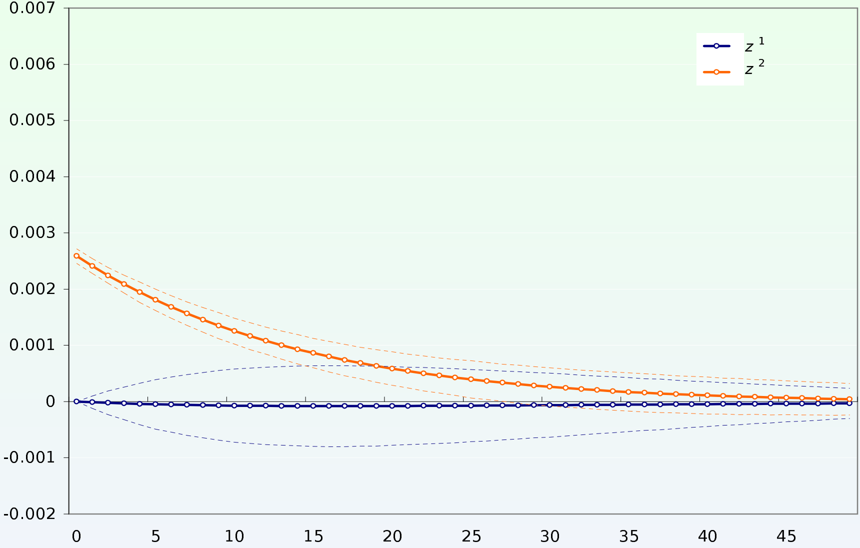
- The innovations ϵ_t are contemporaneously correlated so, we orthogonalize them.

$$\begin{pmatrix} \epsilon_t^1 \\ \epsilon_t^2 \end{pmatrix} = \Omega \begin{pmatrix} u_t^1 \\ u_t^2 \end{pmatrix}, \qquad u_t \sim N(0, I), \qquad \omega_{12} = 0.$$

- We impose the restriction that u_t^2 has a contemporaneous effect on z_t^2 but not on z_t^1. However, we still allow that u_t^1 affects contemporaneously z_t^1 and z_t^2.



Impulse response functions to Orthogonal Productivity Innovations u^1.



Impulse response functions to Orthogonal Productivity Innovations u^2.

Properties of Innovations

1. So Innovations to productivity are similar to those in the univariate model with respect to productivity.
2. They do generate first a fall and then a rise in labor share.
3. Pure innovations to redistribution die out slowly.
4. From forecast error variance decompositions:
    1. Fluctuations in z_t^1 are 100% due to its own innovations. (Not all of it by construction)
    2. 65% of the fluctuations in z_t^2 are due to u^1 and 35% to u^2.

Put these two processes into Model Economies

$$E_0 \left\{ \sum_{t=0}^{\infty} \beta^t \; L_t \; u(c_t, 1-h_t) \right\} \quad u(c_t, 1-h_t) = (1-\alpha)\log(c_t) + \alpha \log(1-h_t)$$

Smalish labor elasticity (2.3) we also look at ∞ elasticity (Hansen-Rogerson).

$$K_{t+1} = (1-\delta)K_t + I_t = (1-\delta)K_t + Y_t - C_t$$

Either

$$Y_t = e^{z_t^0} A \; K_t^{\theta} \left[(1+\lambda)^t \; (1+\eta)^t \; \mu \; h_t\right]^{1-\theta}$$

or

$$Y_t = e^{z_t^1} A K_t^{\theta - z_t^2} \left[(1+\lambda)^t (1+\eta)^t \; \mu \; h_t\right]^{1-\theta+z_t^2}$$

Getting rid of the trends

$$\max_{\{c_t, k_{t+1}, h_t\}_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty} \beta^t \, (1+\eta)^t \left[(1-\alpha)\log(c_t) + \alpha \log(1-h_t)\right]$$

subject to

$$c_t + k_{t+1}(1+\eta)(1+\lambda) \quad = \quad y_t + (1-\delta)k_t$$

and either

$$y_t \quad = \quad e^{z_t^0} \, A \, k_t^{\theta} \, (\mu h_t)^{1-\theta}$$

or

$$y_t \quad = \quad e^{z_t^1} \, A \, k_t^{\theta - z_t^2} \, (\mu h_t)^{1-\theta+z_t^2}$$

Calibration

- There are only four parameters, α, β, θ and δ, (besides η and γ). Let x^* be the steady state value of x. Then, we have

$$
\begin{aligned}
(1-\theta)\frac{y^*}{c^*} &= \frac{\alpha}{1-\alpha}\frac{h^*}{1-h^*} \\
(1+\gamma) &= \beta\left[\left(1-\delta+\theta\frac{y^*}{k^*}\right)\right] \\
\delta &= \frac{i^*}{k^*}-(1+\eta)(1+\gamma)+1 \\
1-\theta &= \text{Labor Share}^*
\end{aligned}
$$

1. The fraction of time devoted to market activities: $h^* = 0.31$.
2. The steady-state consumption-output ratio: $c^*/y^* = 0.75$.
3. The capital-output ratio in yearly terms $K^*/y^* = 2.28$.
4. Labor share $=$0.679.

Findings

	U.S. Data			Univariate $\{z^0\}$			Bivariate $\{z^1, z^2\}$		
	σ_x	$\rho(y,x)$	$\rho(x,x')$	σ_x	$\rho(y,x)$	$\rho(x,x')$	σ_x	$\rho(y,x)$	$\rho(x,x')$
y	**1.59**	1.00	.85	**1.30**	1.00	.72	**.90**	1.00	.73
h	**1.56**	.88	.89	**.64**	.98	.71	**.21**	.29	.73
c	1.25	.87	.86	.44	.91	.80	.71	.91	.77
i	7.23	.91	.80	4.05	.99	.71	1.91	.88	.69
r	.08	.74	.78	.05	.96	.71	.06	.68	.70
w	.76	.08	.70	.69	.98	.75	.78	.87	.77
z^0, z^1	.85	.74	.70	.87	.99	.71	.87	.98	.71
z^2	.47	-.24	.78	-	-	-	.42	-.27	.72

Cyclical Behavior of the Data, U.S. 1954.I-2002.IV and log-log Utility RBC Models

1. Univariate yields standard findings.
2. Hours move less than a third in the bivariate.
3. Consumption moves less in univariate.
4. Factor prices are off-sync (especially r).
5. Differences are huge.

Phase-Shift of the Model Economies

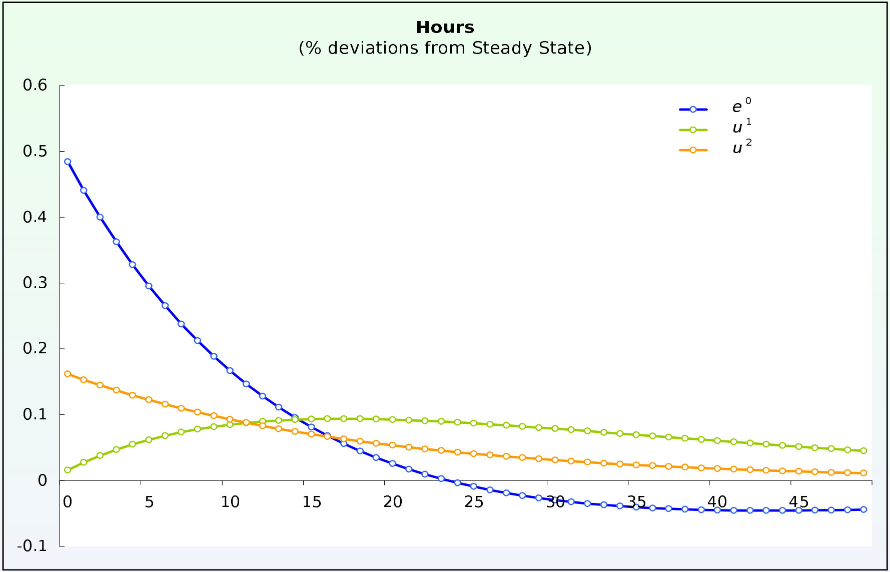
	Cross-correlation of y_t with										
	x_{t-5}	x_{t-4}	x_{t-3}	x_{t-2}	x_{t-1}	x_t	x_{t+1}	x_{t+2}	x_{t+3}	x_{t+4}	x_{t+5}
	Univariate Model										
y	-.01	.11	.27	.46	.70	1.00	.70	.46	.27	.11	-.01
h	.08	.20	.34	.52	.73	.98	.63	.35	.14	-.03	-.15
c	-.21	-.09	.07	.29	.56	.91	.77	.63	.50	.37	.26
i	.05	.17	.32	.50	.72	.99	.65	.39	.18	.02	-.10
r	.12	.24	.37	.54	.73	.96	.58	.30	.08	-.09	-.20
w	-.10	.02	.19	.40	.66	.98	.75	.55	.37	.23	.10
z_t^1	.01	.13	.28	.48	.71	1.00	.69	.44	.24	.08	-.04
	Bivariate Model $\{z_t^1, z_t^2\}$										
y	-.01	.12	.28	.47	.72	1.00	.72	.47	.28	.12	-.01
h	-.13	-.09	-.03	.05	.16	.29	.29	.27	.24	.20	.16
c	-.12	.00	.16	.36	.61	.91	.74	.57	.42	.28	.16
i	.11	.22	.35	.50	.68	.88	.53	.26	.05	-.10	-.21
r	.16	.25	.34	.44	.55	.68	.35	.10	-.07	-.20	-.28
w	-.13	-.01	.14	.33	.58	.87	.71	.56	.41	.28	.17
z_t^1	.03	.16	.31	.50	.72	.98	.67	.41	.20	.04	-.08
z_t^2	-.19	-.22	-.24	-.26	-.27	-.27	-.05	.10	.20	.26	.29

Look at hours (flat) and rates of return (seriously lead).

What is moving what!

	y	c	i	h	r	w	z^1	z^2
u^1	98.9	54.3	95.6	94.1	72.3	93.2	100.0	63.6
u^2	1.1	45.6	4.5	5.9	27.7	6.8	.0	36.4

Forecast Error Variance Decomposition (%)



Hours impulse response functions to innovations to all shocks.

Taking Stock

1. Hours move little and late in response to productivity innovations in the bivariate economy.
2. Redistributive shocks increase hours a little bit that subsequently decay very slowly.

The Rogerson-Hansen Economies

	U.S. Data			Hansen RBC $\{z^0\}$			Hansen RBC $\{z^1, z^2\}$		
	σ_x	$\rho(y,x)$	$\rho(x,x')$	σ_x	$\rho(y,x)$	$\rho(x,x')$	σ_x	$\rho(y,x)$	$\rho(x,x')$
y	**1.59**	1.00	.85	**1.74**	1.00	.71	**.92**	1.00	.73
h	**1.56**	.88	.89	**1.28**	.98	.70	**.41**	.33	.72
c	1.25	.87	.86	.54	.88	.81	.74	.94	.77
i	7.23	.91	.80	5.58	.99	.70	1.74	.91	.69
r	.08	.74	.78	.06	.95	.70	.06	.61	.70
w	.76	.08	.70	.54	.88	.81	.74	.94	.77
z^0, z^1	.85	.74	.70	.87	.99	.71	.87	.94	.71
z^2	.47	-.24	.78	-	-	-	.42	-.13	.72

Cyclical Behavior of the U.S. Data and of the Hansen-Rogerson RBC Model

- Except for the fact that hours are more volatile in both economies the rest is like the baseline case. The reduction in the volatility of hours is about one half.

Why do hours move so little in the bivariate economies?

Let's decompose the analysis into

1. Response of behavior to factor prices
2. Movements of factor prices.

The response of wages: more hump shaped

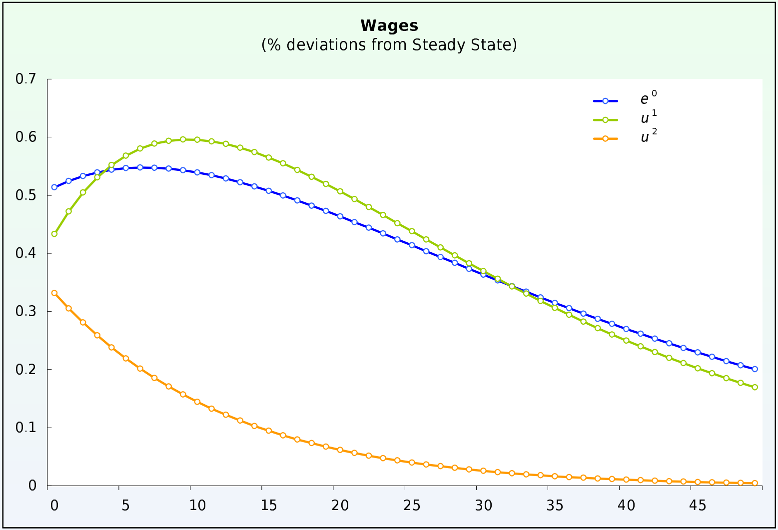


Figure: Wage impulse response functions to innovations to all shocks.

The response of rates of return: sharper fall in bivariate

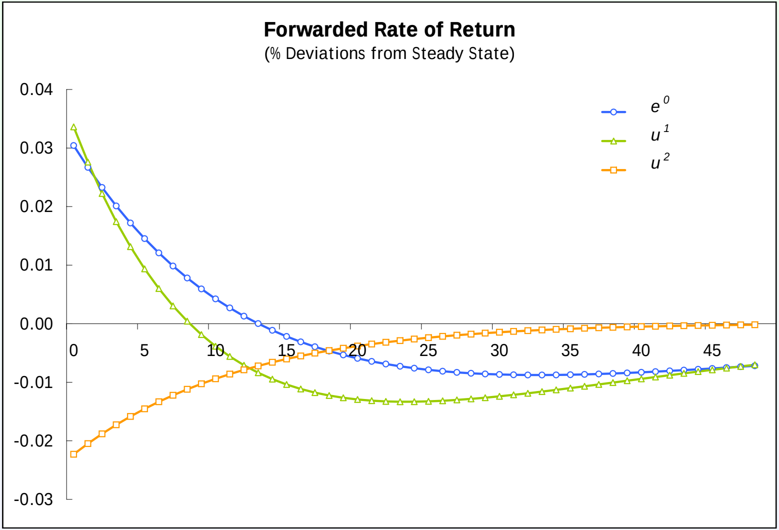


Figure: Rate of return impulse response functions to innovations to all shocks

Intratemp subst: Temporary smaller response

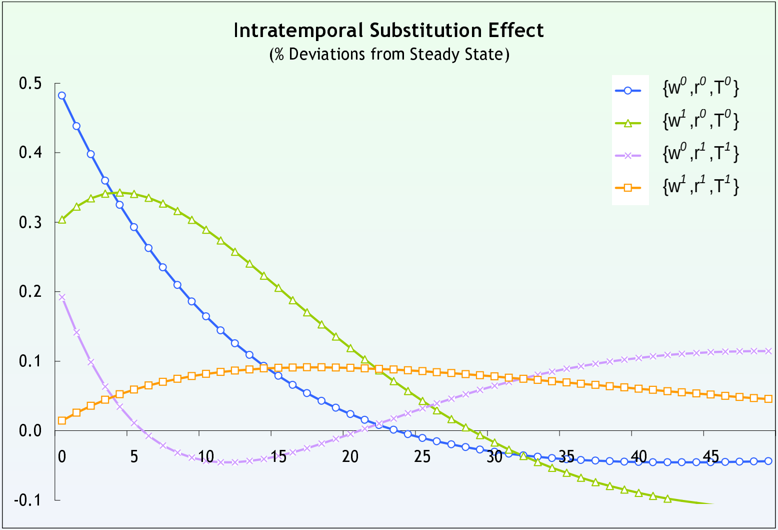


Figure: Intratemporal Substitution Effects

Intertemp subst: late increase

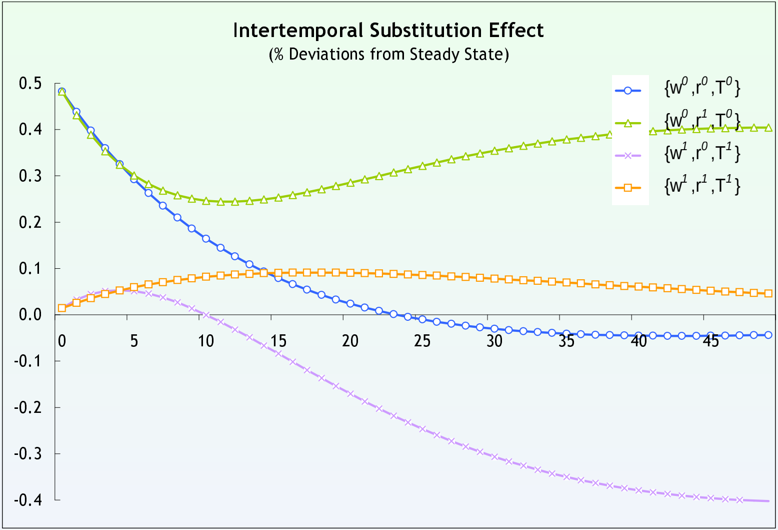


Figure: Intertemporal Substitution Effects

Wealth effect: Large positive (more leisure)

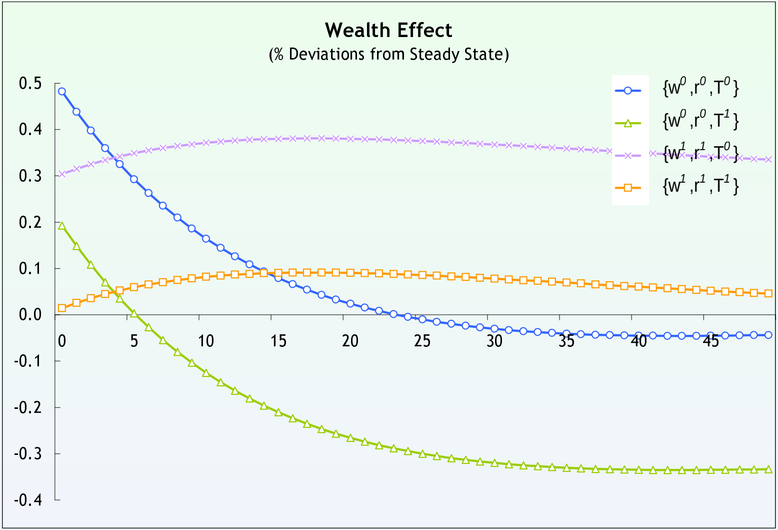


Figure: Wealth Effects

Summary of wealth and substitution effects

- In the bivariate economy the very small response of hours is becayse the substitution effects induce a delay in the response of hours while the wealth effect is responsible for the overall reduction.

- Look again at Figure 7 and seeing how to decompose the differences between the univariate shock effects ($\{w^0, r^0, T^0\}$) and ($\{w^1, r^1, T^1\}$) into the substitution effects ($\{w^1, r^1, T^0\}$) and the wealth effect ($\{w^0, r^0, T^1\}$).

Conclusions

1. We have posed a mild variation on the Standard RBC model, capable of generating cyclically moving factor shares like the data.

2. We have explored the equilibrium implications of such model.

3. We have found dramatic differences: while the univariate model (with low labor elasticity) generates 42.7% of the standard deviation of the data (17.4% of the variance), the bivariate generates 12.8% (1.64% of the variance). A reduction of three and a half times (10).

4. With Hansen-Rogerson preferences the univariate economy generates 82.7% of the standard deviation of hours (68.4% of the variance). The bivariate model yields 25.6% (6.6% of the variance).

5. We should develop a good theory of cyclically moving factor shares.

Searching for a Theory of the Labor Share and its Cyclical Behavior

Se Kyu Choi and José-Víctor Ríos-Rull

An ongoing report

What we do

- We take an existing model "off the shelf" (our Benchmark) and see if it can deliver the facts of the labor share (SPOILER: NO, it can't)
- We modify the original model: benchmark with modified preferences and benchmark with modified technology (both extensions independent)
- The model with modified technology seems to do (part of) the job.

Some Related Literature

- Ríos-Rull and Santaeulalia-Llopis (2006)
- Merz (1995), Andolfatto (1996), Cheron & Langot (2004)
- Shimer (2005), Hagedorn and Manovski (2005)
- Siu and Jaimovich (2006)

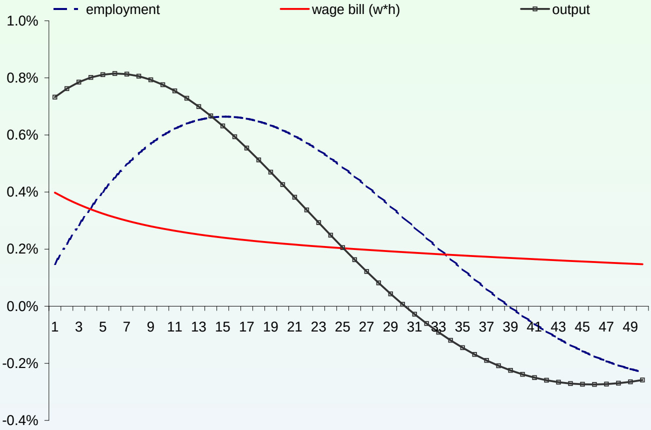


Figure: Response of Labor Share components to a shock in the Solow residual

Benchmark Model: Environment

- Firms rent capital and search/match with workers. The latter creates a law of motion for bodies

$$N' = (1 - \chi)N + M(V, 1 - N)$$

- Aggregate production function subject to technology shocks

$$y = e^z F(K, Nh)$$

(F is Cobb-Douglas)

- Households rent their assets to the firms, consume and supply bodies inelastically
- Aggregate state variables: $\mathcal{S} = \{z, K, N\}$
- Two-stage procedure: firms and workers bargain over wages and workweeks bilaterally; given these values, households and firms solve their dynamic problems

What These Ingredients Do

- The labor share is whN/y (wage bill times employment over output)
- Search & matching makes 'bodies' look like capital: we get **'humped-shaped'** response of N after a shock to z
- Wage/workweek setting through Nash-bargaining creates some degree of rigidity in wages: wh moves less than y and we get **counter-cyclical** labor share

Performance of models

	U.S. Data		Std. RBC		Benchmark	
$\sigma(output)$	1.58		1.39		1.53	
	$\sigma_x/\sigma(y)$	$\rho(y,x)$	$\sigma_x/\sigma(y)$	$\rho(y,x)$	$\sigma_x/\sigma(y)$	$\rho(y,x)$
Labor Input (Nh)	0.99	0.88	0.55	0.99	0.68	0.95
Bodies (N)	0.83	0.80	–	–	0.65	0.88
Hours/worker (h)	0.29	0.70	0.55	0.99	0.12	0.58
real wages (w)	0.50	0.05	0.53	0.99	0.34	0.91
Labor share	0.25	-0.25	–	–	0.11	-0.43
Consumption	0.50	0.93	0.22	0.89	0.23	0.90
Investment	4.45	0.86	4.36	0.99	4.60	0.99

Performance of models

	U.S. Data		Std. RBC		Benchmark	
$\sigma(output)$	1.58		1.39		**1.53**	
	$\sigma_x/\sigma(y)$	$\rho(y,x)$	$\sigma_x/\sigma(y)$	$\rho(y,x)$	$\sigma_x/\sigma(y)$	$\rho(y,x)$
Labor Input (Nh)	0.99	0.88	0.55	0.99	0.68	0.95
Bodies (N)	0.83	0.80	–	–	0.65	0.88
Hours/worker (h)	0.29	0.70	0.55	0.99	0.12	0.58
real wages (w)	0.50	0.05	0.53	0.99	0.34	0.91
Labor share	0.25	-0.25	–	–	0.11	-0.43
Consumption	0.50	0.93	0.22	0.89	**0.23**	0.90
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- Volatilities of output, consumption and investment?
- Benchmark is able to replicate a **Counter-cyclical labor share** (maybe too counter-cyclical), but just a fraction of the **volatility**
- Simulated labor input moves less than in the US data (both models)

What about Labor Share overshooting?

- Nonexistent...

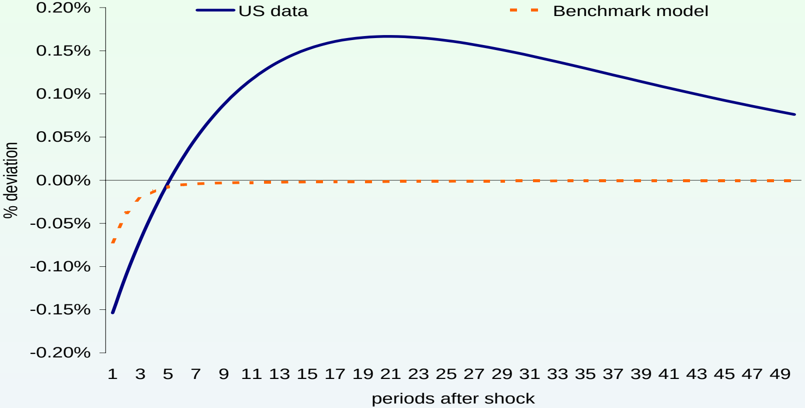

Figure: Response of Labor Share to a shock in the Solow residual of one S.D.: US data and Benchmark

Properties of Benchmark

- Benchmark fails in replicating the impulse response of the real Labor Share (response of employment too small, response of output too big).
- Next, two modifications to the benchmark in order to replicate the 'overshooting': the **Garrison** effect (modified preferences) and a model with two types of workers (modified technology)

A Preference Extension: The Garrison Effect

- Instantaneous utility of the Household in the benchmark:

$$\mathcal{U} = U(c) + N\nu(1-h) + (1-N)\nu(1)$$

- We change this to:

$$\mathcal{U} = U(c) + N\nu(1-h) + (1-N)^{\kappa}\nu(1)$$

$\kappa \in [0,1]$ represents the "garrison" effect

- What does garrison do? It creates curvature in the utility effect of moving people from unemployment to employment

- Since wages are set through Nash-bargaining and they account for the outside option of the worker (des-utility from working) their response to a shock in z should increase

- Still not enough 'action'

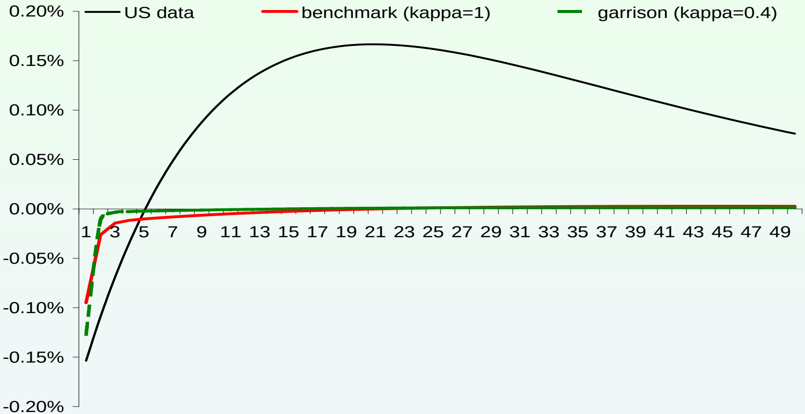

Figure: Response of Labor Share to a shock in the Solow residual of one S.D.: US data and Models

What went wrong?

- This problem is related to Shimer's (2005) criticism of the standard labor search model
- From the problem of the firm, we get an Euler equation for vacancy posting:

$$c_v = \Phi E \left[R' \left(\frac{\partial y'}{\partial n'} - w' h' + (1 - \chi) \mathcal{V}_n \right) \right]$$

- If wages and labor productivity are closely related, the firm doesn't have incentives to post vacancies when hit by a good shock: the model cannot replicate volatility of vacancies nor employment.
- We face a similar problem if we want to match the overshooting of the labor share

Modifying the Technology

- We include two types of workers into the benchmark: unexperienced/new (N_n) and experienced/old (N_o)
- Households: same as before, but take into consideration the two types of occupations (different wages and workweeks)
- Firms post vacancies and get (by assumption) new/unexperienced workers
- New workers transit to old/experienced level with probability $p(z) = pe^z$ (related to Chang, Gomes & Schorfheide (2002)).
- Production function:

$$y = e^z F(k, N_o h_o, N_n h_n)$$

(F is NOT Cobb-Douglas)

Parameterization of the Model

- How do we combine the three inputs into a production function?

- As in Krusell et al. (2000) we use a double nested CES specification:

$$F(k, N_o h_o, N_n h_n) = \left[a_n (N_n h_n)^{-\zeta} + (1 - a_n) \left[a_o (N_o h_o)^{-\tau} + (1 - a_o) k^{-\tau} \right]^{\frac{\zeta}{\tau}} \right]^{-\frac{1}{\zeta}}$$

- We set $\zeta < 0$ and $\tau > 0$
  - N_o and k are complements
  - N_n and the composite of $\{N_o, k\}$ are substitutes

Features and some intuition on the O/N worker model

- Technology is not Cobb-Douglas: elasticity of substitution between inputs is NOT equal to one: Shares have more 'space' to move
- Also, during the cycle we get a composition effect: higher transition of workers to better paying jobs (from N to O)

$\sigma(y)$	U.S. Data 1.58		Benchmark 1.53		o/n workers 1.40	
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Employment (N)	0.83	0.80	0.65	0.88	0.59	0.84
Hours p/worker (h)	0.29	0.70	0.12	0.58	0.18	0.31
Real Wage (w)	0.50	0.05	0.34	0.91	0.37	0.91
Labor sh. (whN/y)	0.29	-0.25	0.11	-0.43	0.16	-0.72
Consumption	0.50	0.93	0.23	0.90	0.31	0.93
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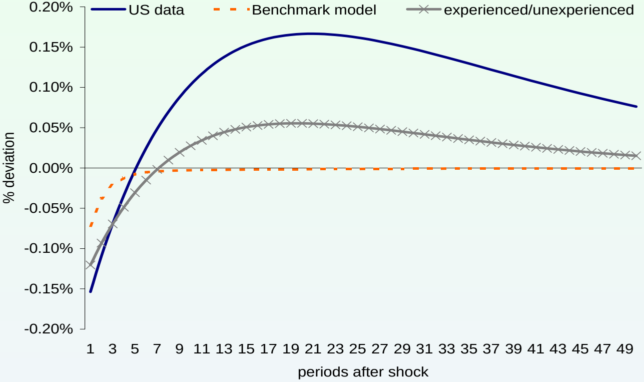
- Labor share: still **too counter-cyclical** , but better **volatility**
- Labor input moves a little LESS than the benchmark

- BUT... overshooting is better (bigger response of wage bill and smaller response of output)



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Conclusions

- Our aim was to match the cyclical behavior of the US labor share
- We obtained partial success by adding two types of workers and "stages" of employment to an existing labor search model
- Cyclical behavior of the labor share: does it matter?
- It matters quite a bit. Given a model with endogenous labor share, the effect of a tech. shock to the volatility of labor input is LESS than what we know

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