Interest Rates and Investment Redux

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Investment and the Cost of Capital

- Monetary policy:
  - Policymakers use leverage over short-term market interest rates to influence the cost of capital.
  - Changes in the cost of capital affect interest-sensitive components of aggregate demand.
- Fiscal policy:
  - Elasticity of investment demand w.r.t. user cost of capital is the key parameter in determining the costs and benefits of alternative corporate tax policies.
- Little consensus regarding elasticity of investment demand:
  - Published estimates range from 0 to -2.
  - "Accelerator" variables (e.g., output, cash flow) have a much larger impact on capital spending than the user cost of capital.

Empirical Challenges

- **Key Components of the User Cost**:
  - Required real rate of return (including a risk premium)
  - Depreciation rate
  - Price of new capital goods (including expected price changes)
  - Tax terms (tax rate, PDV of depreciation allowances, ITC)
- **Aggregate Time-Series Evidence**:
  - Simultaneity between interest rates and investment demand
  - Price of capital and depreciation have little cyclical variation
  - Many tax changes are transitory
- **Firm-Level Evidence**:
  - Credit constraints
  - Investment irreversibility constraints

Our Paper

- Estimate the relationship between firm-level investment decisions and *firm-specific* marginal external financing costs.
- Measure firm-specific external financing costs with prices of outstanding senior unsecured bonds traded in the secondary market.
- Cross-sectional heterogeneity in external financing costs?
  - ➢ Differences in default risk
  - ➢ Differences in recovery rates
  - ➢ Differences in external finance premiums due to capital market imperfections
  - ➢ Differences in liquidity premiums

Key Results

- Investment spending is highly sensitive to movements in *firm-specific* external financing costs:
  - ➢ 1 pp. increase in financing costs ⇒ decline in investment rate between 70–130 bps.
- Interest-sensitivity of investment demand is robust to:
  - ➢ Inclusion of various measures of expected future profits
  - ➢ Inclusion of *firm-specific* measures of expected default risk
  - ➢ Inclusion of cash flow and other liquidity variables
  - ➢ Alternative sample periods

Data Sources

- **Compustat**: firm-level income and balance sheet data (1973–2004, fiscal year-end)
- **Lehman/Warga & Merrill Lynch**: prices of outstanding corporate bonds traded in the secondary market (Jan1973–Dec2004, month-end)
- **Moody's/KMV**: expected default frequencies (EDFs) (Jan1990–Dec2004, month-end)
- **BEA**: 2-digit SIC measures of depreciation and price of capital (1987–2004, year-end)
- **Panel Dimensions**: 6,293 bonds issued by 1,131 firms over the 1973–2004 period

Bond Yields

- Month-end option-adjusted yields on outstanding long-term corporate bonds.
- U.S. nonfarm, nonfinancial issuers only.
- Senior unsecured issues only.
- Term-premium adjustment for each bond on each day
- Nominal yields converted to real yields using
  - ➢ Past realized inflation
  - ➢ Survey measures of expected inflation

Corporate Bond Characteristics

Table 1: Summary Statistics of Key Bond-Specific Variables

Variable	Mean	SD	Min	Med	Max
# of bonds per firm/month	3.28	4.01	1.00	2.00	57.00
Mkt. Value of Issue ($mil.)	266.9	298.1	1.2	197.8	6,771.1
Maturity (years)	13.8	9.4	2.0	10.0	50.0
Effective Duration (years)	6.58	2.89	0.01	6.28	19.54
Composite Rating (S&P)	-	-	D	A3	AAA
Coupon Rate (%)	7.83	2.19	0.00	7.59	17.50
Nominal Yield (%)	8.52	2.89	0.17	8.05	35.31
Real Yield (%)	4.96	2.60	-4.07	4.74	29.99

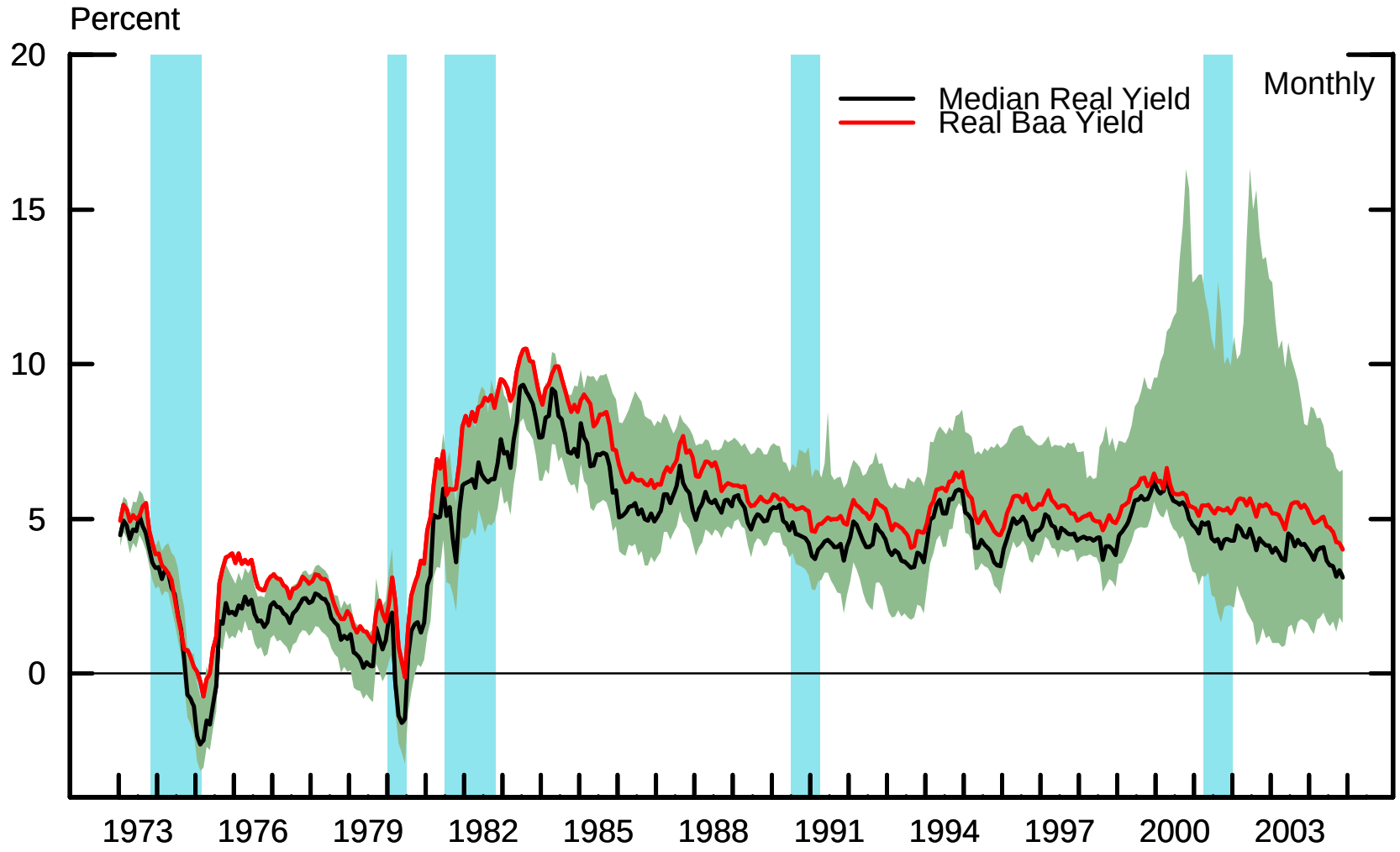
Panel Dimensions

Obs. $= 374,747$ $N = 6,293$ bonds

Min. Tenure $= 1$ Median Tenure $= 45$ Max. Tenure $= 302$

Corporate Bond Characteristics

Figure 1: The Evolution of Real Bond Yields



Firm Characteristics

Table 2: Summary Statistics for Key Firm-Specific Variables

Variable	Mean	SD	Min	Med	Max
Sales ($bil.)	8.36	16.78	$< .00$	3.41	245.0
Mkt. Capitalization ($bil.)	8.27	18.98	$< .00$	2.62	297.7
Par Value to L-T Debt	0.44	0.25	$< .00$	0.41	1.00
Real Interest Rate (%)	5.51	3.08	-2.42	5.04	29.92
Investment to Capital	0.21	0.14	$< .00$	0.18	1.00
Sales to Capital	3.66	3.26	0.13	2.81	24.81
Profits to Capital	0.46	0.36	-0.20	0.37	2.50
Tobin's Q	1.49	0.78	0.45	1.26	15.25

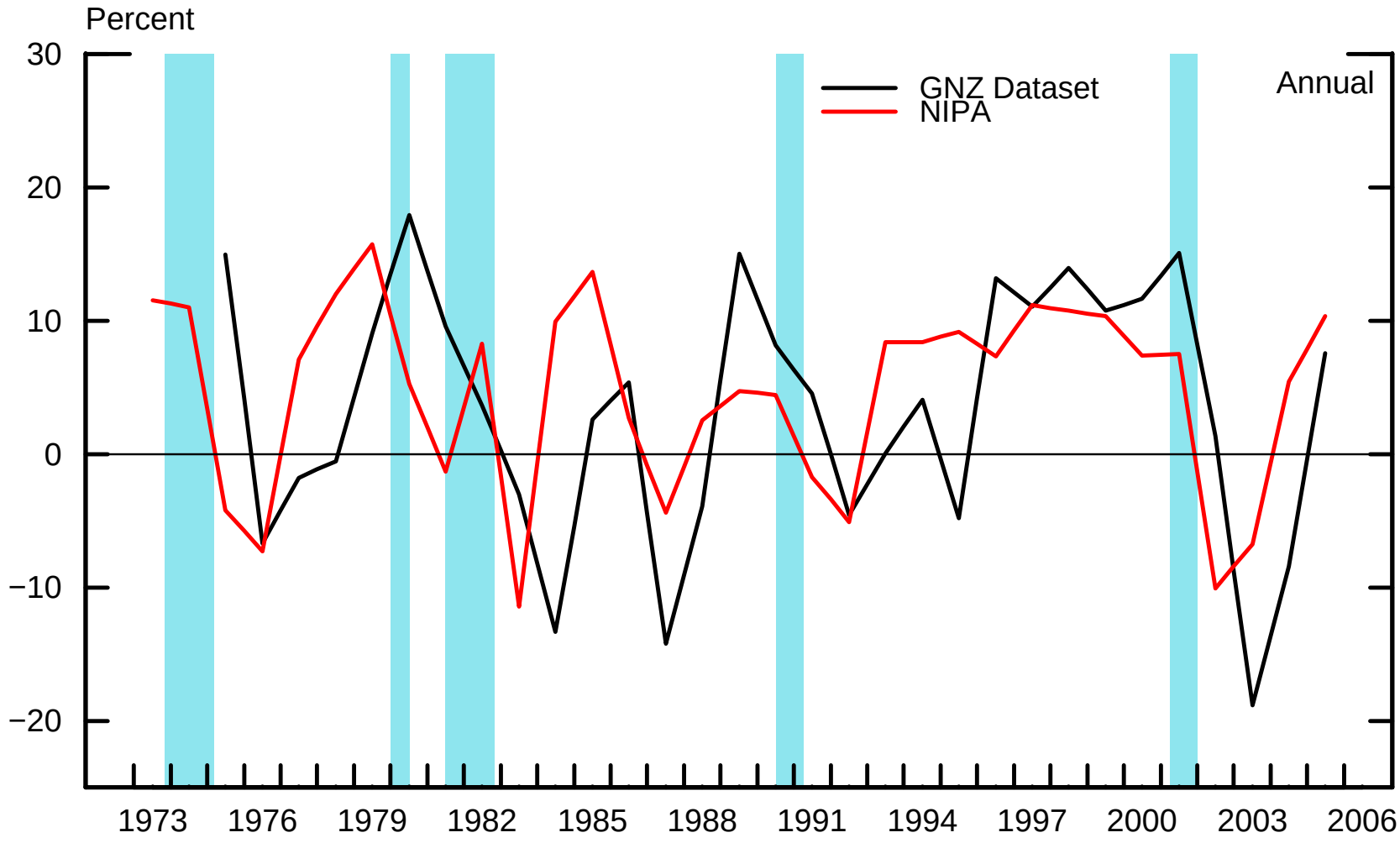
Panel Dimensions

Obs. $= 9,993$ $N = 1,131$ firms

Min. Tenure $= 1$ Median Tenure $= 6$ Max. Tenure $= 32$

Comparing Data with Broader Aggregates

Figure 2: The Growth of Real Business Fixed Investment



Expected Default Risk

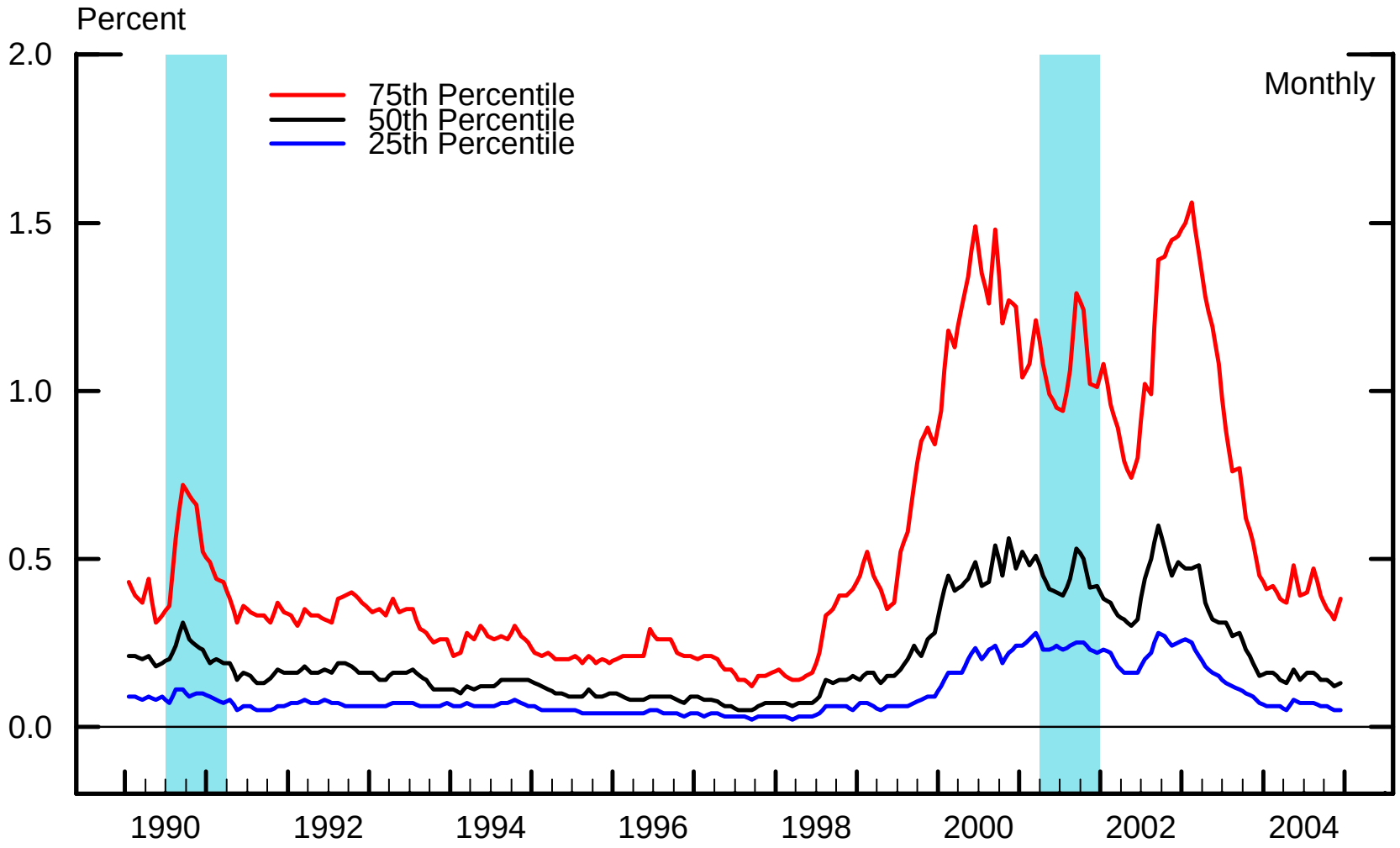
- **Default Probabilities**: expected default frequencies (EDFs)
  - Option-theoretic approach to calculate a firm-specific distance to default (DD):

$$\left[\begin{array}{c}\text{Distance}\\ \text{to Default}\end{array}\right] = \frac{\left[\begin{array}{c}\text{Mkt. Value}\\ \text{of Assets}\end{array}\right] - \left[\begin{array}{c}\text{Default}\\ \text{Point}\end{array}\right]}{\left[\begin{array}{c}\text{Mkt. Value}\\ \text{of Assets}\end{array}\right] \times \left[\begin{array}{c}\text{Asset}\\ \text{Volatility}\end{array}\right]}.$$

  - Use actual defaults used to construct a statistical mapping from DD to EDF.
  - The resulting EDF measures the likelihood that that a firm will default over the subsequent 12 months.

Expected Default Risk

Figure 3: The Evolution of Year-Ahead EDFs



Neoclassical User Cost of Capital

- User cost of capital for firm j in industry s:

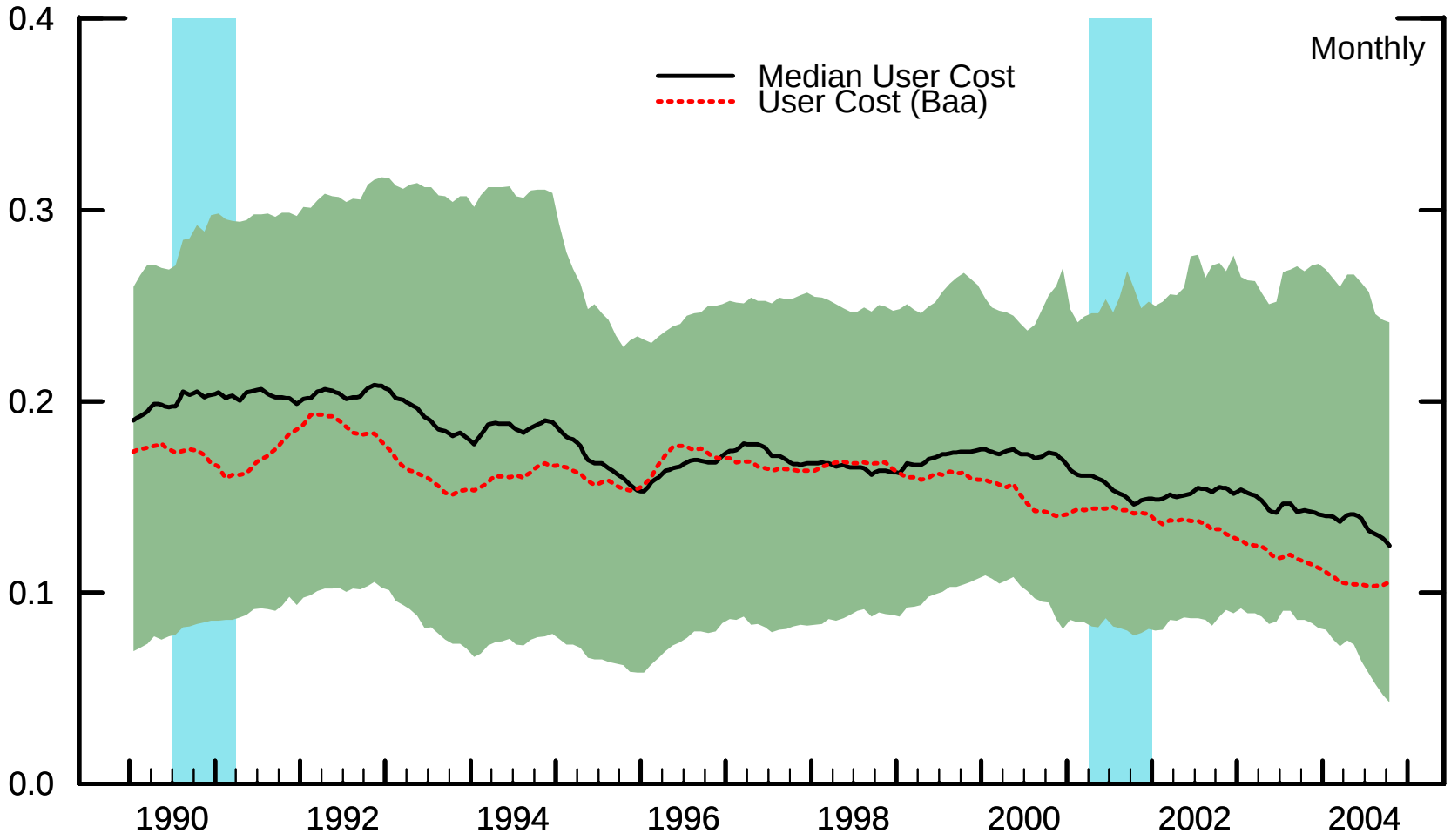
$$C_{jt}^K = \frac{P_{st}^K}{P_{st}^Q}\left[(1-\tau_t)i_{jt} + \delta_{st} - E_t\left(\frac{\Delta P_{s,t+1}^K}{P_{st}^K}\right)\right]\left[\frac{1-\tau_t z_{st}}{1-\tau_t}\right]$$

  - P_{st}^K/P_{st}^Q = relative price of capital goods
  - $(1-\tau_t)i_{jt}$ = after-tax *nominal* interest rate
  - τ_t = corporate tax rate (common to all firms)
  - δ_{st} = depreciation rate
  - z_{st} = present discounted value of depreciation deduction

- Industry-level components $(P_{st}^K, P_{st}^Q, \delta_{st}, z_{st})$ aggregated from asset-level data (25 E&S and 5 NRS types).

User Cost of Capital

Figure 4: The Evolution of the User Cost



Econometric Methodology

- **Baseline Specification**:

$$\frac{I_{jt}}{K_{j,t-1}} = \beta' Z_{jt} + \theta FC_{jt} + \eta_j + \lambda_t + \epsilon_{jt}$$

  - $I_{jt}/K_{j,t-1}$ = investment rate in period t
  - Z_{jt} = vector of investment fundamentals in period t (sales-to-capital ratio, Tobin's Q, lagged investment rate)
  - FC_{jt} = measure of external financing costs in period t (real interest rate, neoclassical user cost)
  - η_j = fixed firm effect
  - λ_t = fixed time effect

- **Sample Periods**: 1974–2004; 1991–2004 (sub-sample)

- **Estimation Methods**:
  - OLS Within/First-Difference
  - First-Difference Dynamic GMM

OLS-Within Estimates

Table 3: Level Specification (1974–2004)

Dependent Variable: I_t/K_{t-1}				
S_t/K_{t-1}	0.028	0.021	-	-
	(0.003)	(0.003)		
Q_{t-1}	-	-	0.052	0.036
			(0.007)	(0.006)
Π_{t-1}/K_{t-2}	-	0.111	-	0.131
		(0.012)		(0.012)
r_t	**-0.878**	**-0.699**	**-0.828**	**-0.636**
	(0.131)	(0.131)	(0.126)	(0.122)
$\Pr > W_\lambda$	$< .001$	$< .001$	$< .001$	$< .001$
BIC	-0.904	-0.941	-0.866	-0.917
Adj. R^2	0.509	0.527	0.489	0.516

First-Difference GMM

Table 4: Dynamic Specification (1974–2004)

Dependent Variable: $\Delta(I_t/K_{t-1})$				
$\Delta(I_{t-1}/K_{t-2})$	0.324	0.295	0.328	0.276
	(0.028)	(0.029)	(0.027)	(0.028)
$\Delta(S_t/K_{t-1})$	0.037	0.034	-	-
	(0.006)	(0.005)		
ΔQ_{t-1}	-	-	0.040	0.040
			(0.008)	(0.007)
$\Delta(\Pi_{t-1}/K_{t-2})$	-	0.031	-	0.065
		(0.019)		(0.017)
Δr_t	**-1.295**	**-1.212**	**-1.093**	**-1.185**
	(0.365)	(0.341)	(0.335)	(0.312)
$\Pr > \lvert m_1 \rvert$	$< .001$	$< .001$	$< .001$	$< .001$
$\Pr > \lvert m_2 \rvert$	0.518	0.574	0.521	0.523
$\Pr > J_N$	1.00	1.00	1.00	1.00

OLS-Within Estimates

Table 5: Level Specification (1991–2004)

Dependent Variable: I_t/K_{t-1}						
S_t/K_{t-1}	0.031	0.031	0.026	-	-	-
	(0.003)	(0.003)	(0.003)			
Q_{t-1}	-	-	-	0.047	0.046	0.036
				(0.007)	(0.006)	(0.006)
EDF_{t-1}	-	**-0.446**	**-0.395**	-	**-0.415**	**-0.368**
		(0.120)	(0.119)		(0.122)	(0.120)
Π_{t-1}/K_{t-2}	-	-	0.088	-	-	0.100
			(0.014)			(0.014)
r_t	**-0.680**	**-0.436**	**-0.340**	**-0.717**	**-0.492**	**-0.382**
	(0.141)	(0.158)	(0.160)	(0.140)	(0.157)	(0.157)
$\Pr > W_\lambda$	$< .001$	$< .001$	$< .001$	$< .001$	$< .001$	$< .001$
BIC	-0.975	-0.984	-1.014	-0.925	-0.932	-0.969
Adj. R^2	0.575	0.580	0.592	0.553	0.557	0.573

First-Difference GMM

Table 6: Dynamic Specification (1991–2004)

Dependent Variable: $\Delta(I_t/K_{t-1})$						
$\Delta(I_{t-1}/K_{t-2})$	0.410	0.398	0.381	0.394	0.383	0.372
	(0.039)	(0.038)	(0.039)	(0.036)	(0.036)	(0.039)
$\Delta(S_t/K_{t-1})$	0.037	0.038	0.036	-	-	-
	(0.009)	(0.008)	(0.007)			
ΔQ_{t-1}	-	-	-	0.037	0.035	0.037
				(0.007)	(0.007)	(0.007)
ΔEDF_{t-1}	-	**-0.207**	**-0.208**	-	**-0.296**	**-0.299**
		(0.185)	(0.176)		(0.171)	(0.169)
$\Delta(\Pi_{t-1}/K_{t-2})$	-	-	0.002	-	-	-0.006
			(0.024)			(0.020)
Δr_t	**-1.306**	**-0.753**	**-0.817**	**-1.033**	**-0.724**	**-0.841**
	(0.455)	(0.396)	(0.378)	(0.402)	(0.359)	(0.353)
$\Pr > \lvert m_1 \rvert$	$< .001$	$< .001$	$< .001$	$< .001$	$< .001$	$< .001$
$\Pr > \lvert m_2 \rvert$	0.645	0.694	0.716	0.539	0.597	0.621
$\Pr > J_N$	0.957	0.983	0.767	0.978	0.971	0.735

OLS-Within Estimates

Table 7: Level Specification (1991–2004)

Dependent Variable: I_t/K_{t-1}						
S_t/K_{t-1}	0.032	0.031	0.027	-	-	-
	(0.003)	(0.003)	(0.003)			
Q_{t-1}	-	-	-	0.049	0.046	0.036
				(0.007)	(0.007)	(0.006)
EDF_{t-1}	-	**-0.544**	**-0.466**	-	**-0.541**	**-0.460**
		(0.112)	(0.110)		(0.112)	(0.108)
Π_{t-1}/K_{t-2}	-	-	0.090	-	-	0.102
			(0.014)			(0.013)
C_t^K	**-0.270**	**-0.182**	**-0.153**	**-0.251**	**-0.165**	**-0.136**
	(0.073)	(0.069)	(0.065)	(0.079)	(0.074)	(0.067)
$\Pr > W_\lambda$	$< .001$	$< .001$	$< .001$	$< .001$	$< .001$	$< .001$
BIC	-0.963	-0.980	-1.012	-0.910	-0.927	-0.965
Adj. R^2	0.570	0.578	0.592	0.547	0.555	0.572

Measurement Error in C_t^K

Table 8: First-Difference 2SLS Estimates (1991–2004)

Dependent Variable: I_t/K_{t-1}						
$\Delta(S_t/K_{t-1})$	0.037	0.037	0.037	-	-	-
	(0.003)	(0.003)	(0.003)			
ΔQ_{t-1}	-	-	-	0.050	0.049	0.048
				(0.006)	(0.005)	(0.006)
ΔEDF_{t-1}	-	**-0.352**	**-0.332**	-	**-0.307**	**-0.304**
		(0.104)	(0.105)		(0.102)	(0.103)
$\Delta(\Pi_{t-1}/K_{t-2})$	-	-	0.035	-	-	0.005
			(0.012)			(0.011)
ΔC_t^K	**-0.782**	**-0.656**	**-0.623**	**-0.794**	**-0.689**	**-0.685**
	(0.190)	(0.152)	(0.194)	(0.174)	(0.177)	(0.177)
$\Pr > W_{\Delta\lambda}$	$< .001$	$< .001$	$< .001$	$< .001$	$< .001$	$< .001$
BIC	-1.826	-1.837	-1.840	-1.752	-1.759	-1.756

Measurement Error in C_t^K

Table 9: First-Difference Dynamic GMM Specification (1991–2004)

	Dependent Variable: $\Delta(I_t/K_{t-1})$					
$\Delta(I_{t-1}/K_{t-2})$	0.420	0.412	0.391	0.383	0.372	0.387
	(0.040)	(0.038)	(0.040)	(0.034)	(0.034)	(0.040)
$\Delta(S_t/K_{t-1})$	0.031	0.033	0.031	-	-	-
	(0.009)	(0.008)	(0.007)			
ΔQ_{t-1}	-	-	-	0.035	0.034	0.038
				(0.007)	(0.007)	(0.007)
ΔEDF_{t-1}	-	**-0.271**	**-0.296**	-	**-0.180**	**-0.292**
		(0.152)	(0.143)		(0.151)	(0.140)
$\Delta(\Pi_{t-1}/K_{t-2})$	-	-	-0.006	-	-	0.031
			(0.024)			(0.023)
ΔC_t^K	**-1.100**	**-0.753**	**-0.759**	**-1.378**	**-1.199**	**-1.030**
	(0.447)	(0.342)	(0.309)	(0.369)	(0.308)	(0.269)
$\Pr > \lvert m_1 \rvert$	$< .001$	$< .001$	$< .001$	$< .001$	$< .001$	$< .001$
$\Pr > \lvert m_2 \rvert$	0.580	0.646	0.672	0.461	0.502	0.565
$\Pr > J_N$	0.970	0.970	0.801	0.989	0.962	0.434

Directions for Future Research

- Investigate the source(s) of interest rate heterogeneity.
- Incorporate firm-specific interest rates into structural investment models.
- Joint modeling of debt and investment dynamics.