On the Sources of the Great Moderation

Jordi Galí and Luca Gambetti

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The Great Moderation

- Basic Evidence (Table 1)
- Two Broad Hypotheses

  (i) good luck
  (ii) structural change (policy or non-policy related)
  $\Rightarrow$ different implications for second moments

- *Our paper*

(i) evidence on changes in second moments of output, hours and labor productivity around the time of the volatility break

(ii) identification of the sources of those changes using time-varying SVAR $\Rightarrow$ time-varying conditional second moments and IRFs

Such evidence may shed light on the merits of alternative explanations for the Great Moderation

Figure 1

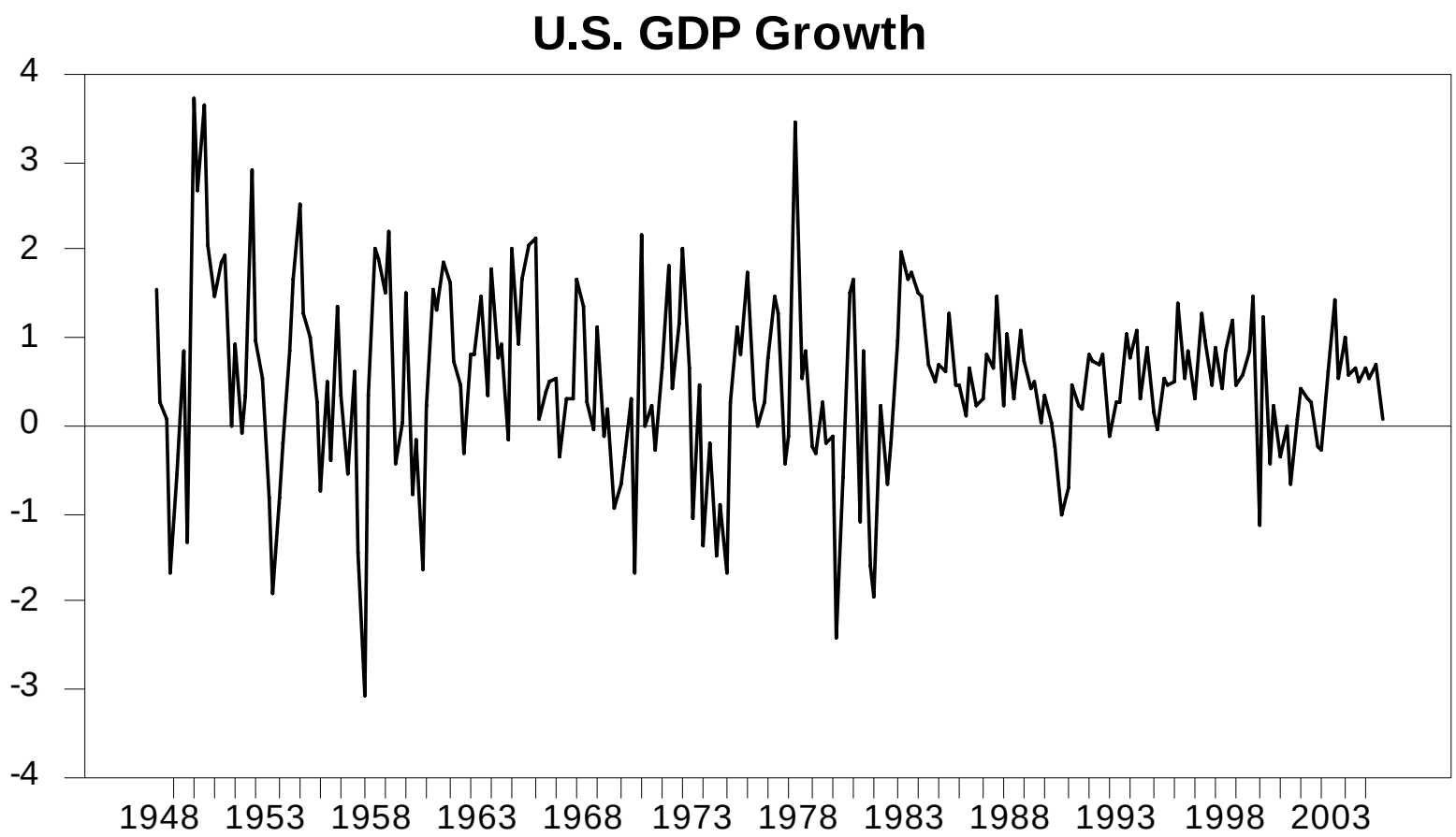
U.S. GDP Growth
4
3
2
1
0
-1
-2
-3
-4
1948
1953
1958
1963
1968
1973
1978
1983
1988
1993
1998
2003

Table 1. The Great Moderation

	Standard Deviation			
	Pre-84	Post-84	$\frac{\text{Post-84}}{\text{Pre-84}}$	p-value
First-Difference				
GDP	1.21	0.54	0.44	<0.01
Nonfarm Business Output	1.57	0.68	0.43	<0.01
BP-Filter				
GDP	2.00	0.94	0.47	<0.01
Nonfarm Business Output	2.59	1.23	0.47	<0.01

Note: All variables transformed by taking the natural logarithm and applying the transformation indicated in the table (first difference or band-pass filter). P-values correspond to a test of equality of variances across the two subsamples based on the asymptotic standard errors of variance estimates computed using an 8-lag window.(see, Priestley (1991), p. 327).

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Our Approach

- Focus on output, hours and labor productivity
- Changes in *unconditional* second moments
- Identification and estimation of *conditional* second moments and their changes over time
- Main tool: Time-varying VAR with stochastic volatility

  - Cogley-Sargent, Primiceri, Gambetti, Benati-Mumtaz
  - identification based on Galí AER 99
    technology and non-technology shocks
    technology shocks only source of unit root in labor productivity
  - extension to Fisher's JPE 05 two technology shock model

Main Findings

- Increase in the volatility of hours and labor productivity *relative* to that of output.
- Decline in the cyclicality of labor productivity (relative to both hours and output)
- Main source of output volatility decline: fall in contribution of non-technology shocks
- Large decline in the correlation of labor productivity with both output and hours *conditional* on non-technology shocks, accelerating in the 1990s.
- Large negative correlation of hours with both output and labor productivity conditional on technology shocks. Exception: the second half of the 1970s (oil shocks) and 1990s (the dotcom boom period).

$\Rightarrow$ Picture more complex picture than suggested by good luck hypothesis

$\Rightarrow$ Structural changes in labor market, timing close to GM. Causality?

The Labor Market and the Great Moderation

- Focus on output, hours and labor productivity
- Quarterly U.S. data
- Nonfarm business sector
- Sample period: 1948:I-2005:IV

- Changes in Unconditional Volatilities (Table 2)
- Changes in Unconditional Comovements (Table 3)

Table 2. Changes in Volatility

	Standard Deviation				*Relative Standard Deviation*		
	Pre-84	Post-84	$\frac{\text{Post-84}}{\text{Pre-84}}$	p-value	Pre-84	Post-84	$\frac{\text{Post-84}}{\text{Pre-84}}$
First-Difference							
Output	1.57	0.68	0.43	0.00	1.00	1.00	1.00
Hours	1.05	0.65	0.61	0.00	0.66	0.95	1.41
Productivity	1.00	0.61	0.62	0.00	0.63	0.89	1.44
BP-Filter							
Output	2.59	1.23	0.47	0.00	1.00	1.00	1.00
Hours	2.08	1.39	0.67	0.06	0.79	1.10	1.40
Productivity	1.18	0.68	0.57	0.01	0.45	0.55	1.21

Table 3. Changes in Cross-Correlations

First-Difference	*pre-84*	*post-84*	*change*
Output, Hours	0.78	0.57	-0.20^{**} (0.08)
Hours, Productivity	0.18	-0.41	-0.59^{**} (0.10)
Output, Productivity	0.75	0.50	-0.24^{**} (0.11)
BP-Filter	*pre-84*	*post-84*	*change*
Output, Hours	0.89	0.86	-0.02 (0.09)
Hours, Productivity	0.18	-0.46	-0.65^{**} (0.15)
Output, Productivity	0.61	0.03	-0.58^{**} (0.19)

A Time-Varying Structural VAR

Let $x_t \equiv [\Delta(y_t - n_t), n_t]$

$$x_t = A_{0,t} + A_{1,t}\ x_{t-1} + A_{2,t}\ x_{t-2} + ... + A_{p,t}\ x_{t-p} + u_t \tag{1}$$

where $E_t\{u_t u_t'\} = \Sigma_t$.and $E_t\{u_t x_{t-k}'\} = E_t\{u_t u_{t-k}'\} = 0$ for $k = 1, 2, 3, ...$

Let $A_t \equiv [A_{0,t}, A_{1,t}..., A_{p,t}]$ and $\theta_t \equiv vec(A_t')$, we assume

$$\theta_t = \theta_{t-1} + \omega_t \tag{2}$$

where $\omega_t \sim N(0, \Omega)$ is serially uncorrelated and independent of $\{u_t\}$.

Let $\Sigma_t \equiv F_t D_t F_t'$ where F_t is lower triangular with ones on the diagonal and D_t is a diagonal matrix.

Define $\gamma_t = vec(F_t^{-1})$ and $\sigma_t = vec(D_t)$.

We assume

$$\gamma_t = \gamma_{t-1} + \zeta_t$$

$$\log \sigma_t = \log \sigma_{t-1} + \xi_t$$

where $\zeta_t \sim N(0, \Psi)$ and $\xi_t \sim N(0, \Xi)$ are serially and mutually uncorrelated.

Identification

Structural shocks: $\varepsilon_t \equiv [\varepsilon_t^a, \varepsilon_t^d]'$, satisfying $E\{\varepsilon_t \varepsilon_t'\} = I$

ε_t^a : technology shock

ε_t^d : non-technology shock

Assumption:

$$u_t = K_t \ \varepsilon_t$$

for all t, for some non-singular matrix K_t satisfying $K_t K_t' = \Sigma_t$.

Identifying restriction: only technology shocks have a long-run effect on labor productivity

Resulting decomposition:

$$x_{i,t} = \mu_t^i + \sum_{k=0}^{\infty} C_{t,k}^{ia} \ \varepsilon_{t-k}^a + \sum_{k=0}^{\infty} C_{t,k}^{id} \ \varepsilon_{t-k}^d$$

Changing Labor Market Dynamics and the Great Moderation

- Unconditional Second Moments (F2-3)
- Conditional Volatilities: What are the Forces behind the Great Moderation? (F4, T4)

$$var(\Delta y_t) = var(\Delta y_t^a) + var(\Delta y_t^d)$$

- Conditional Correlations and Structural Change (F5, T5)

$$corr(x_t, z_t) = \lambda_a \ corr_a(x_t, z_t) \ + \lambda_d \ corr_d(x_t, z_t)$$

where $\lambda_i \equiv \frac{\sigma_i(x_t)}{\sigma(x_t)} \ \frac{\sigma_i(z_t)}{\sigma(z_t)}$.

- Time-Varying Impulse Responses (F6-8)
- Extension: Fisher Three-Variable Model

Figure 2a
Time-Varying Standard Deviations

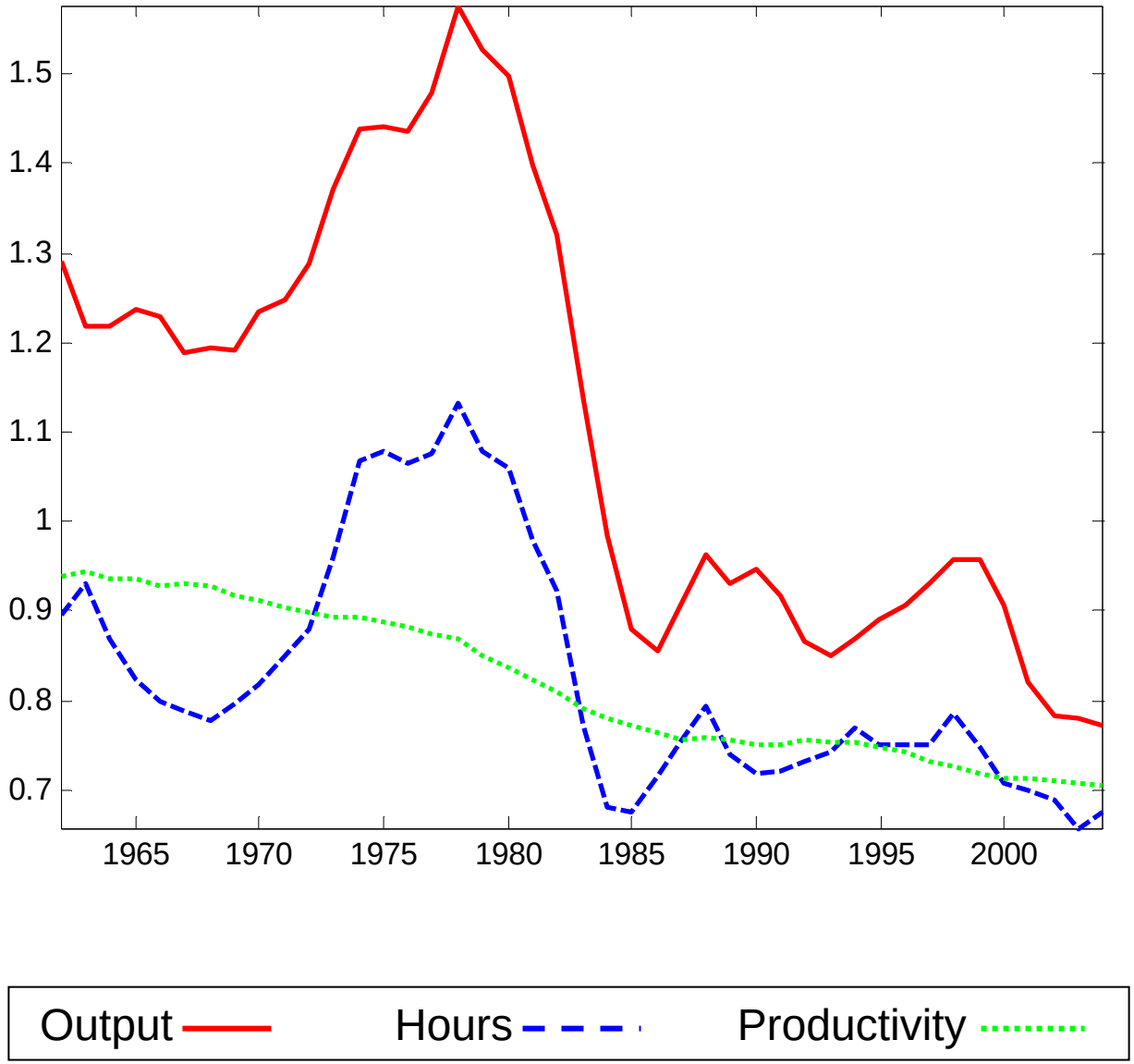

Figure 2b
Time-Varying Relative Standard Deviations

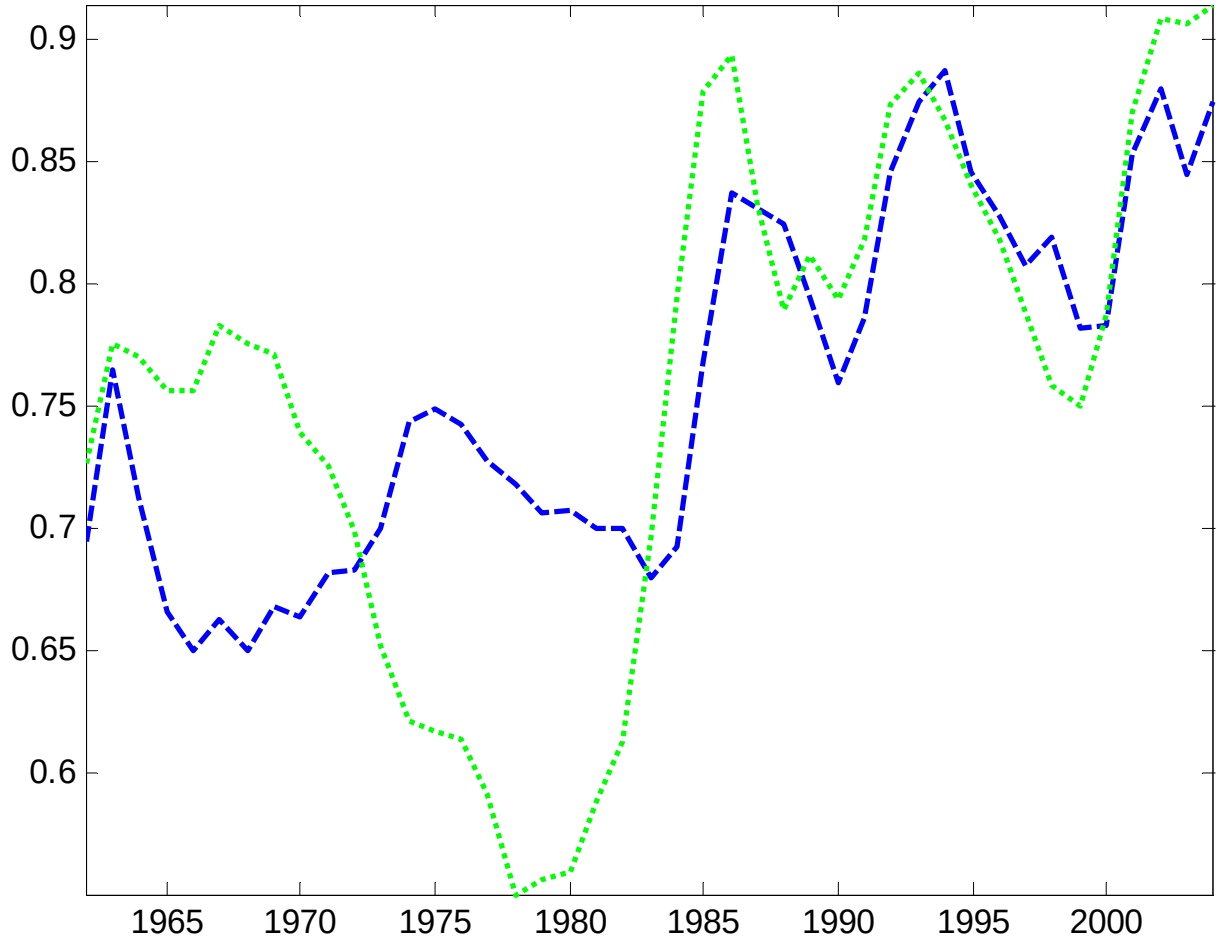

Figure 3
Time-Varying Unconditional Correlations

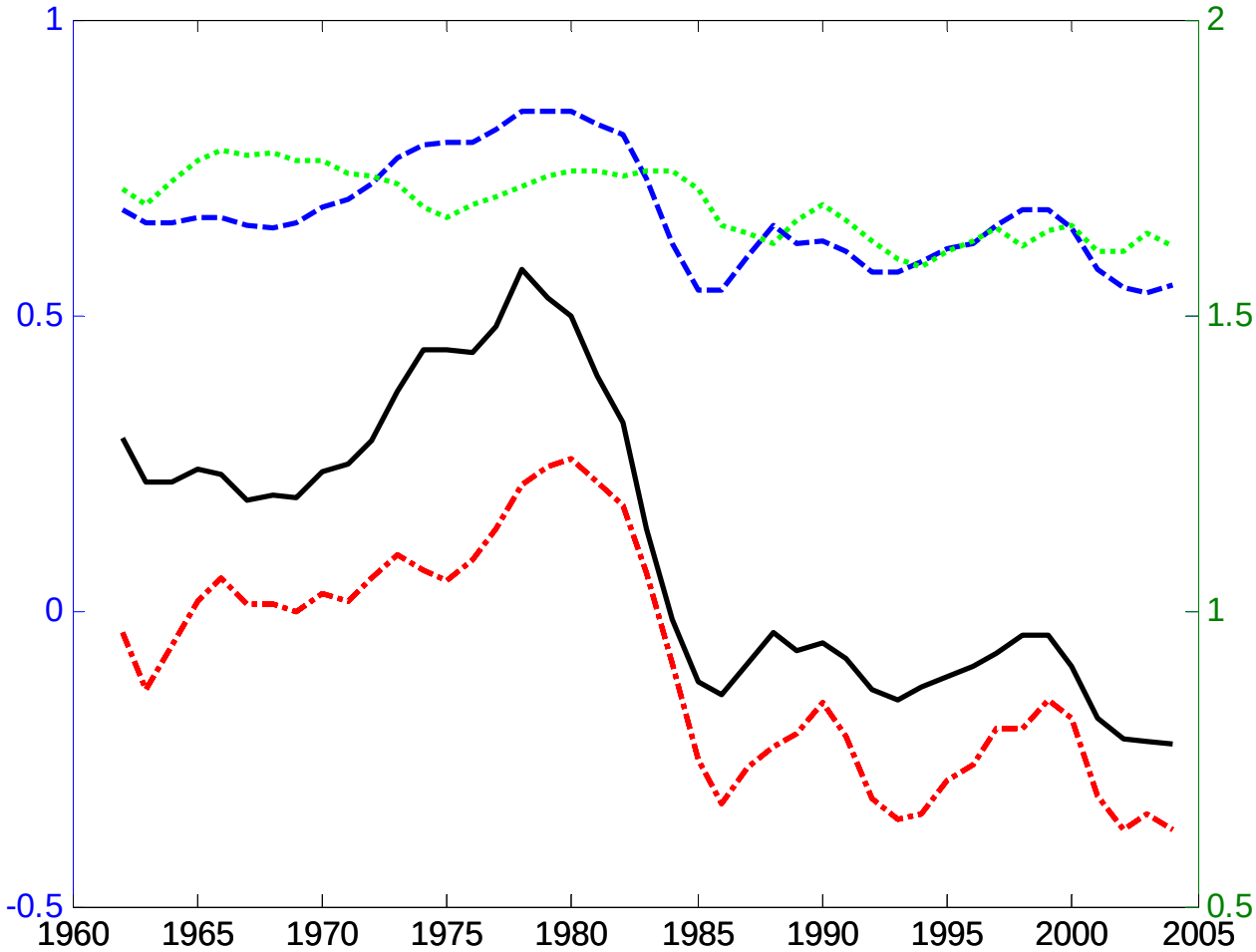

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Figure 4a
Conditional Standard Deviations: Output

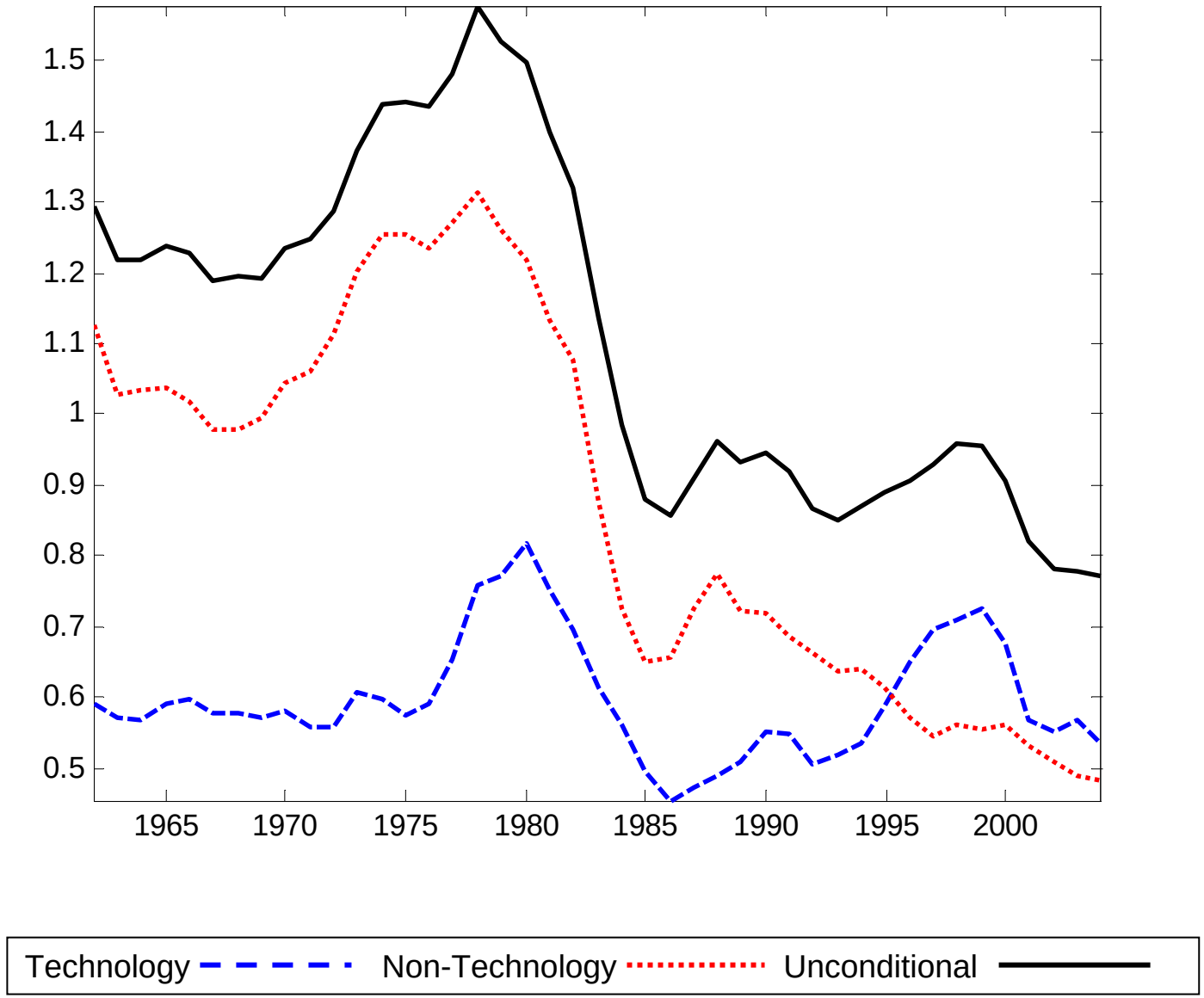

Figure 4b
Conditional Standard Deviations: Hours

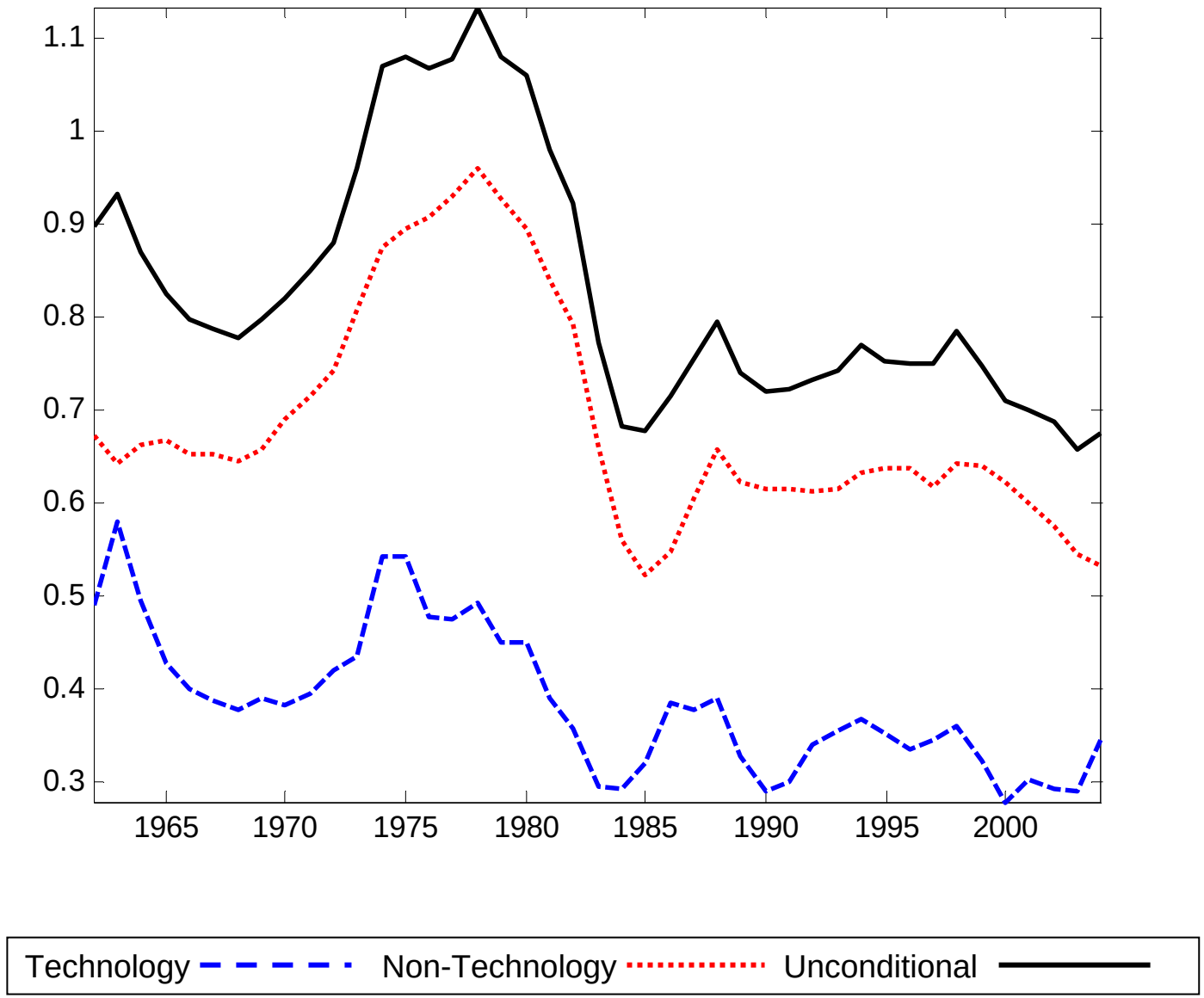

Figure 4c
Conditional Standard Deviations: Labor Productivity

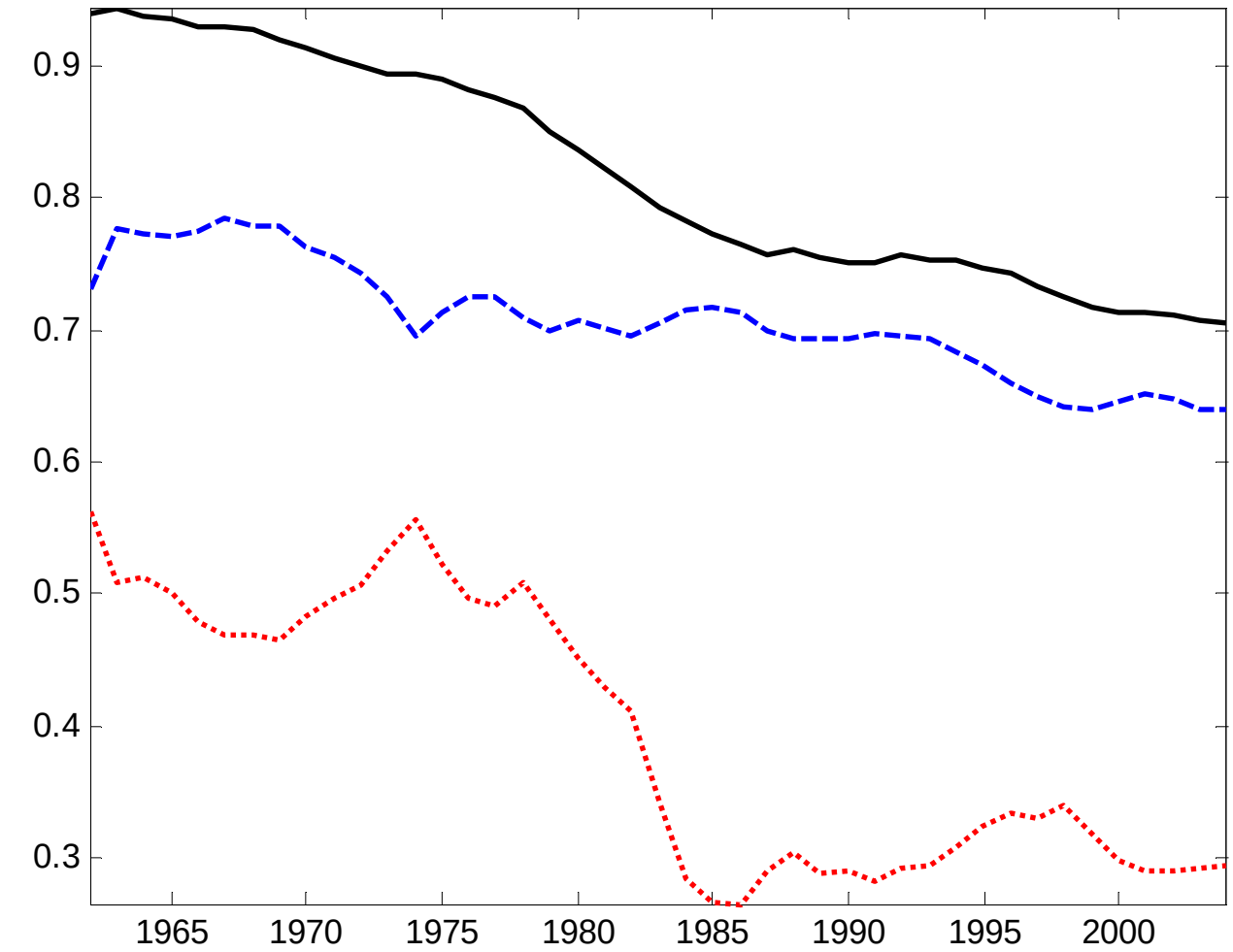

Table 4. Changes in Conditional Volatility

	Non-Technology Shocks				*Technology Shocks*			
	Pre-84	Post-84	$\frac{\text{Post-84}}{\text{Pre-84}}$	p-value	Pre-84	Post-84	$\frac{\text{Post-84}}{\text{Pre-84}}$	p-value
First-Difference								
Output	1.14	0.62	0.54	0.00	0.52	0.54	1.05	0.70
Hours	0.79	0.65	0.82	0.26	0.34	0.21	0.61	0.00
Productivity	0.46	0.20	0.37	0.00	0.72	0.67	0.88	0.52
BP-Filter								
Output	1.93	1.19	0.62	0.07	0.65	0.65	1.01	0.95
Hours	1.59	1.35	0.85	0.51	0.47	0.30	0.65	0.05
Productivity	0.49	0.33	0.67	0.06	0.89	0.81	0.91	0.59

Changing Labor Market Dynamics and the Great Moderation

- Unconditional Second Moments (F2-3)
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$$var(\Delta y_t) = var(\Delta y_t^a) + var(\Delta y_t^d)$$

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$$corr(x_t, z_t) = \lambda_a \ corr_a(x_t, z_t) \ + \lambda_d \ corr_d(x_t, z_t)$$

where $\lambda_i \equiv \frac{\sigma_i(x_t)}{\sigma(x_t)} \ \frac{\sigma_i(z_t)}{\sigma(z_t)}$.

- Time-Varying Impulse Responses (F6-8)
- Extension: Fisher Three-Variable Model

Figure 5a
Conditional Correlations: Hours - Output

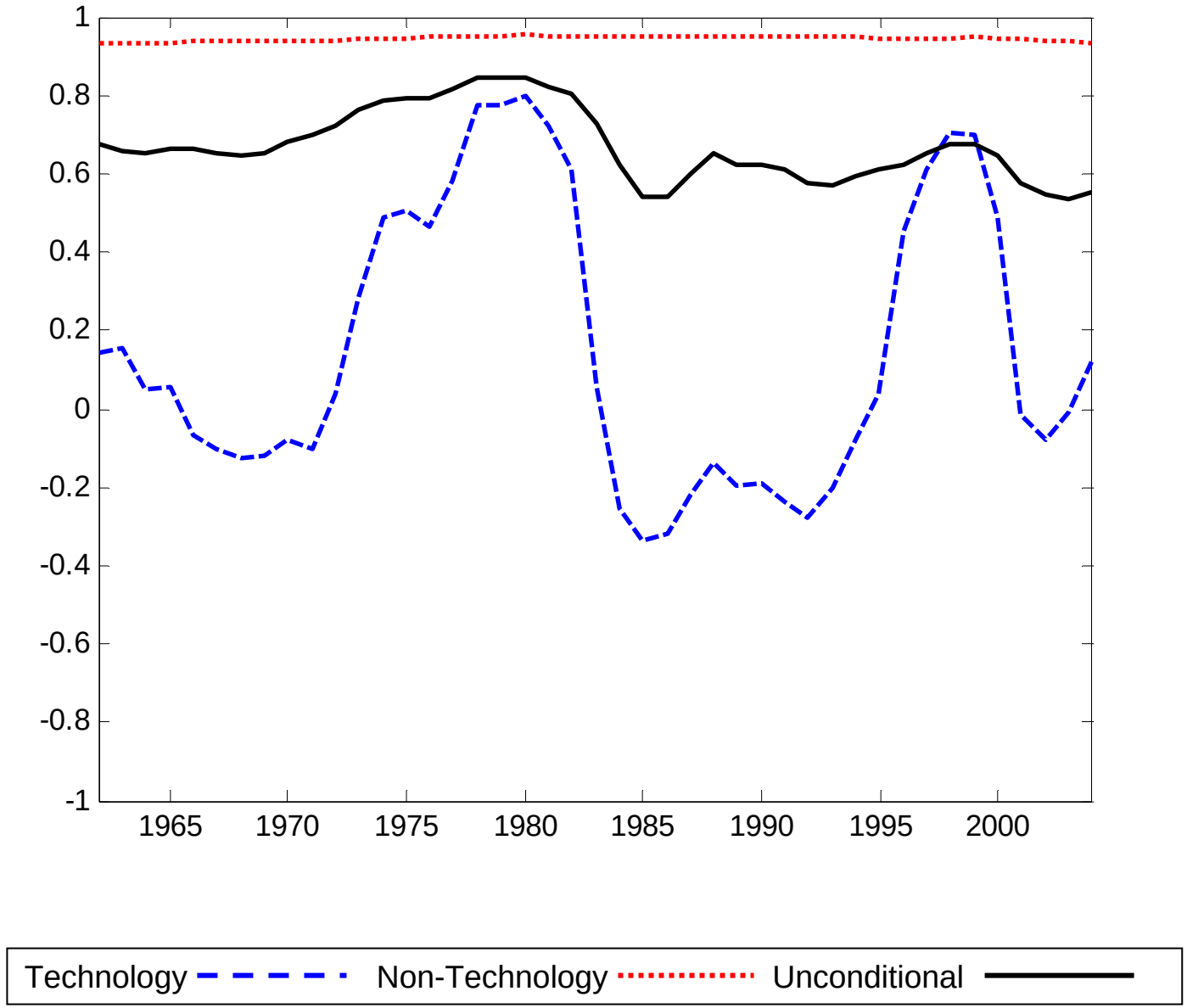

Figure 5b
Conditional Correlations: Labor Productivity - Hours

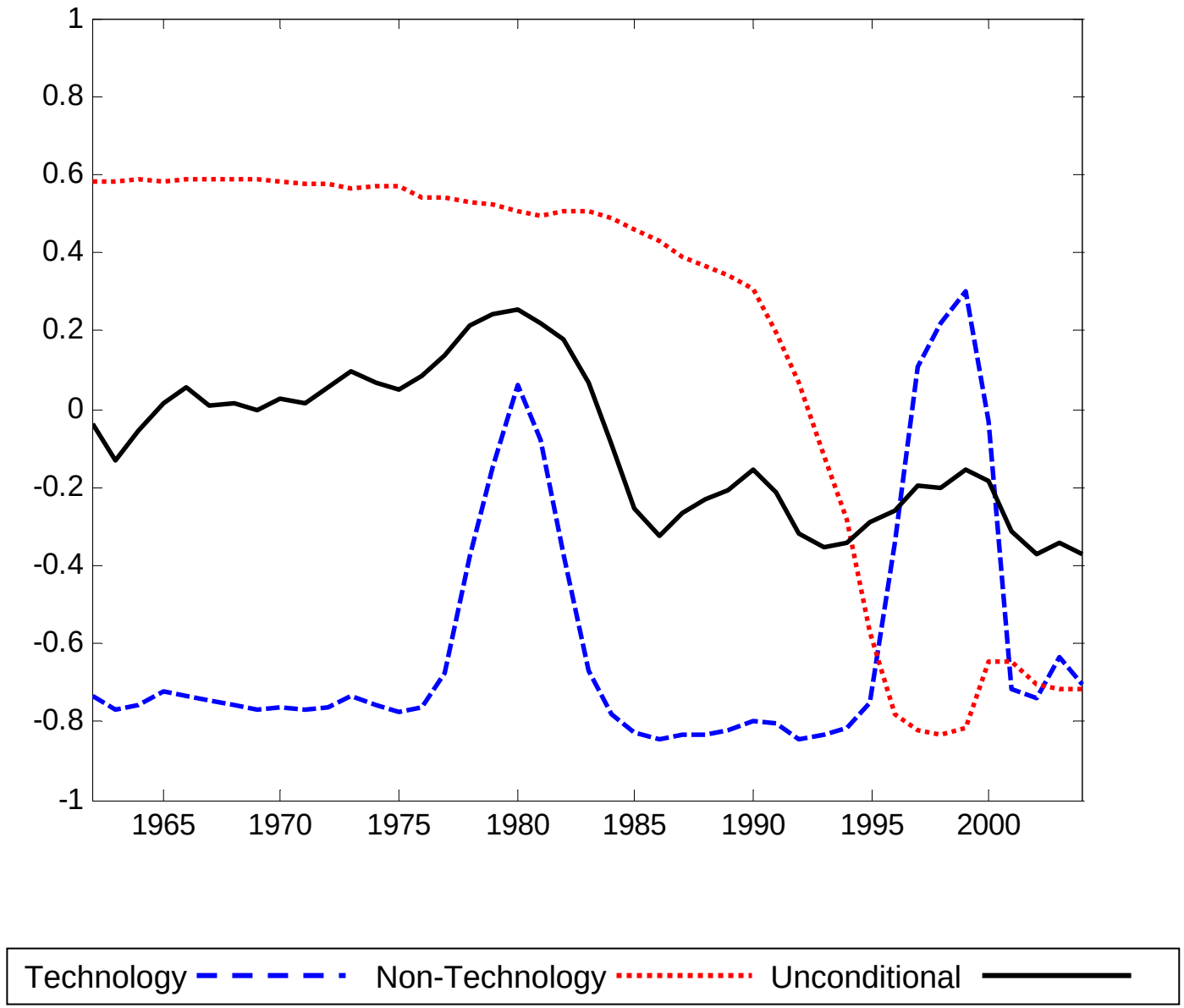

Figure 5c
Conditional Correlations: Labor Productivity - Output

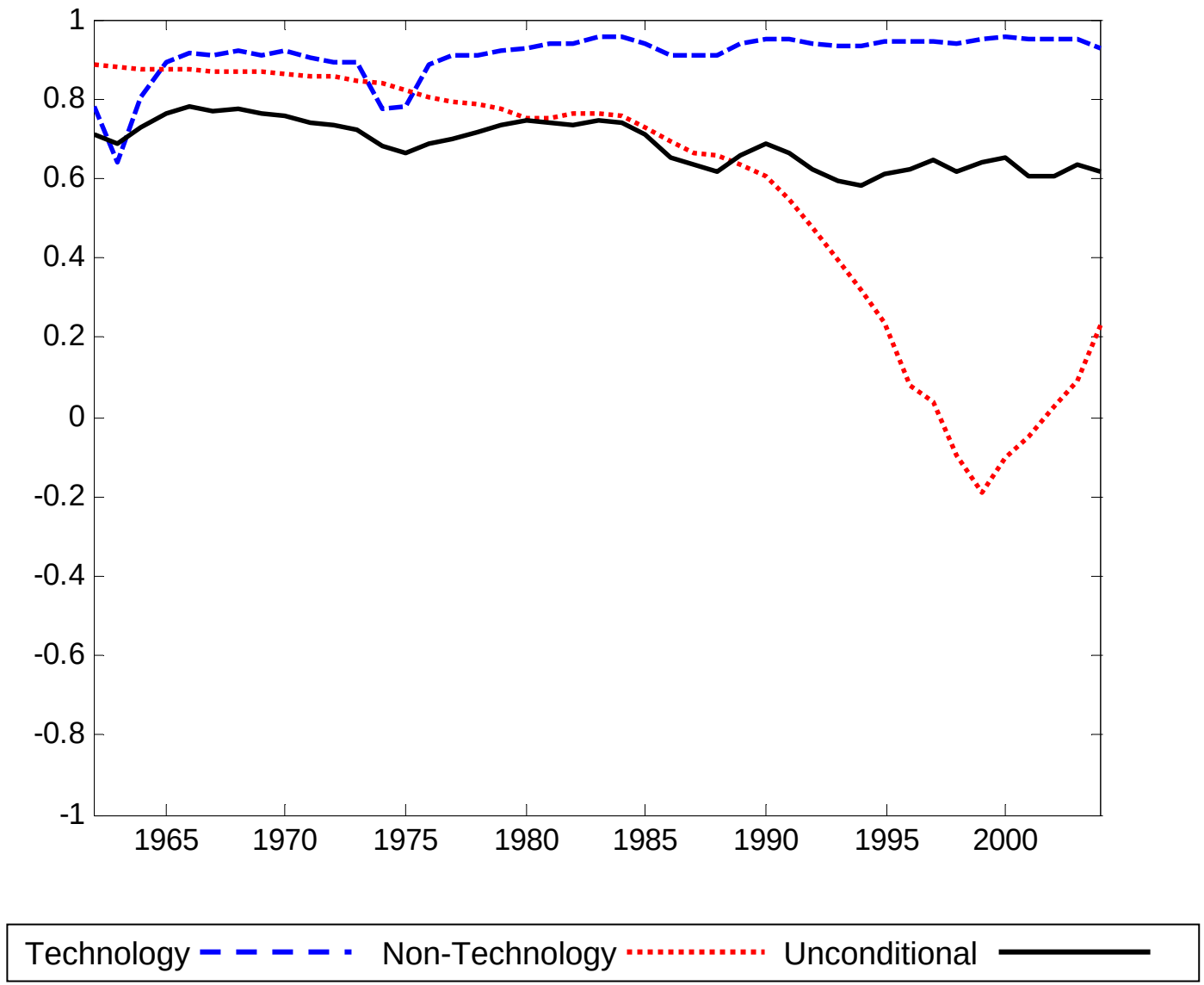

Table 5. Changes in Conditional Correlations

	Non-Technology Shocks			*Technology Shocks*		
	pre-84	post-84	change	pre-84	post-84	change
First-Difference						
Output, Hours	0.94	0.94	−0.00 (*NA*)	-0.39	-0.48	−0.09 (0.10)
Hours, Productivity	0.63	-0.30	−0.93** (0.08)	-0.75	-0.70	0.04 (0.07)
Output, Productivity	0.84	-0.01	−0.85** (0.16)	0.90	0.96	0.05 (0.08)
BP-Filter						
Output, Hours	0.97	0.97	−0.01 (*NA*)	-0.26	-0.34	−0.06 (0.19)
Hours, Productivity	0.60	-0.59	−1.19** (0.12)	-0.71	-0.65	0.06 (0.11)
Output, Productivity	0.75	-0.39	−1.14** (0.15)	0.86	0.93	0.07** (0.03)

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Figure 6a
Non-Technology Shocks: Output Response

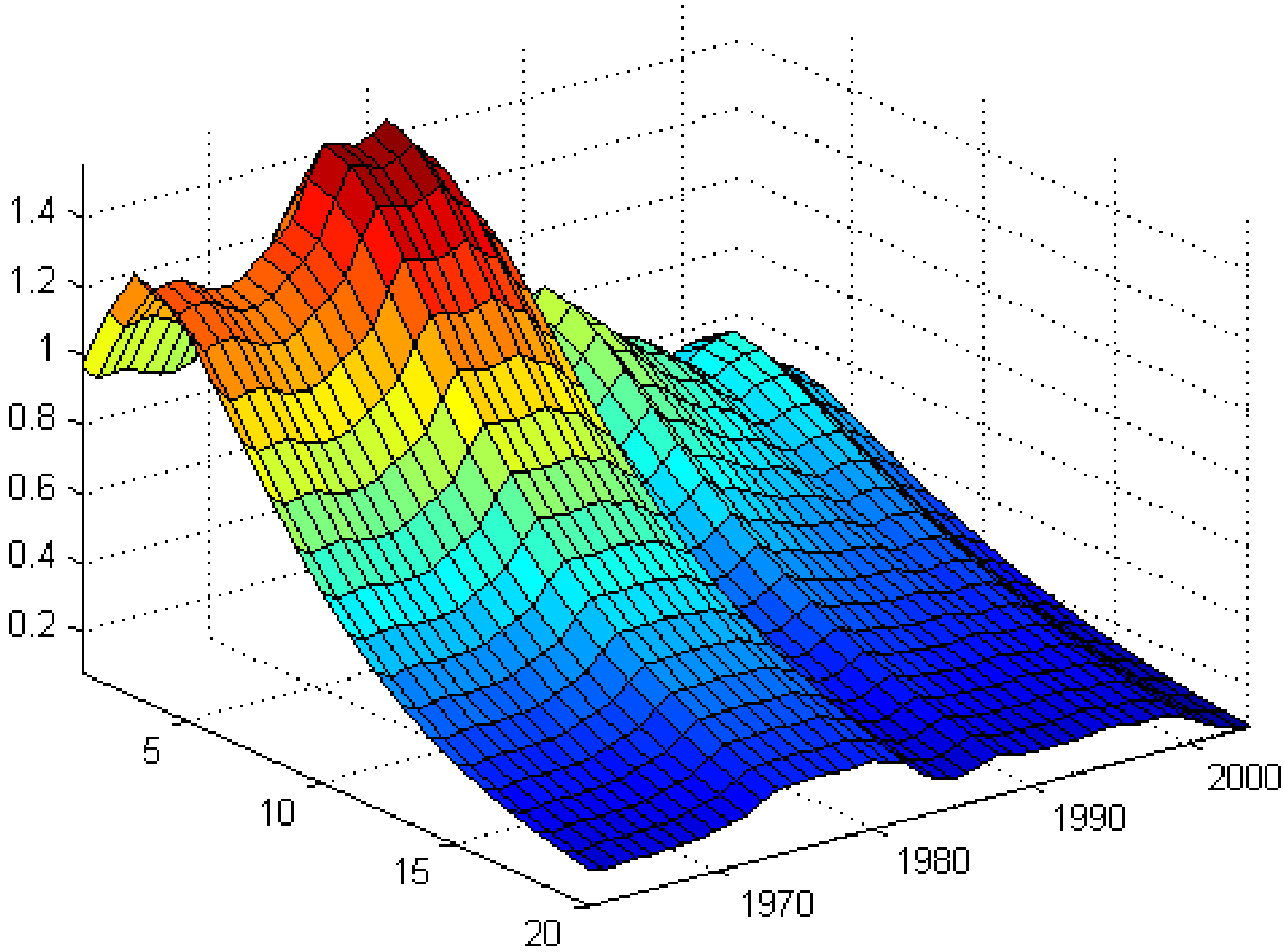
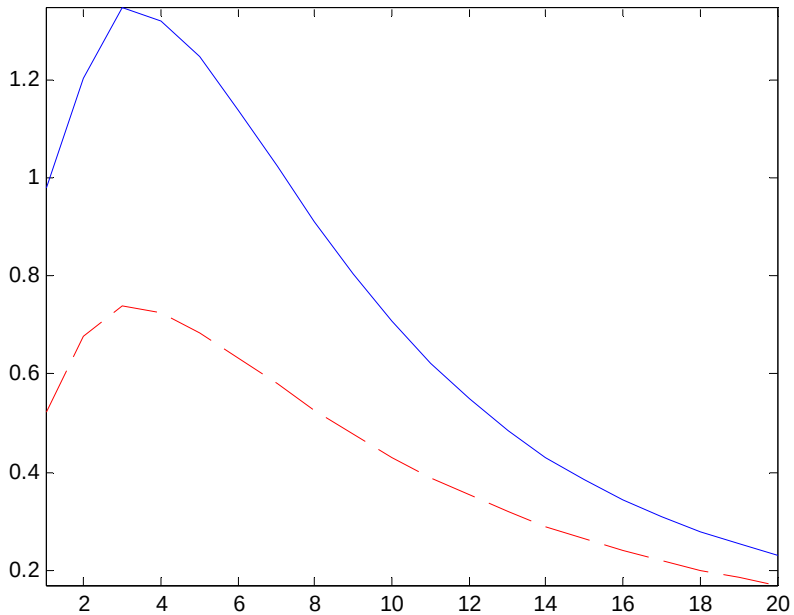


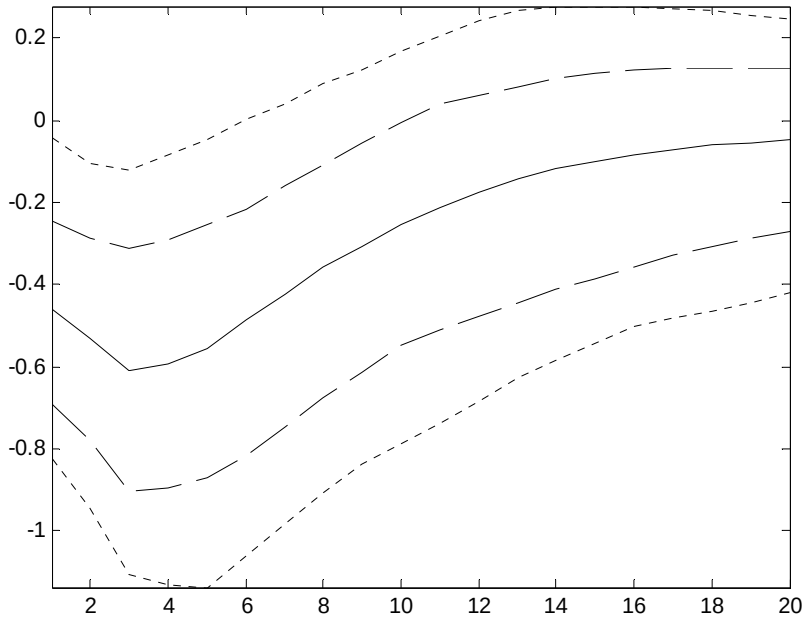
Figure 6b



Pre-84

Post-84

Figure 6c



Post-84 minus Pre-84

Figure 7a
Non-Technology Shocks: Labor Productivity Response

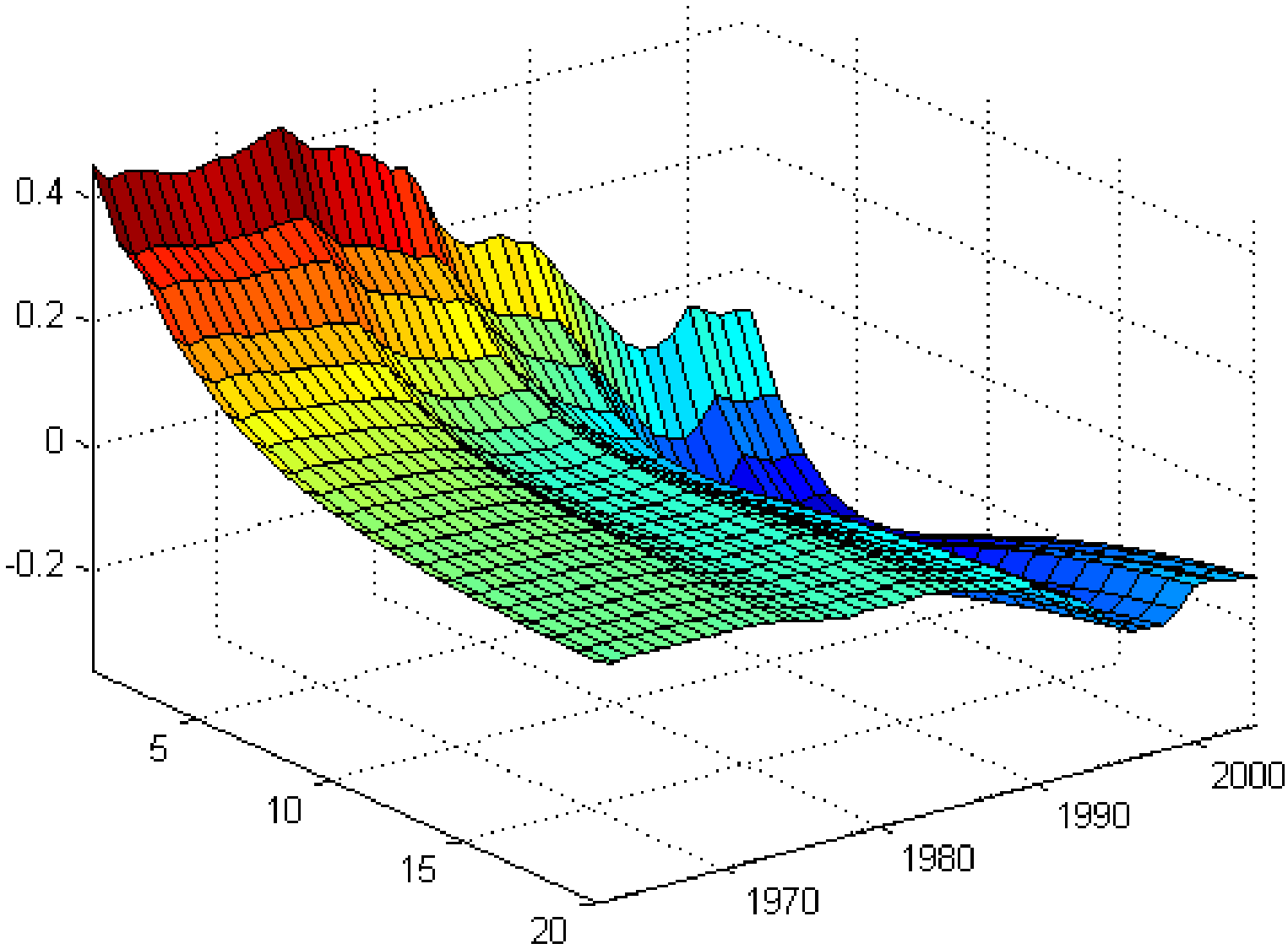
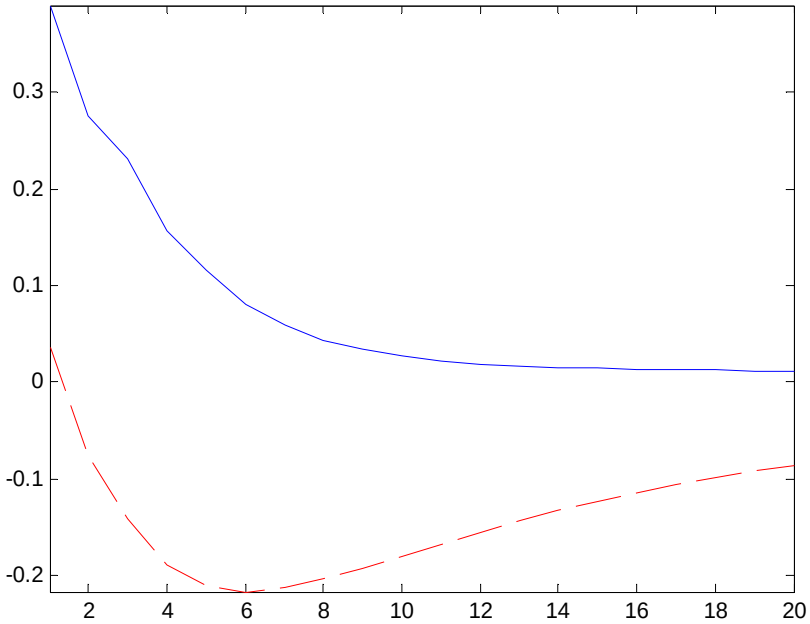


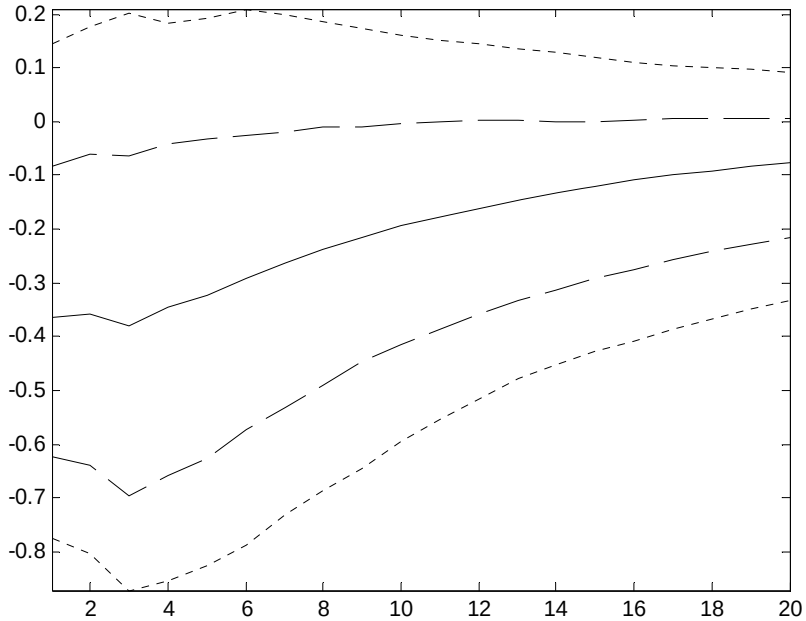
Figure 7b



Pre-84

Post-84

Figure 7c



Post-84 minus Pre-84

Figure 8a
Technology Shocks: Hours Response

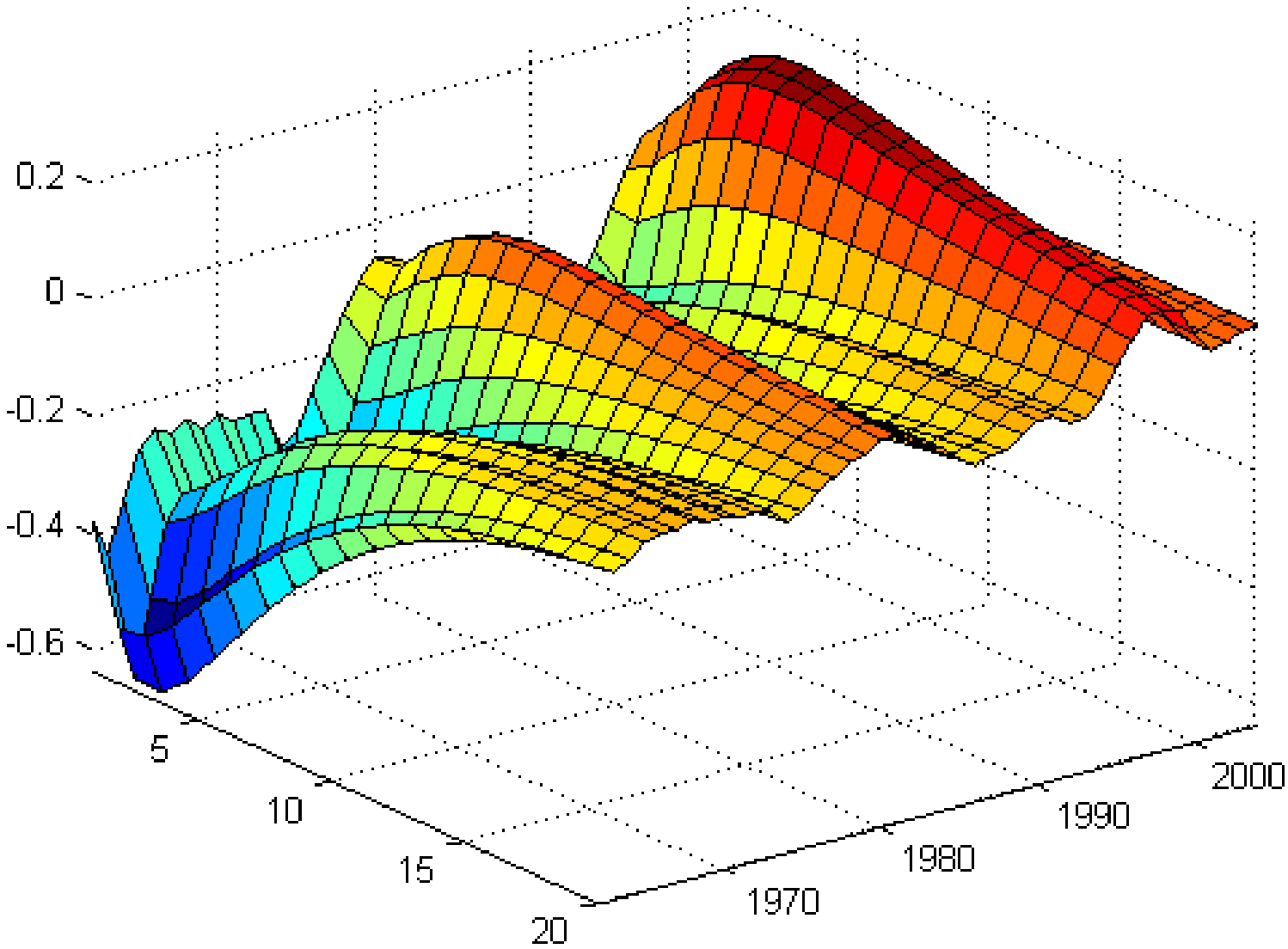
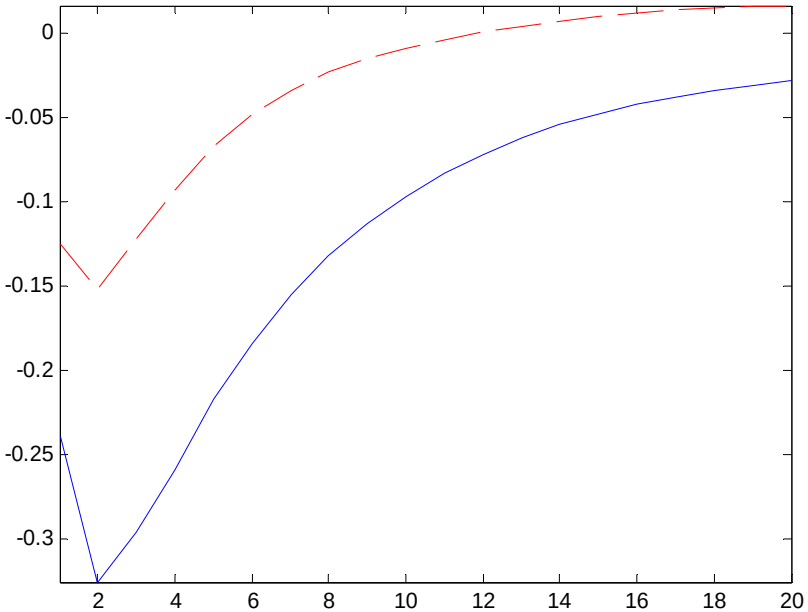


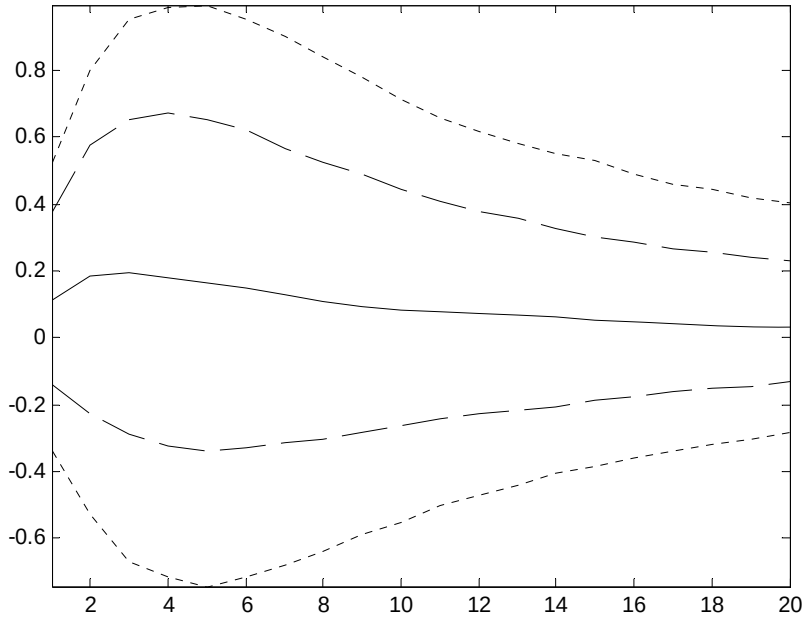
Figure 8b



Pre-84

Post-84

Figure 8c



Post-84 minus Pre-84

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Figure 9
Augmented Model: Conditional Output Volatilities

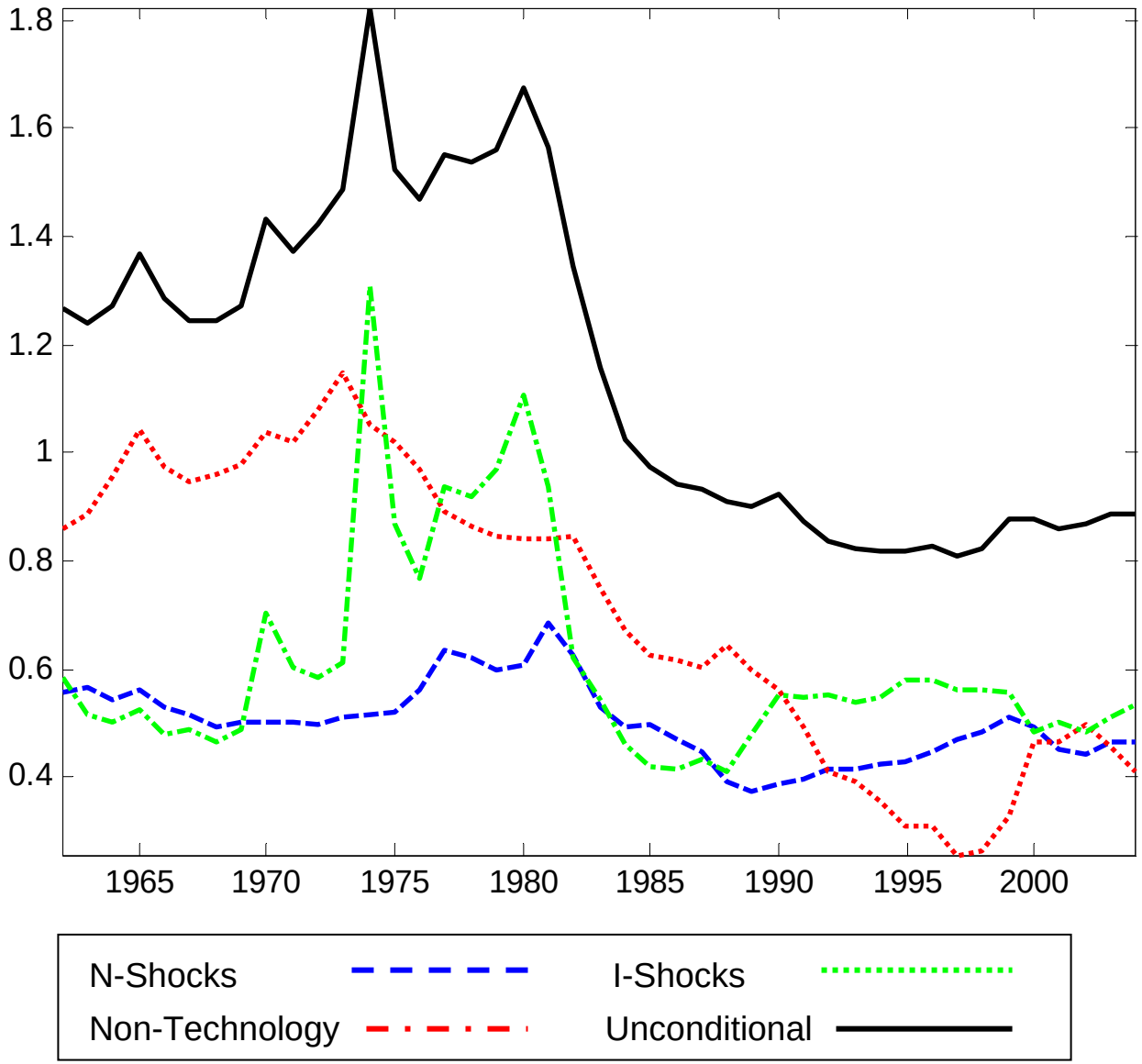
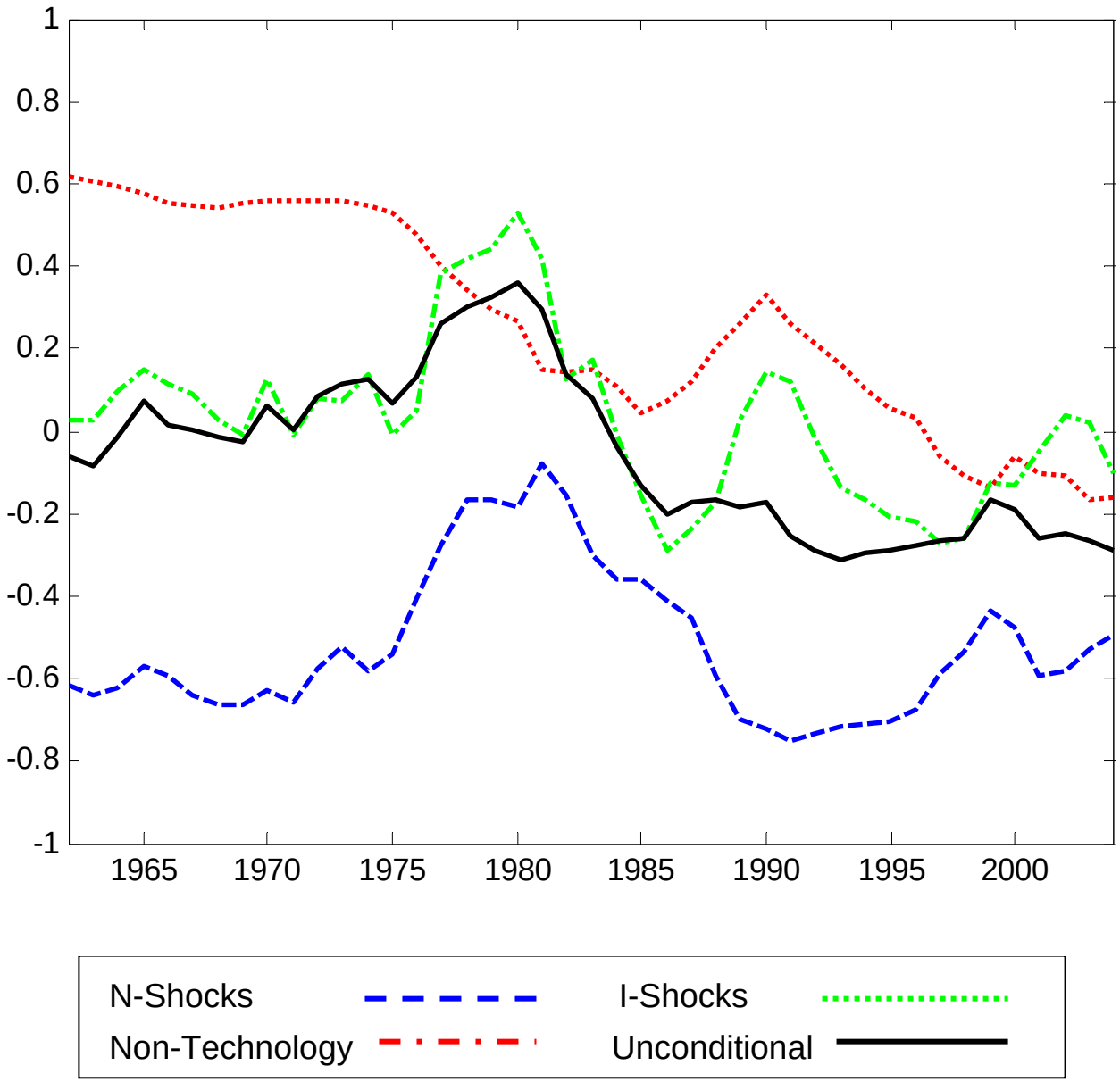


Figure 10
Augmented Model: Conditional Hours-Labor Productivity Correlations



Main Findings and Some Implications

- Main source of the Great Moderation: smaller contribution of non-technology shocks

  - no RBC explanation (contrary to Arias-Hansen-Ohanian hypothesis)
  - what role for good luck (smaller shocks)? what role for policy?

- Change in the response of labor productivity to a demand shock

  - main source of change in labor productivity-hours correlations

- Substantial evidence against "good luck" hypothesis
- Evidence consistent (but not a proof) of more stabilizing (less destabilizing) policies.
- Caveat: Imperfect accommodation of technology shocks?
- Structural change in the labor market? Causal role as a source of volatility decline?

A Hypothesis: The End of SRIRL?

Technology

$$y_t = a_t + (1 - \alpha)\ n_t^* + \xi_t$$

where

$$n_t^* = n_t + e_t$$

n_t : measured (log) labor input
e_t : (log) effort

Assumption: $e_t = \gamma\ n_t^*$

γ : index of labor hoarding

Measured Labor Productivity:

$$y_t - n_t = a_t + \left(\frac{\gamma - \alpha}{1 - \gamma}\right)\ n_t + \xi_t$$

Greater labor market flexibility? Also consistent with changes in relative volatilities.
Causal role? Mechanism? Further work needed...