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SIMON KUZNETS MEMORIAL LECTURES
2000
LECTURE #2

BREAKDOWN OF GROWTH

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UCLA

- <u>2-Deflator Method</u>

$$\Delta Y^* = w^*\Delta L^* \quad + \quad (\rho+\delta)\Delta K^* \quad + \quad R^*$$

- <u>Traditional TFP Method</u>

$$\Delta Y = \quad \phi_L \Delta L \quad + \quad \phi_K \Delta K \quad + \quad R$$

$$Y^* \neq Y \qquad L^* \neq L \qquad K^* \neq K$$

but $$s_L = \frac{w^* L^*}{Y^*} = \frac{\phi_L L}{Y}$$

$$s_K = \frac{(\rho+\delta)K^*}{Y^*} = \frac{\phi_K K}{Y}$$

- So both methods look similar in the following form:

$$\frac{R^*}{Y^*} = \frac{\Delta Y^*}{Y^*} - s_L \frac{\Delta L^*}{L^*} - s_K \frac{\Delta K^*}{K^*}$$

and

$$\frac{R}{Y} = \frac{\Delta Y}{Y} - s_L \frac{\Delta L}{L} - s_K \frac{\Delta K}{K}$$

- But they are different

$$Y^* = \frac{\text{Value Added}}{\text{GDP Deflator}}$$

K^* = Capital measured in GDP Baskets

....

Y = Output in yards of cloth or value added at constant prices

K = Captial measured as number of machines or as an index of capital goods at constant prices

- 2-Deflator Method does not <u>require us</u> to have data on relative prices of output or on relative price of inputs.

- This is very important because

  a) We hardly ever have prices at the firm level.

  b) We often do not have them at the industry level.

  c) When we have then, they are very often unreliable.

- Also, 2-Deflator Method is very easy to apply, hence very attractive.

- But does it work??

  We will show that it does work.

- 2 Variations:

  a) Do basic calculations using the 2-Deflator Method, then adjust for price changes.

  b) Use 2-Deflator Method without price adjustments.

- Price adjustment is simple.

$$\frac{\Delta Y*}{Y*} = \frac{\Delta Y}{Y} + \frac{\Delta P}{P}$$

so

$$\frac{\Delta Y*}{Y*} - \frac{\Delta P}{P} = s_L \frac{\Delta L*}{L*} + s_K \frac{\Delta K*}{K*} + \left[\frac{R*}{Y*} - \frac{\Delta P}{P}\right]$$

$$\frac{\Delta Y}{Y} = s_L \frac{\Delta L*}{L*} + s_K \frac{\Delta K*}{K*} + \frac{R**}{Y*}$$

where

$$\frac{R**}{Y*} = \left[\frac{R*}{Y*} - \frac{\Delta P}{P}\right]$$

- Biggest Point:

2-Deflator Method multiplies by a huge factor (probably between 10 and 100) the range of data that we can study via breakdown of growth.

- One cannot exaggerate the importance of this point.

- As we did yesterday, we compare the 2-Deflator with the Jorgenson Method, comparing both 1-year changes and changes over 5-year non-overlapping periods. We do this for the

$$\text{Labor Contribution}: \quad s_L \frac{\Delta L}{L} \quad \text{with} \quad s_L \frac{\Delta L^*}{L^*}$$

$$\text{Capital Contribution}: \quad s_K \frac{\Delta K}{K} \quad \text{with} \quad s_K \frac{\Delta K^*}{K^*}$$

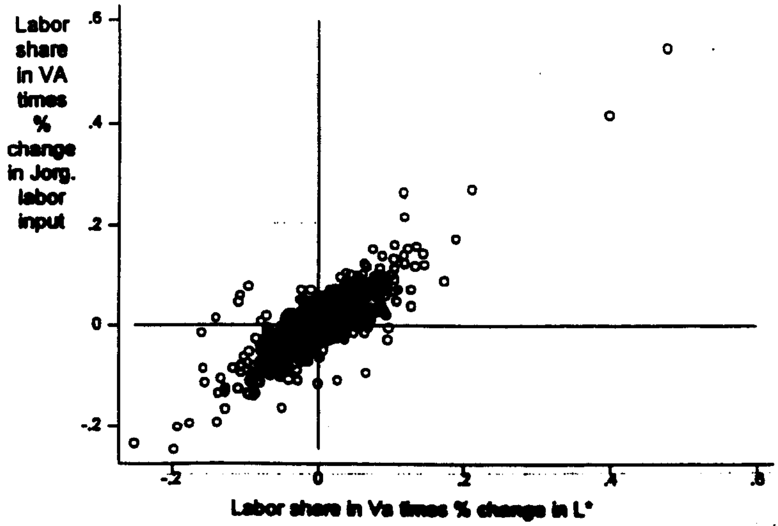
$$\text{Calculated TFP}: \quad R \quad \text{with} \quad R^*$$

Value Added under

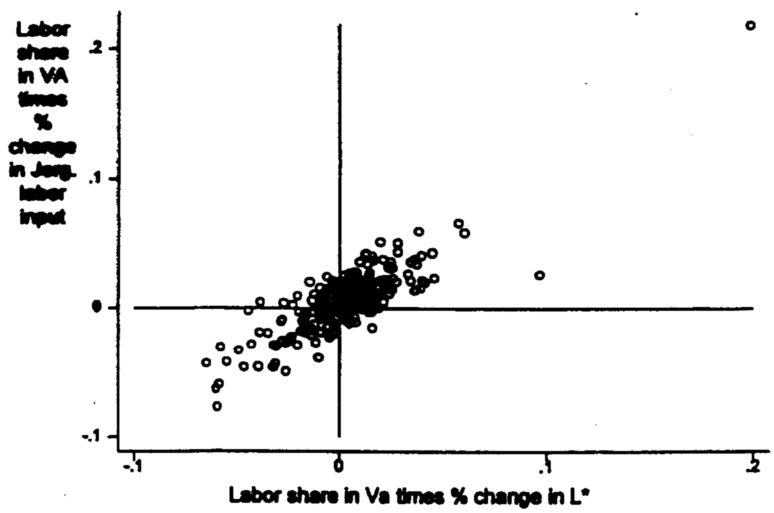
$$\text{both concepts}: \quad \frac{\Delta Y}{Y} \quad \text{with} \quad \frac{\Delta Y^*}{Y^*}$$

(Latter shifts Jorgenson quantity variable to a value added basis.)

Figure 1
Jorgenson vs Two-Deflator Labor Contribution
Yearly Data (1949-91)
(r=.8095)



5-Year Data (Annual Average Rates)
(r=.8359)



DATA from JORGENSON KLEMS 35

35 Sector Breakdown

(minus petroleum & govt enterprises)

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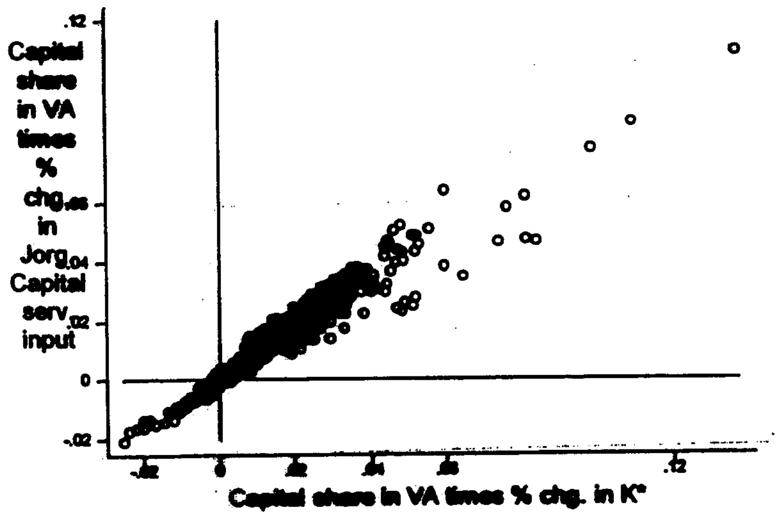
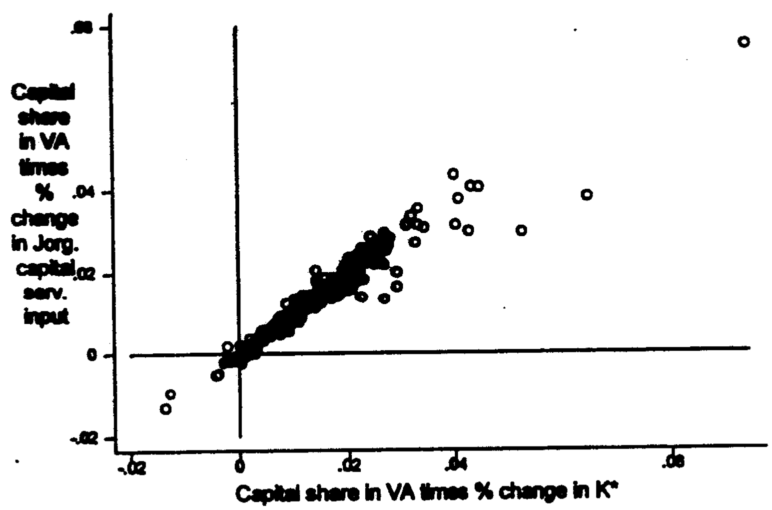
Figure 2
Jorgenson vs Two-Deflator Capital Contribution
(Yearly Data) 1948-91
(r=.9647)



5-Year Data (Annual Average Rates)
(r=.9634)



DATA from JORGENSON KLEM 35

35 Sector Breakdown

(minus petroleum and govt enterprise)

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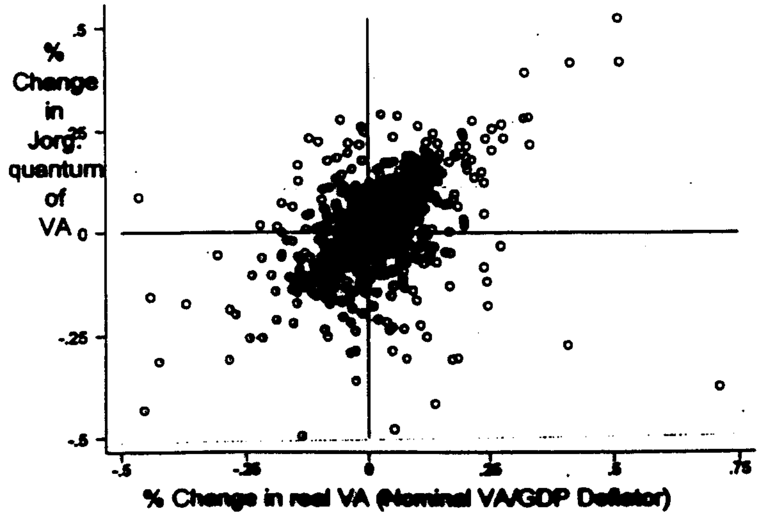
Figure 3
Average Rates of Growth of the Quantity of Value Added
Jorgenson vs Two-Deflator Methods
(Yearly Data)
(r=.4733)



5-Year Data (Annual Average Rates)
(r=.5245)

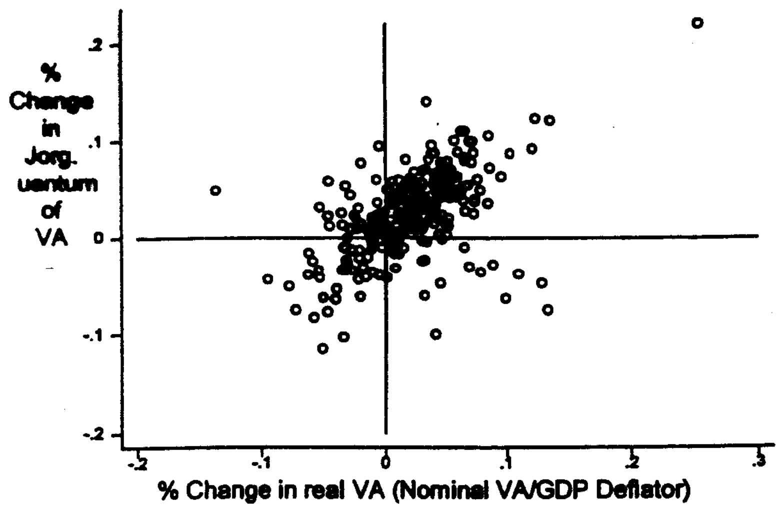
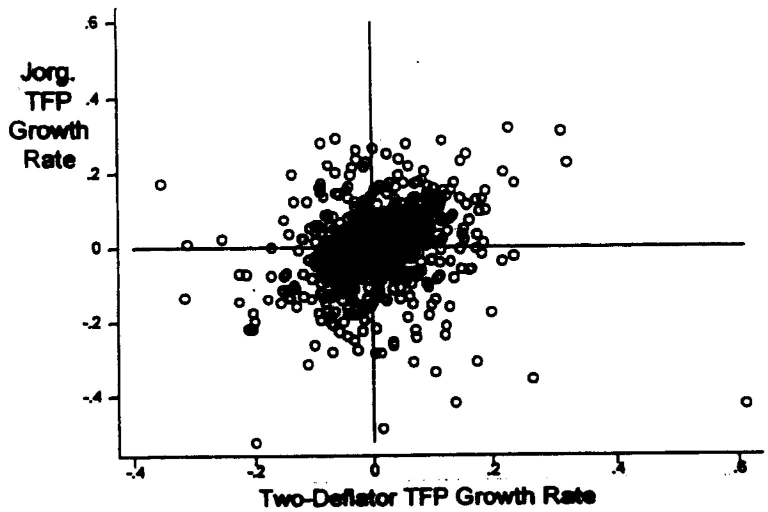
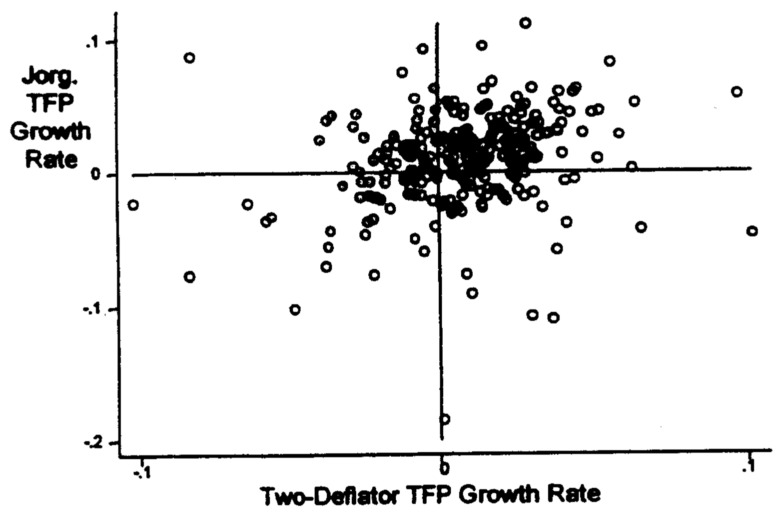


Figure 4
Jorgenson vs Two-Deflator TFP Growth
Yearly Data
(r=.2353)



5-Year Data (Annual Average Rates)
(r=.2391)



- Now, we look at the effects of doing price adjustments:

  a) Shift 2-Deflator ΔTFP to a "Jorgenson Basis" by subtracting ΔPva/Pva.

  b) Shift "Jorgenson" ΔTFP to a "2-Deflator Basis" by adding ΔPva/Pva.

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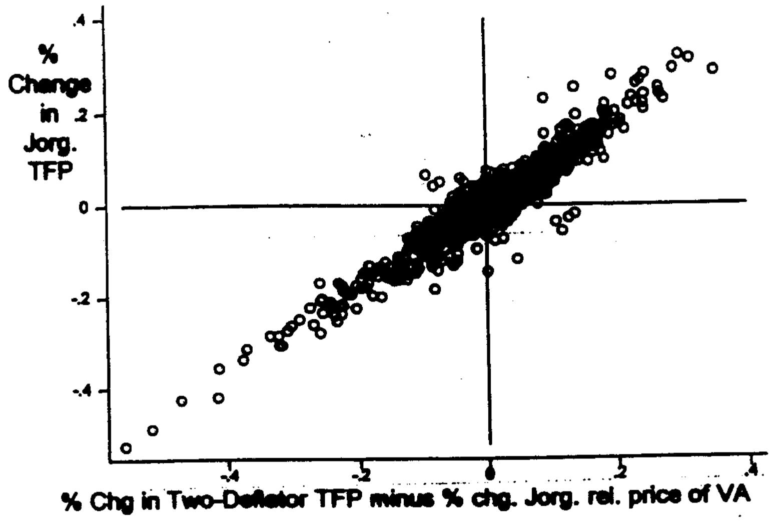
Figure 5
Jorgenson vs "Two-Deflator Adjusted" TFP Growth
Yearly Data
(r=.9385)



5-Year Data (Annual Average Rates)
(r=.9418)

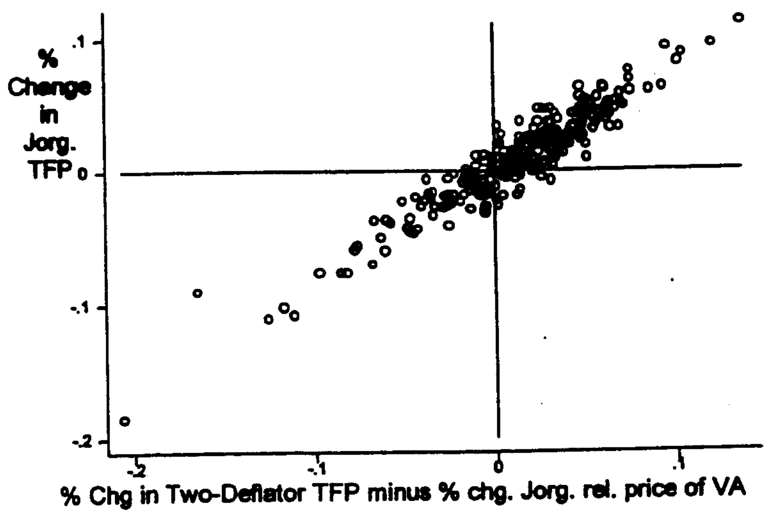
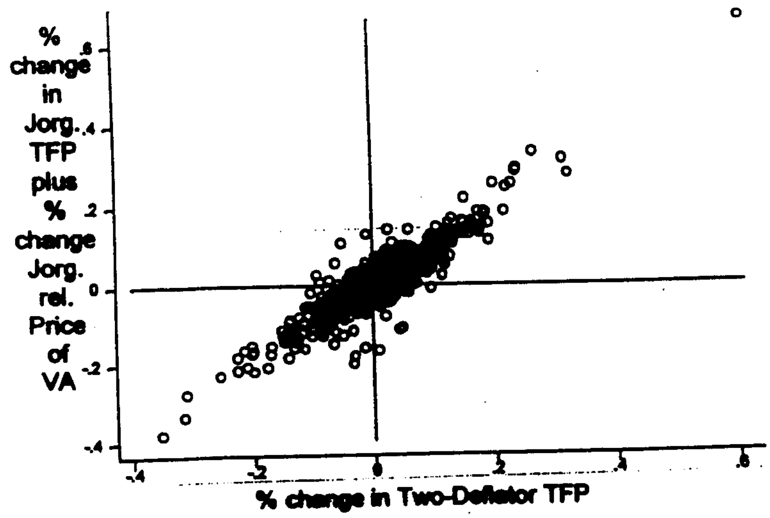
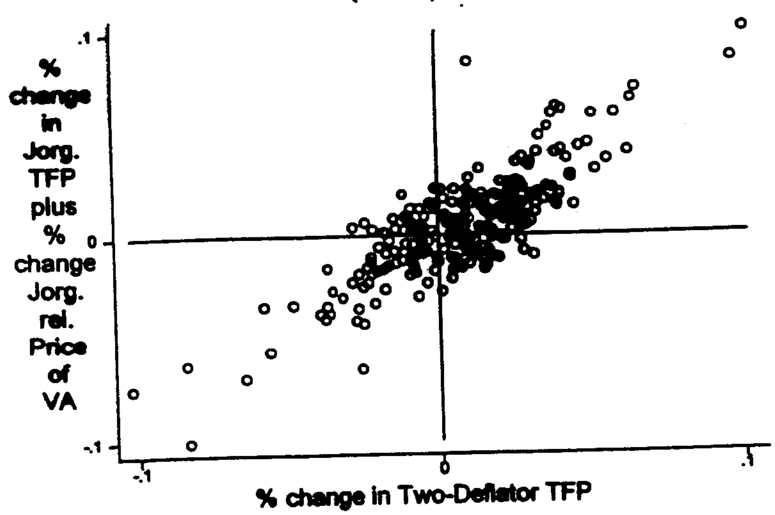


Figure 6
"Jorgenson Modified" vs Two-Deflator TFP Growth
Yearly Data
(r=.8827)

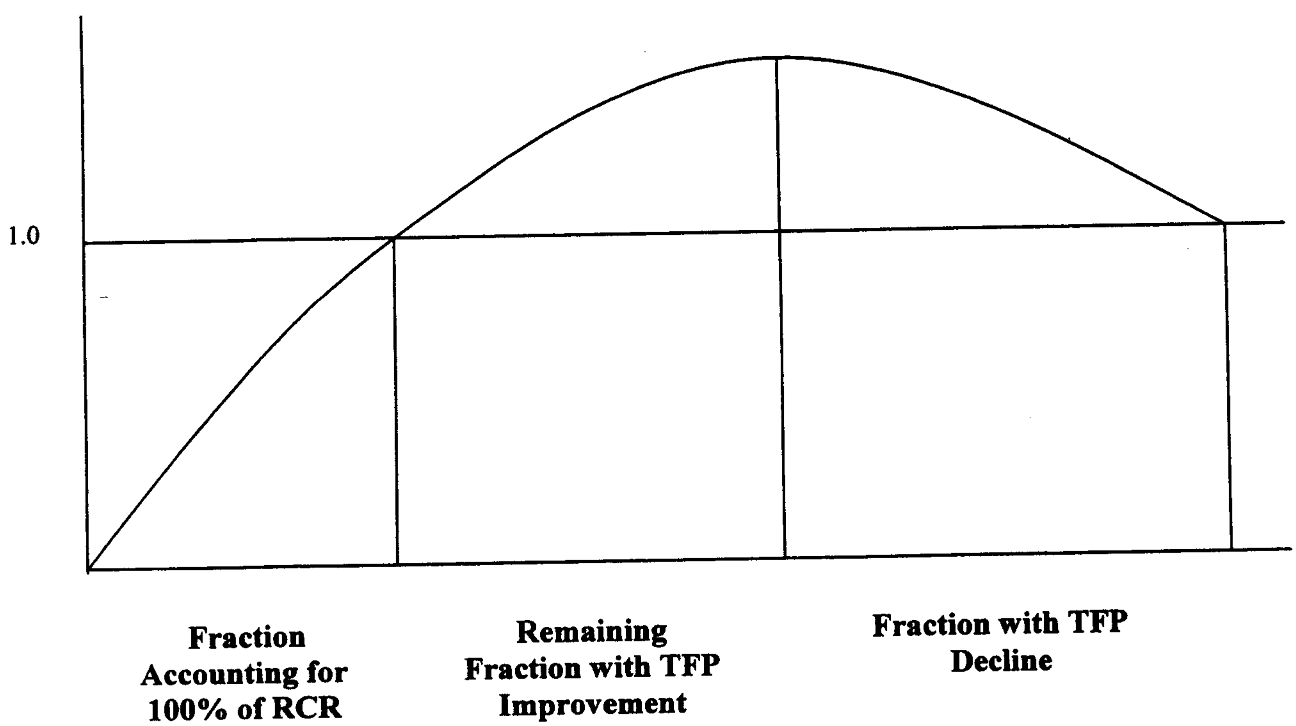


5-Year Data (Annual Average Rates)
r=(.8317)



- Now, we try to extract inferences from the data.
- My Presidential Address gave a lot of attention to instances of negative changes in TFP – i.e. of increasing real costs.

SUNRISE-SUNSET DIAGRAM



- The three indicated fractions nicely summarize the "shape" of a Sunrise-Sunset Diagram.
- To give an idea of the rates of TFP growth involved, we have the second panel on each page.
- This presents overall rates of TFP growth within each of the cells defined in the first breakdown.
- I call attention to the top comparison in each panel.-

Why? Because this uses the 2-Deflator results without any price adjustments.

• Please note how close the results are in all three comparisons within each panel. But especially the top panel. The pictures emerging from Jorgenson and the unadjusted 2-Deflator calculations are virtually identical.

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TABLE 11
Distribution of Initial Value Added by TFP Performance
Yearly Changes (1419 Observations, 1948-1991)

	Fraction Accounting for 100 % of RCR A	Remaining fraction with TFP improvement B	Fraction with TFP decline C	All
Jorgenson	0.041	0.550	0.409	1.000
2DFL	0.044	0.529	0.427	1.000
Jorgenson	0.041	0.550	0.409	1.000
2DFLadj.	0.068	0.536	0.396	1.000
2DFL	0.044	0.529	0.427	1.000
Jorg. modified	0.015	0.518	0.467	1.000

Average annual Rate of TFP Improvements in Category

	Fraction Accounting for 100 % of RCR	Remaining fraction with TFP improvement	Fraction with TFP decline	All
Jorgenson	0.1952	0.0429	-0.0578	0.0080
2DFL	0.1634	0.0350	-0.0433	0.0073
Jorgenson	0.1952	0.0429	-0.0578	0.0080
2DFLadj.	0.1723	0.0467	-0.0633	0.0117
2DFL	0.1634	0.0350	-0.0433	0.0073
Jorg. modified	0.2321	0.0350	-0.0388	0.0036

Source: Calculations of year-to-year changes in value added and in real cost reduction (%ΔTFP) underlying Table 8 (for Jorgenson and 2DFL), Column 2 of Table 9 (for 2DFLadj) and for column 1 of Table 10 (for Jorg. modified).

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TABLE 12
Distribution of Initial Value Added by TFP Performance
Average Annual Rates over Five-year Periods (264 Observations, 1948-1988)

	Fraction Accounting for 100 % of RCR A	Remaining fraction with TFP improvement B	Fraction with TFP decline C	All
Jorgenson	0.178	0.481	0.341	1.000
2DFL	0.208	0.455	0.337	1.000
Jorgenson	0.178	0.481	0.341	1.000
2DFLadj.v	0.208	0.485	0.307	1.000
~~2DFL~~	~~0.208~~	~~0.455~~	~~0.337~~	~~1.000~~
Jorg. modified	0.095	0.530	0.375	1.000

Average annual Rate of TFP Improvement in Category

	Fraction Accounting for 100 % of RCR	Remaining fraction with TFP improvement	Fraction with TFP decline	All
Jorgenson	0.0455	0.0188	-0.0266	0.0098
2DFL	0.0400	0.0137	-0.0185	0.0083
Jorgenson	0.0455	0.0188	-0.0266	0.0098
2DFLadj.	0.0629	0.0216	-0.0341	0.0131
2DFL	0.0400	0.0137	-0.0185	0.0083
Jorg. modified	0.0521	0.0123	-0.0173	0.0050

Source: Same as Table 11. Individual data points are five-year averages of the data points of Table 11.

- Now, we turn to a huge data set, NBER – 458 Manufacturing Industries, 1958-94.

- First, we look at the scatter of the 2-Deflator versus the Traditional ΔTFP.

- As before, with price correction, they are almost the same.

- Without price correction, they look somewhat messy.

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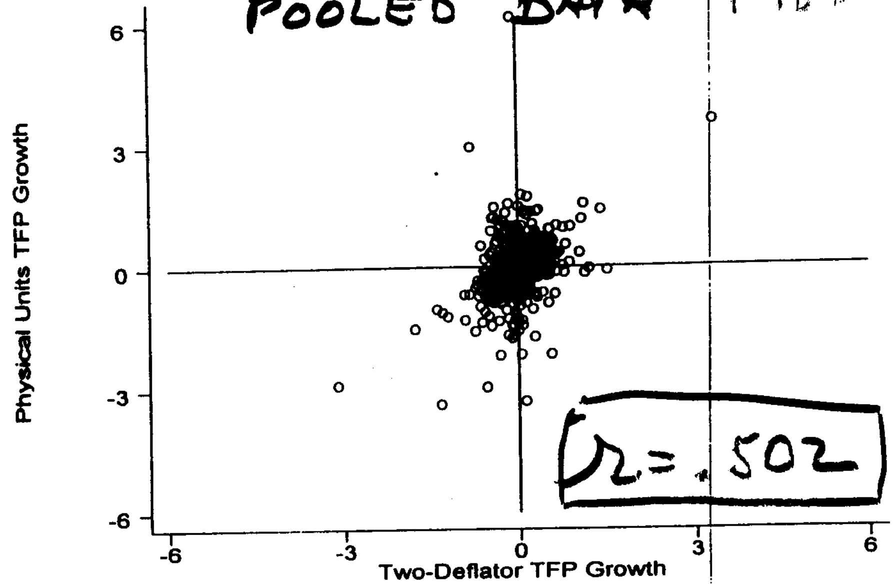
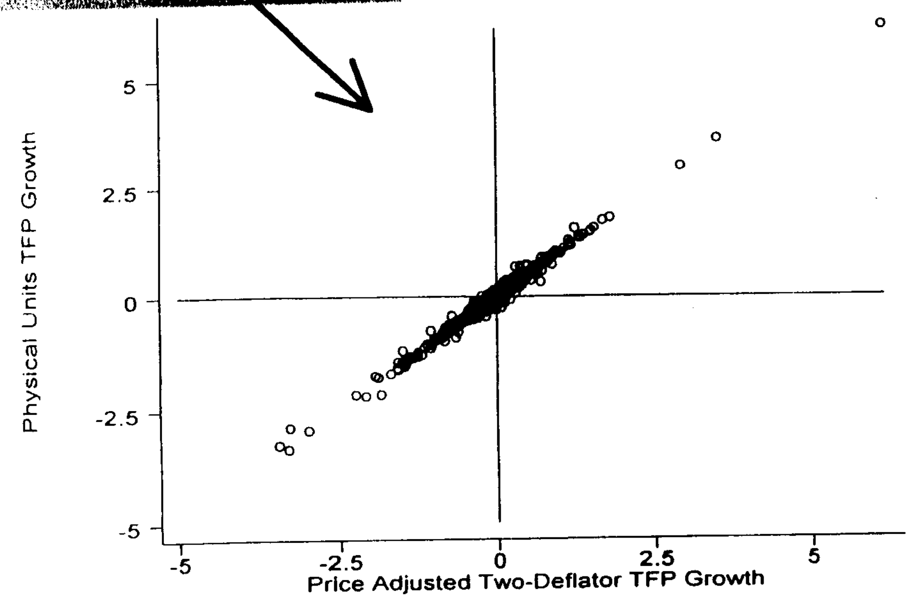
NBER -- 458 MANUFACTURING SECTORS

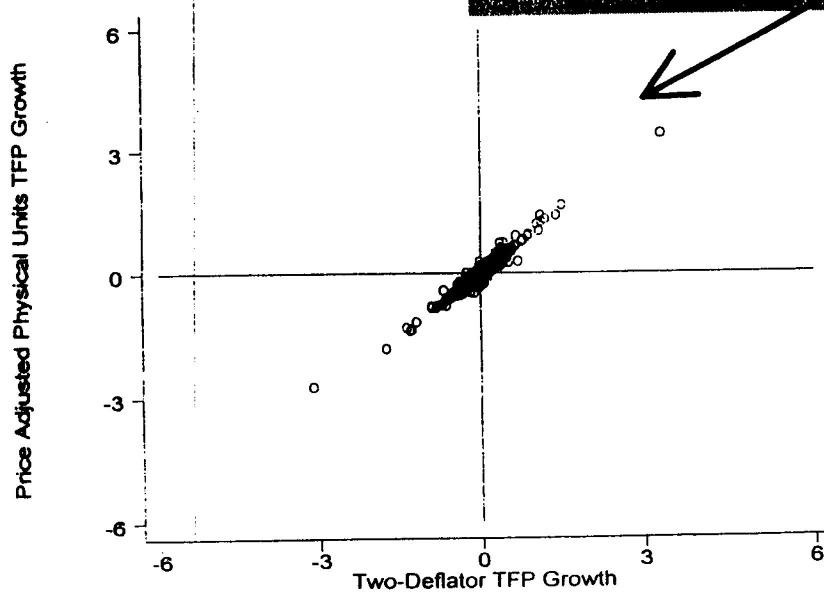
Price Adjusting the TFP Growth Estimates

POOLED DATA 1958-1994



r = .502





- But the correlation within each scatter are quite good even without price adjustment.
- They are way better when price adjustment is made.

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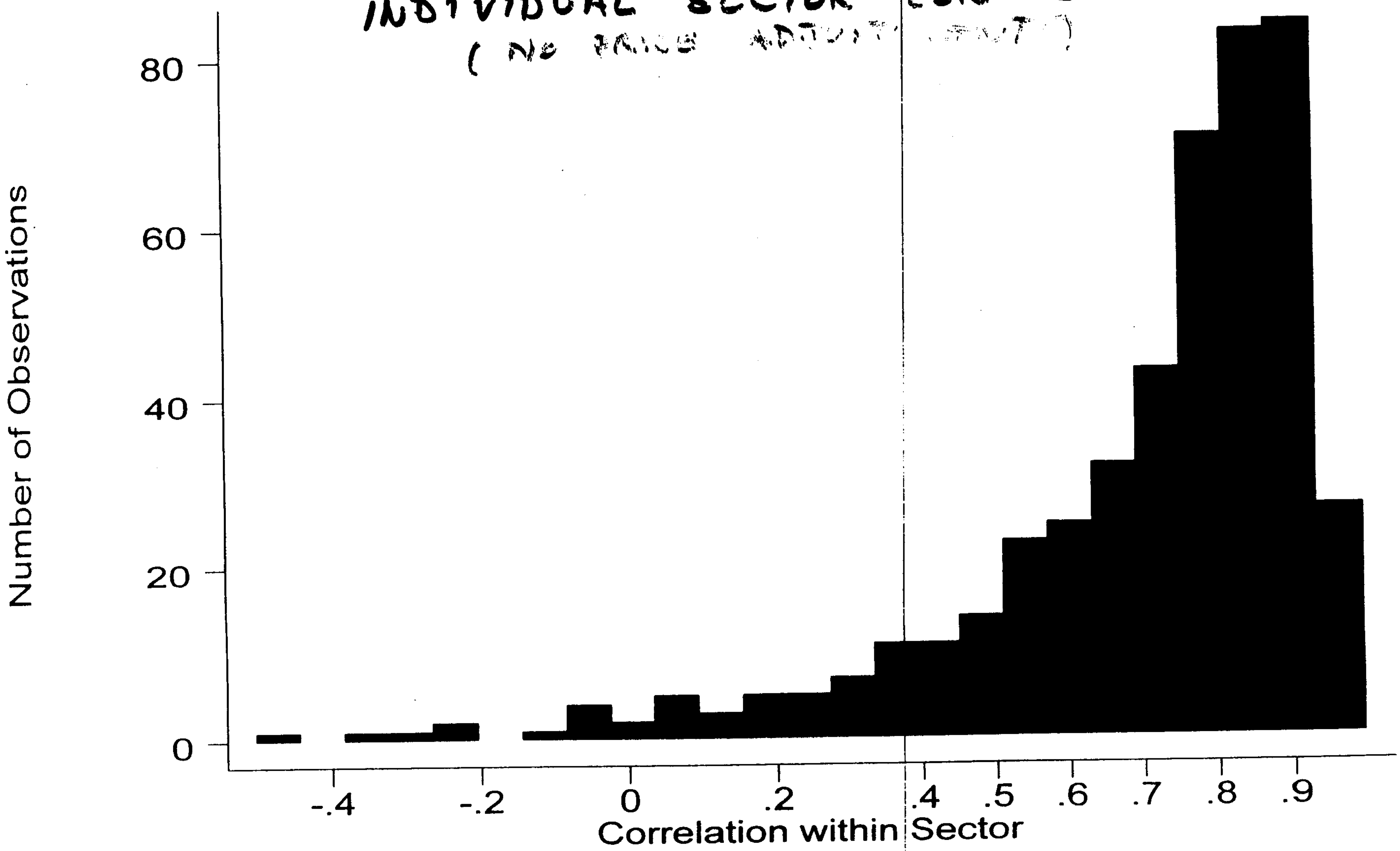
Two-Deflator vs. Physical Units TFP Growth

458 (4-Digit SIC) Manufacturing Sectors, 1958–94
36 year-to-year changes each
INDIVIDUAL SECTOR CORRELATIONS
(NO PRICE ADJUSTMENT)



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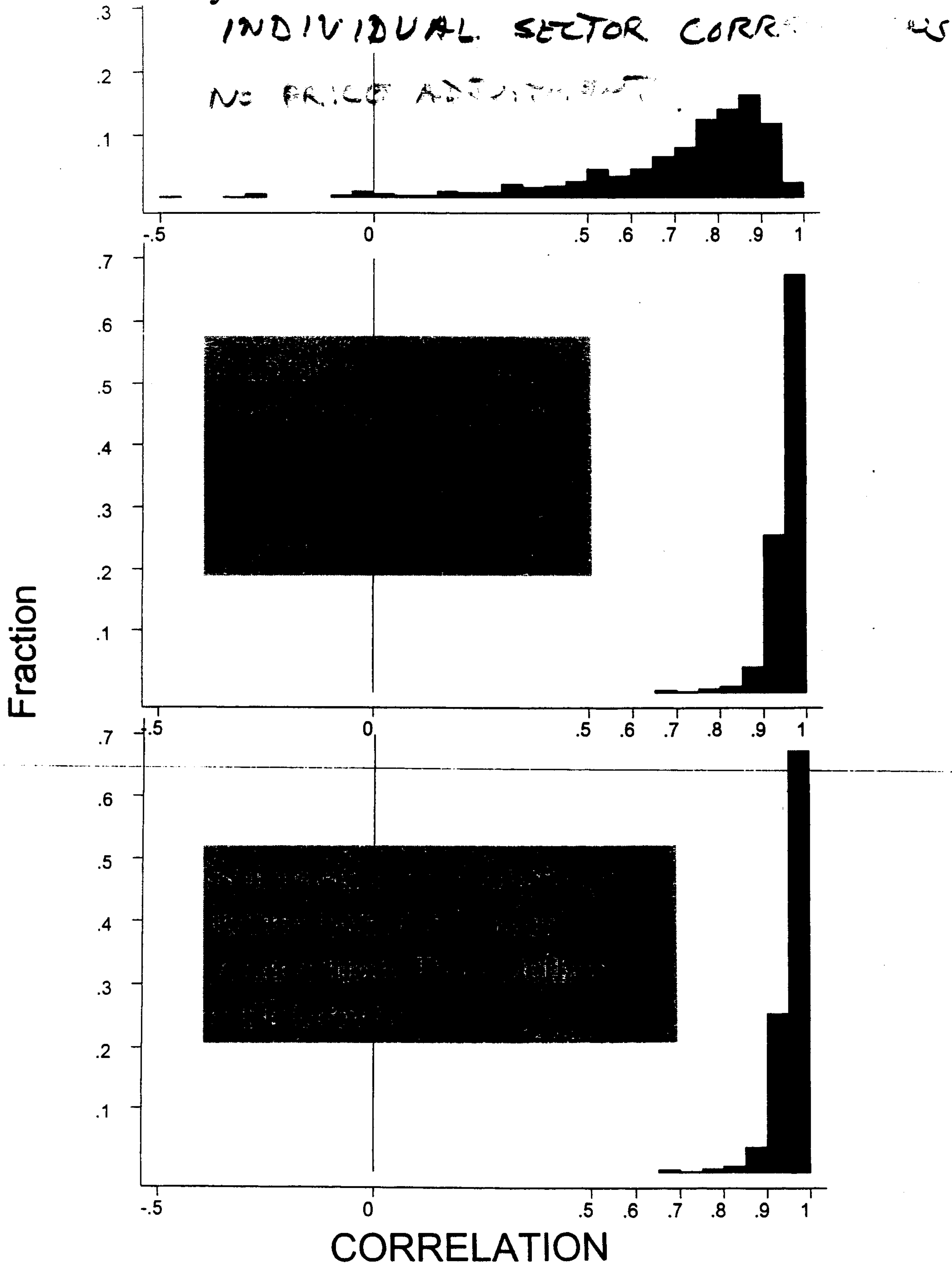
Physical units vs Two-Deflator TFP



- Now, we look at "predictions" using the NBER data. These all with 2-Deflator unadjusted data.

- Recall our "Growth Syndrome":

  - First, we have real cost reductions (ΔTFP>0).
  - This produces, in some order, investment and higher rates of return.
  - In the process, output goes up.
  - And <u>maybe</u> the employment of labor increases.

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PREDITING RATES OF RETURN

Variable	Obs	Mean	Std. Dev.	Min	Max
b_1	458	0.118948	0.083929	-0.03946	0.501454
b_2	458	0.082151	0.082294	-0.11355	0.537687
b_3	458	0.041761	0.08405	-0.14202	0.537743
b_4	458	0.036237	0.086746	-0.18346	0.633468

$$d\rho_j = \rho_{t+j} - \left[\frac{\rho_{t-1} + \rho_t}{2}\right]$$

$$d\rho_j = a + b_j \Delta TFP_t + e$$

Data Source: NBER 458 Manufacturing Industries Database from 1958 to 1992

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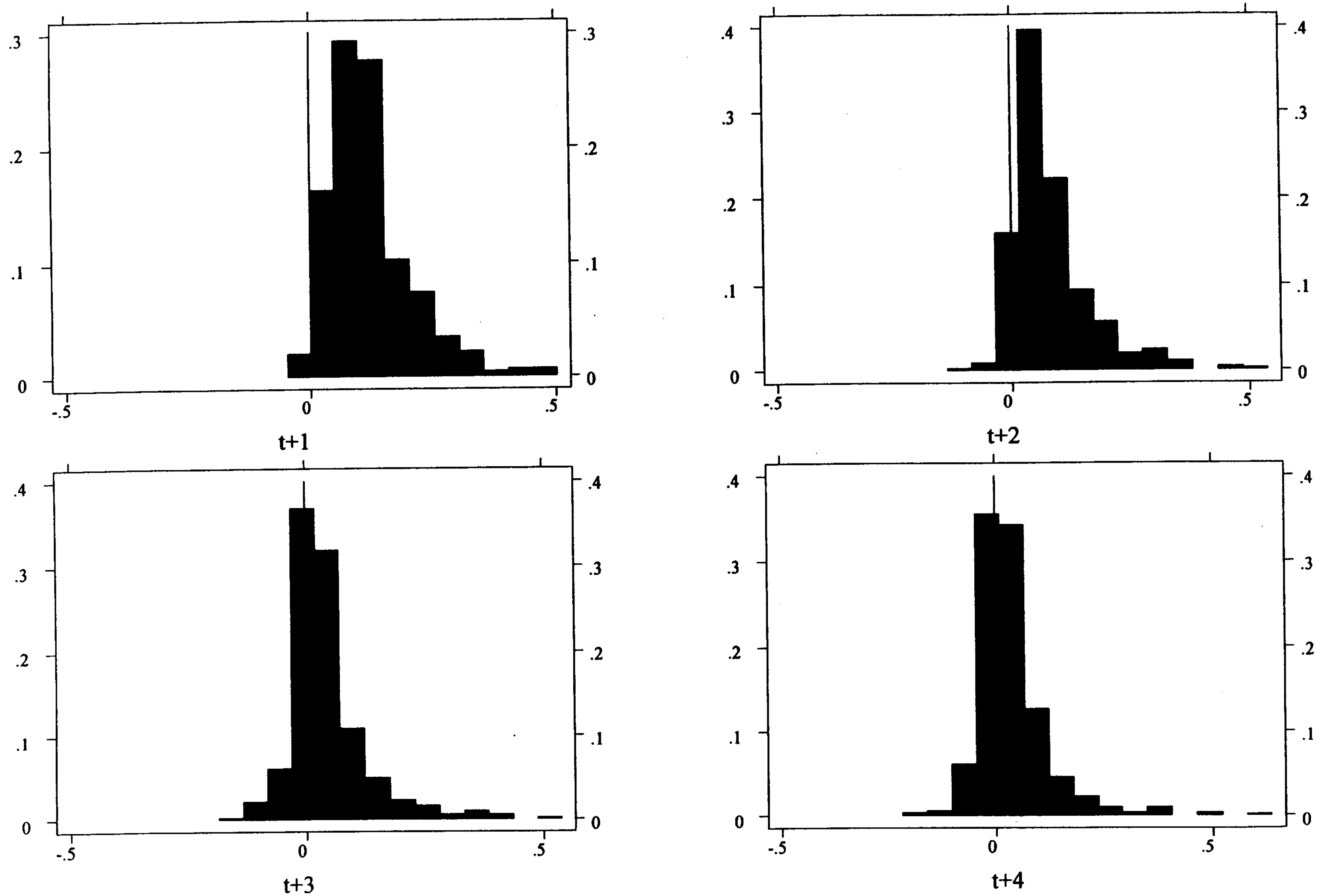

Distribution of Coefficient for Rate of Return

Data Source: NBER 458 Manufacturing Industries Database from 1958 to 1992

PREDICTING INVESTMENT

Variable	Obs	Mean	Std. Dev.	Min	Max
b_1	458	0.91236	1.139383	-6.55743	13.4523
b_2	458	1.092412	1.1239	-6.97798	6.158016
b_3	458	1.028215	1.119888	-2.94143	9.642923
b_4	458	0.987436	1.07193	-2.20407	6.03586

$$di_j = \left(\frac{\Delta K}{K}\right)_{t+j} - \left[\frac{\left(\frac{\Delta K}{K}\right)_{t-1} + \left(\frac{\Delta K}{K}\right)_{t}}{2}\right]$$

$$di_j = a + b_j \, \Delta TFP_t + e$$

Data Source: NBER 458 Manufacturing Industries Database from 1958 to 1992

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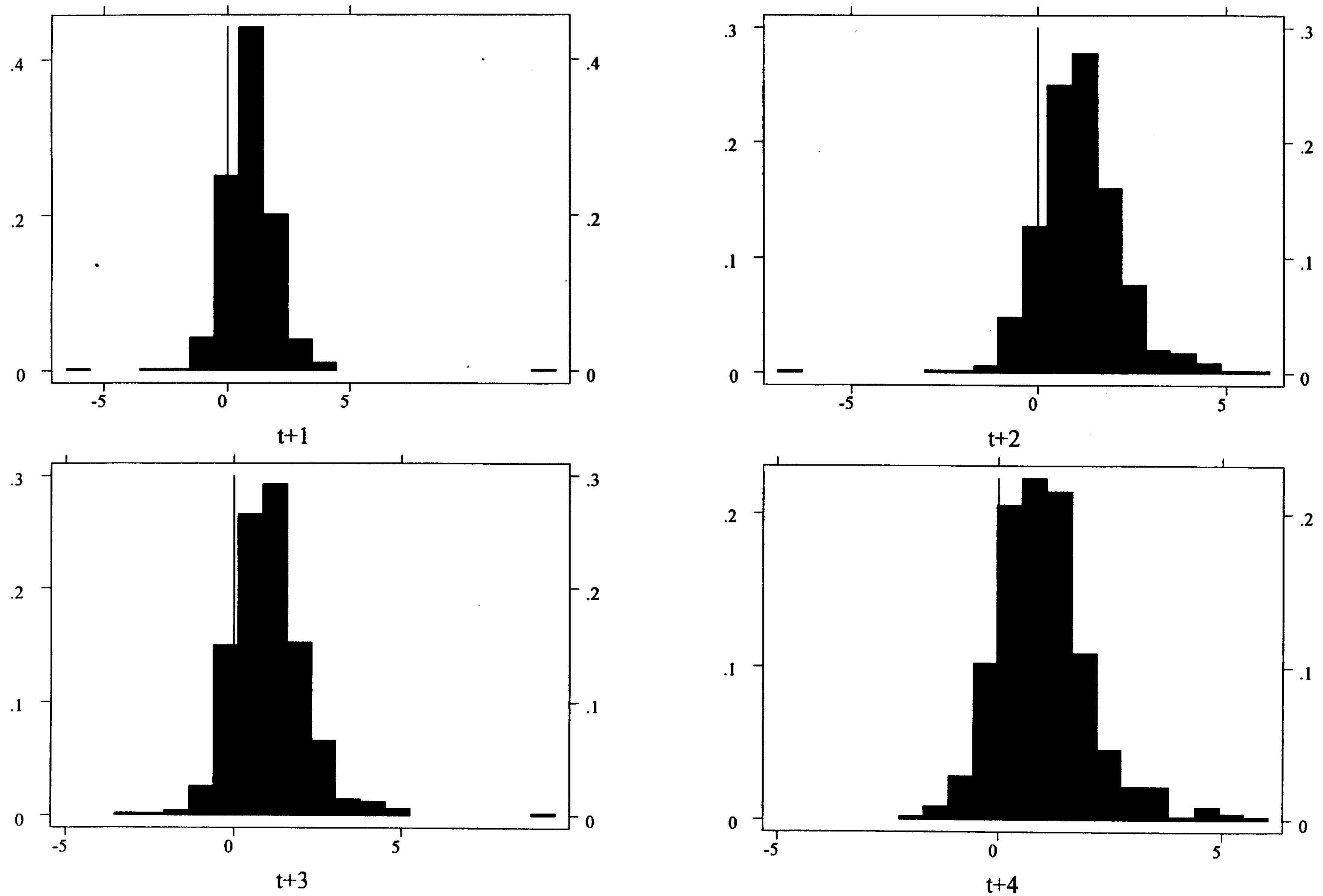


Distribution of Coefficient for Rate of Investment

Data Source: NBER 458 Manufacturing Industries Database from 1958 to 1992

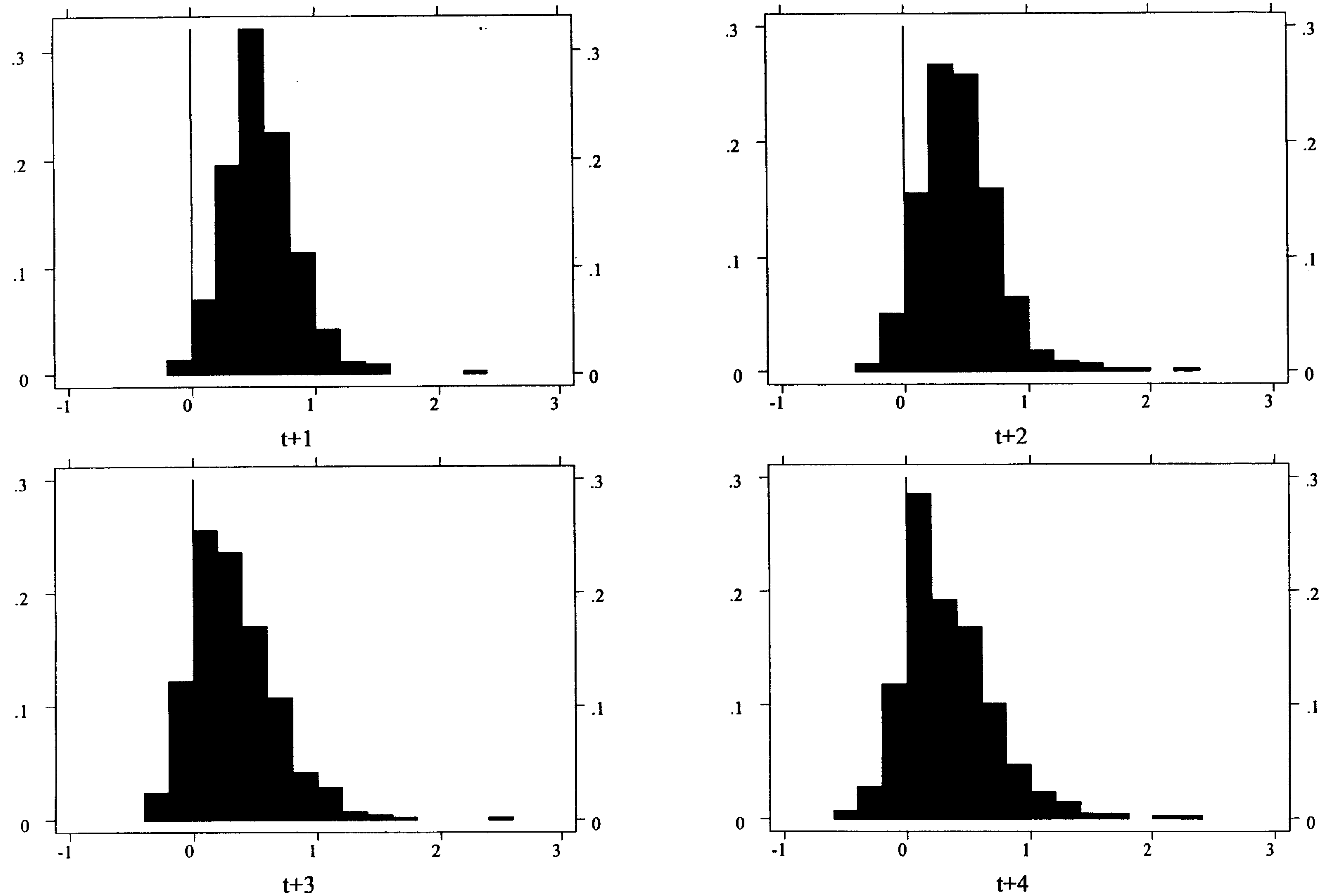
PREDICTING OUTPUT

Variable	Obs	Mean	Std. Dev.	Min	Max
b_1	458	0.559539	0.287642	-0.11916	2.201468
b_2	458	0.439059	0.320583	-0.26786	2.320151
b_3	458	0.333137	0.341268	-0.37061	2.410413
b_4	458	0.334917	0.376029	-0.45452	2.307526

$$dY_j = \frac{Y_{t+j}}{\left[\frac{Y_{t-1} + Y_t}{2}\right]}$$

$$dY_j = a + b_j \, \Delta TFP_t + e$$

Data Source: NBER 458 Manufacturing Industries Database from 1958 to 1992



Distribution of Coefficient for Output

Data Source: NBER 458 Manufacturing Industries Database from 1958 to 1992

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PREDITING EFFECTIVE LABOR

Variable	Obs	Mean	Std. Dev.	Min	Max
b_1	458	0.355875	0.289515	-0.37769	1.78226
b_2	458	0.336572	0.307729	-0.59494	1.792044
b_3	458	0.291623	0.303515	-0.60827	2.331
b_4	458	0.311044	0.321404	-0.681	2.203658

$$dL^*_j = \frac{L^*_j}{\left[\dfrac{L^*_{t-1} + L^*_t}{2}\right]}$$

$$dL^*_j = a + b_j \, \Delta TFP_t + e$$

Data Source: NBER 458 Manufacturing Industries Database from 195 to 1992

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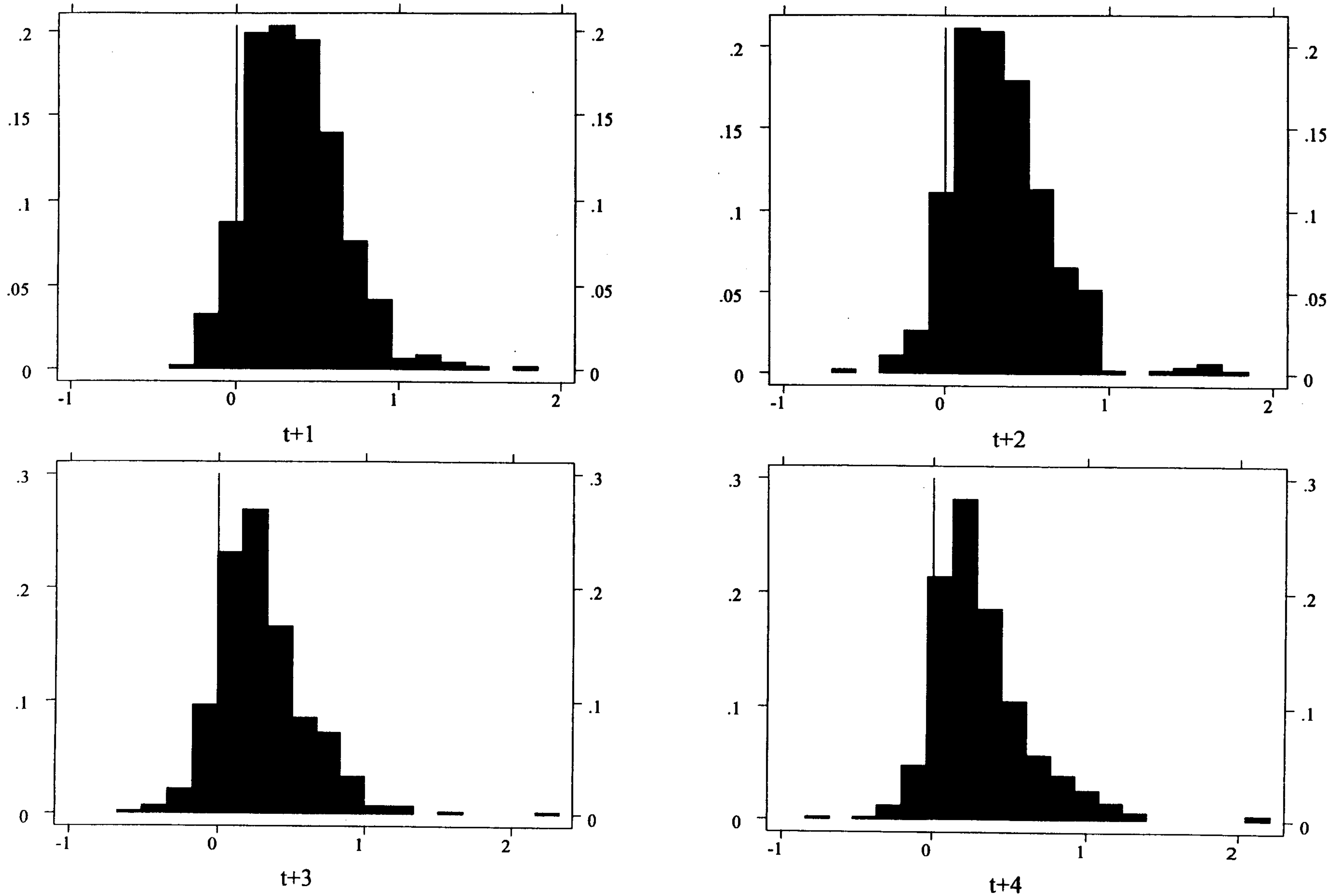

Distribution of Coefficient for Effective Labor

Data Source: NBER 458 Manufacturing Industries Database from 1958 to 1992

- All the evidence confirms the existence of the "Growth Syndrome".

- TFP improvement now pushes up the rate of return next year, and, by declining amounts, for at least three more years.

- The same is true for the investment rate, where the effect seems to be concentrated a bit farther into the future.

- The output effect also extends for at least four years and is more steady through time.

- And finally, a substantial and lasting effect on labor use is indicated.

Issues of Causality

- One question that many of you may have concerns the direction of causality and the extent of feedback.
- To check this we worked with panel data with fixed effect for each industry.
- When a variable was used as a predictor, four lags were employed.

	R^2	R^2	
TFP to ρ	.80	.06	ρ to TFP
TFP to (ΔK*/K*)	.21	.02	(ΔK*/K*) to TFP
TFP to Y	.87	.01	Y to TFP

Direction of Causality for 458 Manufacturing Industries from NBER data (1958-92). Reported R^2s are weighted adjusted R^2s.

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CAUSALITY: TFP GROWTH RATES -> RATES OF RETURN

$$\rho_{i,t} = \alpha_i + \beta_1 \Delta TFP_{i,t-1} + \beta_2 \Delta TFP_{i,t-2} + \beta_3 \Delta TFP_{i,t-3} + \beta_4 \Delta TFP_{i,t-4} + \varepsilon$$

Dependent Variable: RHO?
Method: GLS (Cross Section Weights)
Date: 12/09/99 Time: 18:21
Sample: 1963 1994
Included observations: 32
Total panel (balanced) observations 14656

Variable	Coefficient	Std. Error	t-Statistic	Prob.
TDTFP?(-1)	0.099175	0.002420	40.98931	0.0000
TDTFP?(-2)	0.074317	0.002441	30.44276	0.0000
TDTFP?(-3)	0.046838	0.002468	18.98015	0.0000
TDTFP?(-4)	0.038828	0.002452	15.83485	0.0000
Fixed Effects				

Weighted Statistics

R-squared	0.806616	Mean dependent var	0.185719
Adjusted R-squared	0.800336	S.D. dependent var	0.111985
S.E. of regression	0.050039	Sum squared resid	35.54054
F-statistic	19734.71	Durbin-Watson stat	0.876900
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.796403	Mean dependent var	0.141161
Adjusted R-squared	0.789791	S.D. dependent var	0.109260
S.E. of regression	0.050094	Sum squared resid	35.61908
Durbin-Watson stat	0.599004		

Data Source: NBER 458 Manufacturing Industries from 1958 to 1992

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CAUSALITY: RATES OF RETURN-> TFP GROWTH RATES

$$\Delta TFP_{i,t} = \alpha_i + \beta_1 \rho_{i,t-1} + \beta_2 \rho_{i,t-2} + \beta_3 \rho_{i,t-3} + \beta_4 \rho_{i,t-4} + \varepsilon$$

Dependent Variable: TDTFP?
Method: GLS (Cross Section Weights)
Date: 12/09/99 Time: 18:25
Sample: 1962 1994
Included observations: 33
Total panel (balanced) observations 15113

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RHO?(-1)	-0.559919	0.024364	-22.98109	0.0000
RHO?(-2)	-0.084488	0.030630	-2.758376	0.0058
RHO?(-3)	0.104068	0.030154	3.451225	0.0006
RHO?(-4)	0.109101	0.023242	4.694021	0.0000
Fixed Effects				

Weighted Statistics

R-squared	0.090108	Mean dependent var	0.017039
Adjusted R-squared	0.061478	S.D. dependent var	0.124080
S.E. of regression	0.120206	Sum squared resid	211.6982
F-statistic	483.6357	Durbin-Watson stat	2.025027
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.080295	Mean dependent var	0.014240
Adjusted R-squared	0.051357	S.D. dependent var	0.123784
S.E. of regression	0.120563	Sum squared resid	212.9600
Durbin-Watson stat	2.183746		

Data Source: NBER 458 Manufacturing Industries from 1958 to 1992

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CAUSALITY: TFP GROWTH RATES -> RATES OF INVESTMENT

$$INVRAT_{i,t} = \alpha_i + \beta_1 \Delta TFP_{i,t-1} + \beta_2 \Delta TFP_{i,t-2} + \beta_3 \Delta TFP_{i,t-3} + \beta_4 \Delta TFP_{i,t-4} + \varepsilon$$

Dependent Variable: INVRAT?
Method: GLS (Cross Section Weights)
Date: 12/09/99 Time: 18:23
Sample: 1963 1994
Included observations: 32
Total panel (balanced) observations 14656

Variable	Coefficient	Std. Error	t-Statistic	Prob.
TDTFP?(-1)	0.043750	0.003260	13.41996	0.0000
TDTFP?(-2)	0.055114	0.003303	16.68533	0.0000
TDTFP?(-3)	0.065662	0.003345	19.63083	0.0000
TDTFP?(-4)	0.043373	0.003318	13.07087	0.0000
Fixed Effects				
Weighted Statistics				
R-squared	0.235379	Mean dependent var		0.023289
Adjusted R-squared	0.210545	S.D. dependent var		0.054948
S.E. of regression	0.048822	Sum squared resid		33.83320
F-statistic	1456.478	Durbin-Watson stat		1.194864
Prob(F-statistic)	0.000000			
Unweighted Statistics				
R-squared	0.191813	Mean dependent var		0.021060
Adjusted R-squared	0.165564	S.D. dependent var		0.053539
S.E. of regression	0.048906	Sum squared resid		33.94942
Durbin-Watson stat	1.112492			

Data Source: NBER 458 Manufacturing Industries from 1958 to 1992

CAUSALITY: RATES OF INVESTMENT-> TFP GROWTH RATES

$$\Delta TFP_{i,t} = \alpha_i + \beta_1 INVRAT_{i,t-1} + \beta_2 INVRAT_{i,t-2} + \beta_3 INVRAT_{i,t-3} + \beta_4 INVRAT_{i,t-4} + \varepsilon$$

Dependent Variable: TDTFP?
Method: GLS (Cross Section Weights)
Date: 12/09/99 Time: 18:18
Sample: 1963 1994
Included observations: 32
Total panel (balanced) observations 14655

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INVRAT?(-1)	-0.337854	0.017866	-18.91038	0.0000
INVRAT?(-2)	0.025054	0.018725	1.337986	0.1809
INVRAT?(-3)	-0.025363	0.017469	-1.451897	0.1466
INVRAT?(-4)	-0.051284	0.016328	-3.140948	0.0017
Fixed Effects				
Weighted Statistics				

R-squared	0.048265	Mean dependent var	0.015040
Adjusted R-squared	0.017351	S.D. dependent var	0.124927
S.E. of regression	0.123839	Sum squared resid	217.6647
F-statistic	239.9193	Durbin-Watson stat	2.188214
Prob(F-statistic)	0.000000		
Unweighted Statistics			
R-squared	0.042057	Mean dependent var	0.012826
Adjusted R-squared	0.010942	S.D. dependent var	0.124700
S.E. of regression	0.124016	Sum squared resid	218.2876
Durbin-Watson stat	2.292250		

Data Source: NBER 458 Manufacturing Industries from 1958 to 1992

CAUSALITY: TFP GROWTH RATES -> OUTPUT

$$Y_{i,t} = \alpha_i + \beta_1 \Delta TFP_{i,t-1} + \beta_2 \Delta TFP_{i,t-2} + \beta_3 \Delta TFP_{i,t-3} + \beta_4 \Delta TFP_{i,t-4} + \varepsilon$$

Dependent Variable: GDPDF?
Method: GLS (Cross Section Weights)
Date: 12/09/99 Time: 18:58
Sample: 1963 1994
Included observations: 32
Total panel (balanced) observations 14656

Variable	Coefficient	Std. Error	t-Statistic	Prob.
TDTFP?(-1)	232.5733	13.17454	17.65323	0.0000
TDTFP?(-2)	170.0432	13.44903	12.64353	0.0000
TDTFP?(-3)	111.9923	13.63771	8.211954	0.0000
TDTFP?(-4)	75.74750	13.42035	5.644225	0.0000
Fixed Effects				
Weighted Statistics				
R-squared	0.875480	Mean dependent var		5104.203
Adjusted R-squared	0.871436	S.D. dependent var		3032.534
S.E. of regression	1087.340	Sum squared resid		1.68E+10
F-statistic	33265.31	Durbin-Watson stat		0.413625
Prob(F-statistic)	0.000000			
Unweighted Statistics				
R-squared	0.896097	Mean dependent var		2215.810
Adjusted R-squared	0.892723	S.D. dependent var		3484.838
S.E. of regression	1141.396	Sum squared resid		1.85E+10
Durbin-Watson stat	0.217448			

Data Source: NBER 458 Manufacturing Industries from 1958 to 1992

Kuznets Lecture II

CAUSALITY: RATES OF RETURN-> TFP GROWTH RATES

$$\Delta TFP_{i,t} = \alpha_i + \beta_1 Y_{i,t-1} + \beta_2 Y_{i,t-2} + \beta_3 Y_{i,t-3} + \beta_4 Y_{i,t-4} + \varepsilon$$

Dependent Variable: TDTFP?
Method: GLS (Cross Section Weights)
Date: 12/09/99 Time: 19:05
Sample: 1962 1994
Included observations: 33
Total panel (balanced) observations 15113

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDPDF?(-1)	-1.97E-05	1.74E-06	-11.33221	0.0000
GDPDF?(-2)	-4.57E-06	2.46E-06	-1.854078	0.0637
GDPDF?(-3)	3.64E-06	2.49E-06	1.461663	0.1439
GDPDF?(-4)	1.24E-05	1.78E-06	6.980988	0.0000
Fixed Effects				
Weighted Statistics				
R-squared	0.043927	Mean dependent var		0.017033
Adjusted R-squared	0.013844	S.D. dependent var		0.124362
S.E. of regression	0.123499	Sum squared resid		223.4555
F-statistic	224.3833	Durbin-Watson stat		2.155580
Prob(F-statistic)	0.000000			
Unweighted Statistics				
R-squared	0.033716	Mean dependent var		0.014240
Adjusted R-squared	0.003312	S.D. dependent var		0.123784
S.E. of regression	0.123579	Sum squared resid		223.7455
Durbin-Watson stat	2.273131			

Data Source: NBER 458 Manufacturing Industries from 1958 to 1992

- Now, we turn to a comparison of the 2-Deflator and the Traditional Methods using the NBER data set. The basic data are simple correlations between ΔTFP in period t with ΔY, ΔVA, ΔK, and ΔL, both contemporaneously and for periods t+1, t+2, and t+3.

- We record in the following tables the number of cases (out of 458) in which the correlation in question was positive. In each table the "same" story is told four times:

  ΔTFP* to ΔY*

  ΔTFP* to ΔY

  ΔTFP to ΔY*

  ΔTFP to ΔY

- The first table goes from ΔTFP to output, the second from ΔTFP to ΔValue added, the third from ΔTFP to investment, the fourth from ΔTFP to labor force, and the fifth from ΔTFP to $(\rho+\delta)$.
- The bottom line is that all the stories are basically the same. In particular, ΔTFP* is just about as good a "predictor" of ΔY as it is of ΔY*, and ΔTFP is just about as good a predictor of ΔY* as it is of ΔY. Equally, ΔTFP* predicts ΔVA as well as ΔVA*, and ΔN nearly as well as ΔL*.

- This tells us that the difference in methods of calculation of TFP is not the source of any major difference in results. Potential bias due to change in relative price being in both ΔTFP^* and ΔY^* and in both ΔTFP^* and ΔVA^* do not seem to matter. ΔTFP^* is good at predicting even when the "predictand" is ΔY or ΔVA, neither of which contains a price-change element.

TFP GROWTH RATE AS A PREDICTOR OF OUTPUT (CORRELATIONS BETWEEN ΔTFP AND ΔY)

	ΔTFP^*_t (2-Deflator) # of Positive Correlations	ΔTFP_t (Traditional) # of Positive Correlations
ΔY^*_t	411	431
ΔY^*_{t+1}	306	281
ΔY^*_{t+2}	155	168
ΔY^*_{t+3}	145	169
ΔY_t	448	455
ΔY_{t+1}	282	285
ΔY_{t+2}	140	155
ΔY_{t+3}	151	178

Note: All results are significant at least at 0.0002 level.

TFP GROWTH RATE AS A PREDICTOR OF VALUE ADDED (CORRELATIONS BETWEEN ΔTFP AND ΔVA)

	ΔTFP^*_t (2-Deflator) # of Positive Correlations	ΔTFP_t (Traditional) # of Positive Correlations
ΔVA^*_t	458 •	447 •
ΔVA^*_{t+1}	245	234
ΔVA^*_{t+2}	124 •	155 •
ΔVA^*_{t+3}	245	181 •
ΔVA_t	449 •	458 •
ΔVA_{t+1}	215	246
ΔVA_{t+2}	147 •	142 •
ΔVA_{t+3}	150 •	175 •

Note : "•" results are significant at least at 0.0008 level.

TFP GROWTH RATE AS A PREDICTOR OF INVESTMENT (CORRELATIONS BETWEEN ΔTFP AND ΔK)

	ΔTFP^*_t (2-Deflator) # of Positive Correlations	ΔTFP_t (Traditional) # of Positive Correlations
ΔK^*_t	300 •	347 •
ΔK^*_{t+1}	358 •	324 •
ΔK^*_{t+2}	299 •	286 •
ΔK^*_{t+3}	241	259
ΔK_t	121 •	154 •
ΔK_{t+1}	296 •	269 •
ΔK_{t+2}	339 •	313 •
ΔK_{t+3}	314	287 •

Note: "•" results are significant at least at 0.0001 level.

TFP GROWTH RATE AS A PREDICTOR OF LABOR (CORRELATIONS BETWEEN ΔTFP AND ΔL)

	ΔTFP^*_t (2-Deflator) # of Positive Correlations	ΔTFP_t (Traditional) # of Positive Correlations
ΔL^*_t	402 •	423 •
ΔL^*_{t+1}	356 •	311 •
ΔL^*_{t+2}	269	230
ΔL^*_{t+3}	205	219
ΔL_t	416 •	402 •
ΔL_{t+1}	348 •	337 •
ΔL_{t+2}	203	200
ΔL_{t+3}	188	217

Note: "•" results are significant at least at 0.0001 level.

- Finally, we come to the prediction of the gross rate of return ($\rho+\delta$). Here we only have the rate of return from the 2-Deflator Method. But we can see once again that we can predict it just about equally well starting from ΔTFP or from ΔTFP*

TFP GROWTH RATE AS A PREDICTOR OF GROSS RATES OF RETURN (CORRELATIONS BETWEEN ΔTFP AND ($\rho+\delta$))

	ΔTFP^*_t (2-Deflator) # of Positive Correlations	ΔTFP_t (Traditional) # of Positive Correlations
$(\rho+\delta)_t$	453	389
$(\rho+\delta)_{t+1}$	435	366
$(\rho+\delta)_{t+2}$	399	322
$(\rho+\delta)_{t+3}$	304	267

Note: All results are significant at least at 0.0001 level.

- Now, we turn to yet another data set – the U.N. Industrial Statistics, broken down into 3-digit manufacturing sectors. Here the calculations were made for four industrialized countries, four rapid growers from East Asia, and four Latin American countries.
- Here we only can use the 2-Deflator Method, as we do not have breakdowns of value added into price and quantity components.
- But we are doing the same kind of predicting we did earlier using the NBER data set.

- The next table takes as its "predictand" the changes in the net rate of return from time [(t + t-1) / 2] to time t+j. Our prediction of positive correlations is amply confirmed. (The 4 cases with less than 50% positive correlations are underlined; note that 3 of them are for period t+4.)

Kuznets Lecture II (54)

% ACCURATE PREDICTING % $\Delta\rho$ from $\frac{\rho_t+\rho_{t-1}}{2}$

(percentage of $\rho_t > 0$)

	$\rho_{t+1}-(\rho_t+\rho_{t-1})/2$	$\rho_{t+2}-(\rho_t+\rho_{t-1})/2$	$\rho_{t+3}-(\rho_t+\rho_{t-1})/2$	$\rho_{t+4}-(\rho_t+\rho_{t-1})/2$
Canada	89.3%	82.1%	42.9%	25.0%
USA	92.9%	67.9%	60.7%	89.3%
Japan	100.0%	88.9%	100.0%	96.3%
UK	89.3%	85.7%	78.6%	89.3%
Indonesia	88.0%	64.0%	60.0%	64.0%
Korea	92.9%	82.1%	67.9%	78.6%
Malaysia	82.1%	78.6%	64.3%	50.0%
Philippines	89.3%	89.3%	89.3%	57.1%
Chile	92.9%	85.7%	75.0%	67.9%
Colombia	64.3%	60.7%	53.6%	46.4%
Mexico	53.8%	73.1%	65.4%	42.3%
Panama	84.0%	84.0%	72.0%	72.0%
Average	84.9%	78.5%	69.1%	64.8%

Correlations between Contemporaneous TFP Growth Rate and Rates of Return for Three Digit Manufacturing Sectors from U.N. Industrial Statistics

- There follows a series of graphs which consolidate the results for the 12 countries. Please recall that all the basic regressions are within one 3-digit industry within one country.

- The histograms show how many individual correlations lie between 0.1 and 0.2, between 0.2 and 0.3, etc. Positive correlations are reflected in green and negative ones in red.

- In the four graphs, we have ΔTFP at time t being used to "predict" differences up to 4 periods ahead in

$$\rho^*_{t+j} - \frac{(\rho^*_{t-1} + \rho^*_t)}{2}$$

$$\frac{Y^*_{t+j}}{\left[\dfrac{Y^*_{t-1} + Y^*_t}{2}\right]}$$

$$\frac{K^*_{t+j}}{\left[\dfrac{K^*_{t-1} + K^*_t}{2}\right]}$$

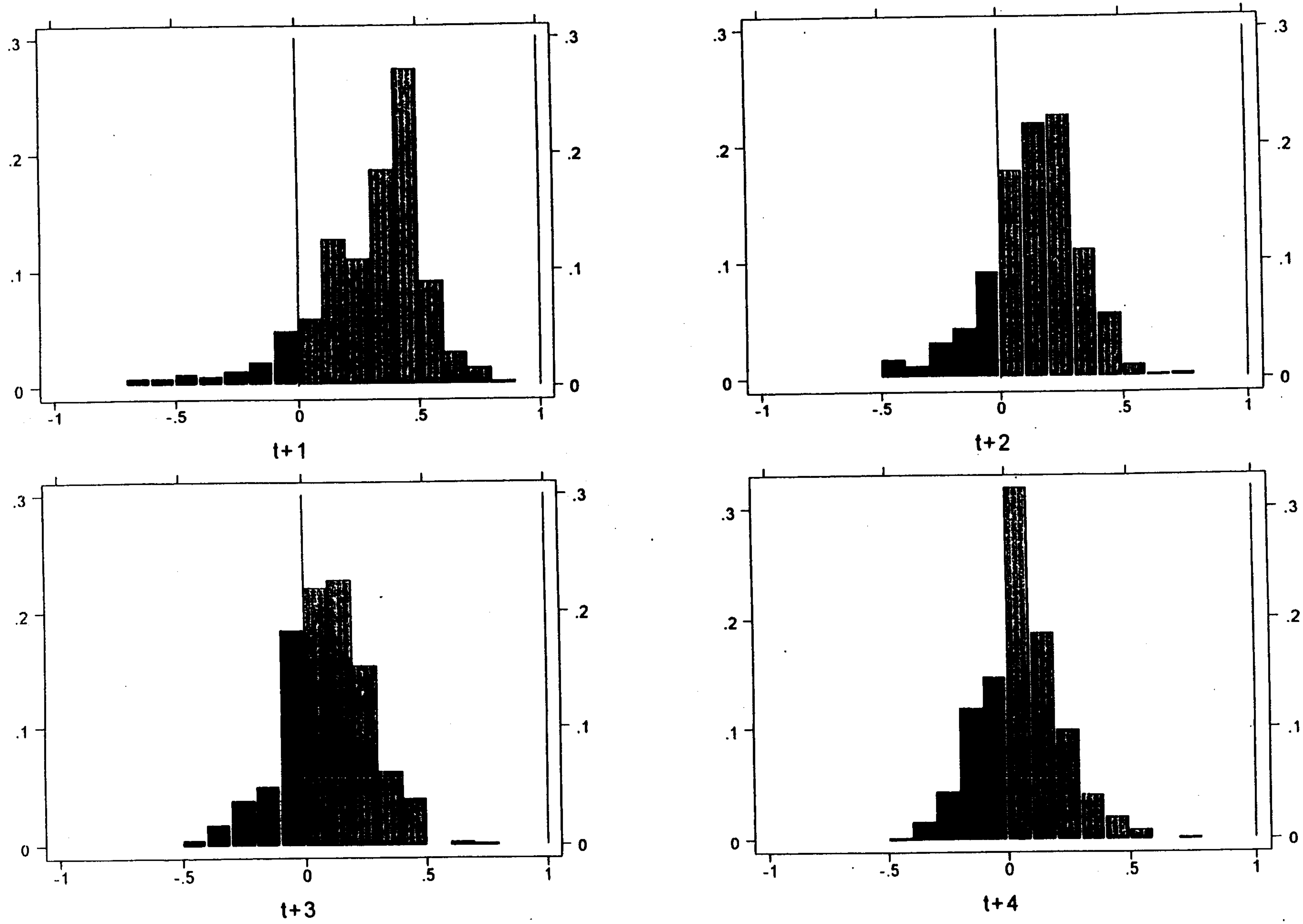
$$\left(\frac{I^*}{K^*}\right)_{t+j} - \frac{\left(\left(\dfrac{I^*}{K^*}\right)_{t-1} + \left(\dfrac{I^*}{K^*}\right)_t\right)}{2}$$

$$\frac{L^*_{t+j}}{\left[\dfrac{L^*_{t-1} + L^*_t}{2}\right]}$$

- Once again we find confirmation of our "syndrome" of real cost reduction followed by higher rates of profit, increased investment, increased output, and even (in this case) increased use of labor.

Kuznets Lecture II - 18

% ΔTFP$_t$ PREDICTING % Δp from $\frac{p_{t-1} + p_t}{2}$

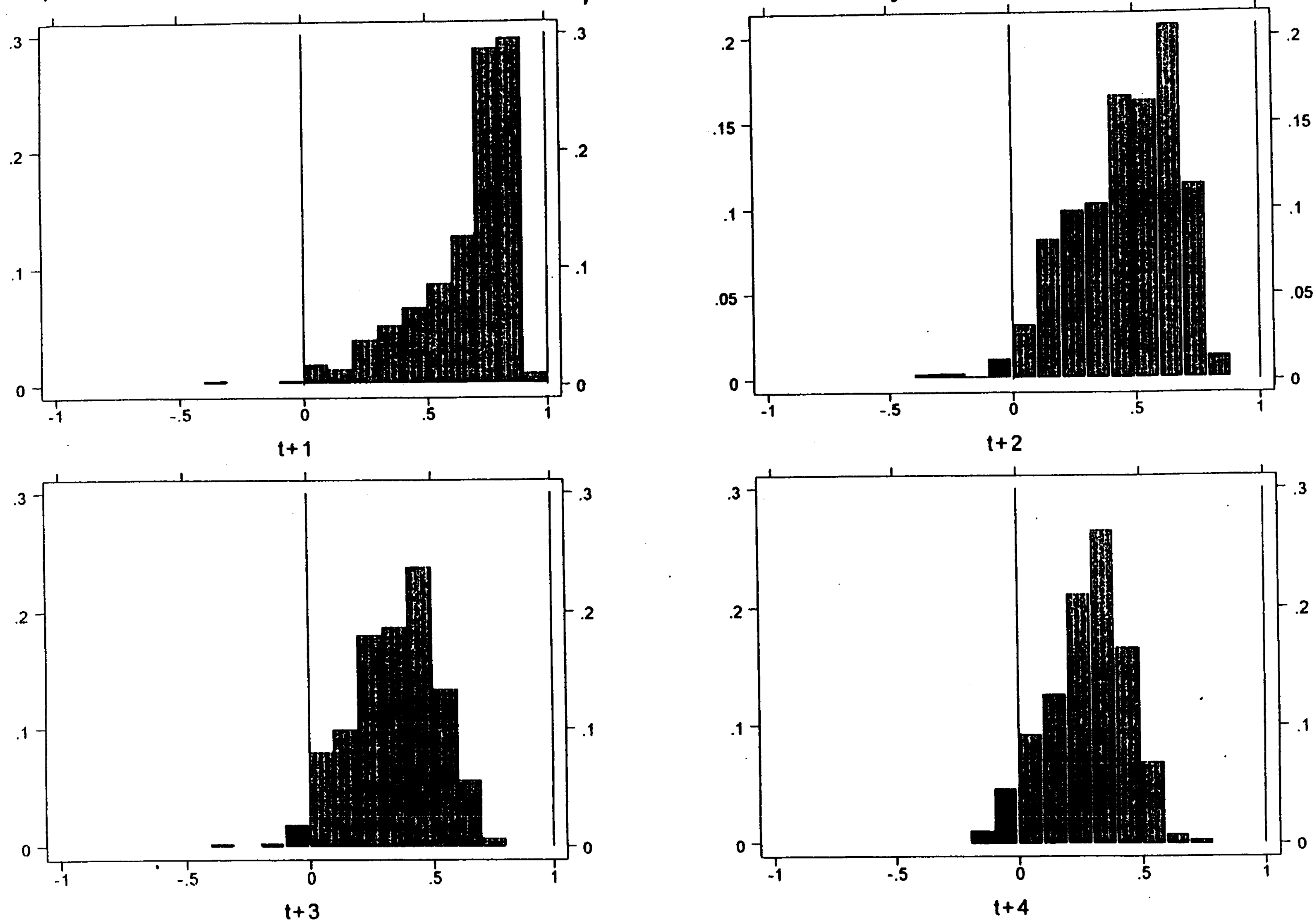


U.N.: Correlation between TFP and Rate of Return

CORRELATIONS ARE WITHIN SECTORS FOR EACH COUNTRY

Kuznets Lecture II - V9

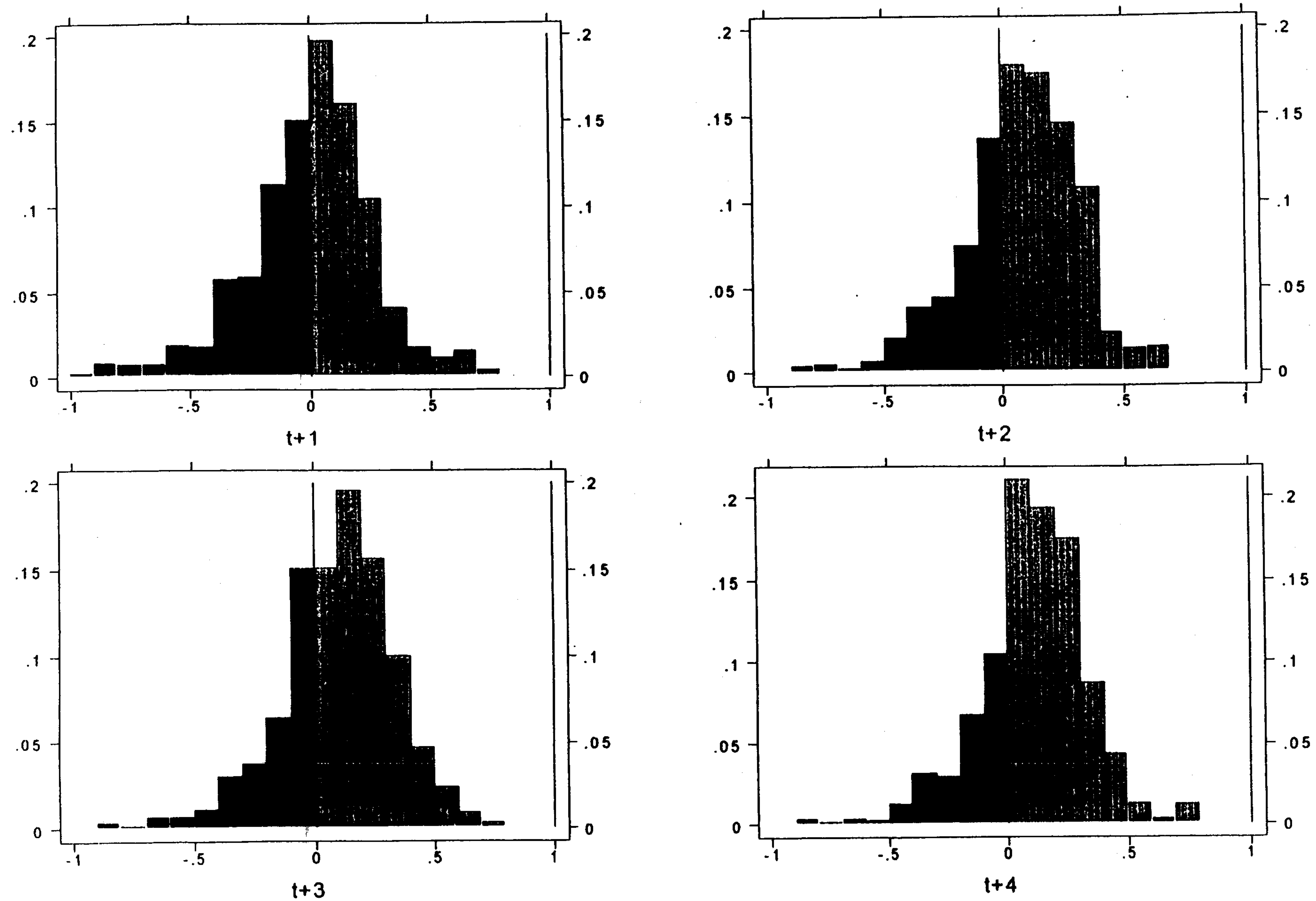
% ΔTFP PREDICTING Δy from $\frac{y_{t-1}+y_t}{2}$



U.N.: Correlation between TFP and Output

CORRELATIONS ARE WITHIN SECTORS FOR EACH COUNTRY

% ΔTFP_t PREDICTING % ΔK from $\frac{K_{t-1}+K_t}{2}$

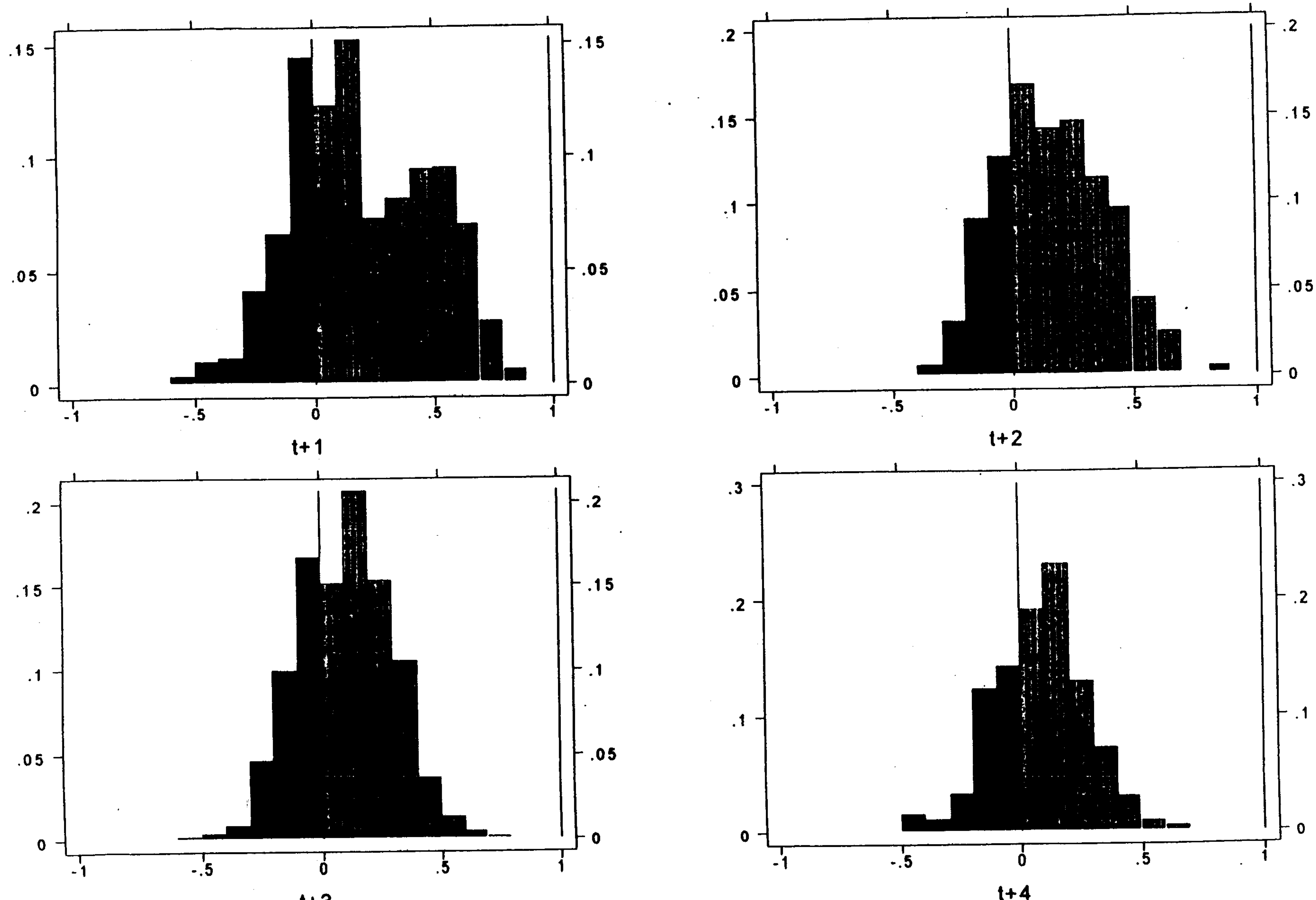


U.N.: Correlation between TFP and Capital Stock

CORRELATIONS ARE WITHIN SECTORS FOR EACH COUNTRY

Kuznets Lecture II - 61

% ΔTFP$_t$ PREDICTING % ΔI from $\frac{I_{t-1}+I_t}{2}$

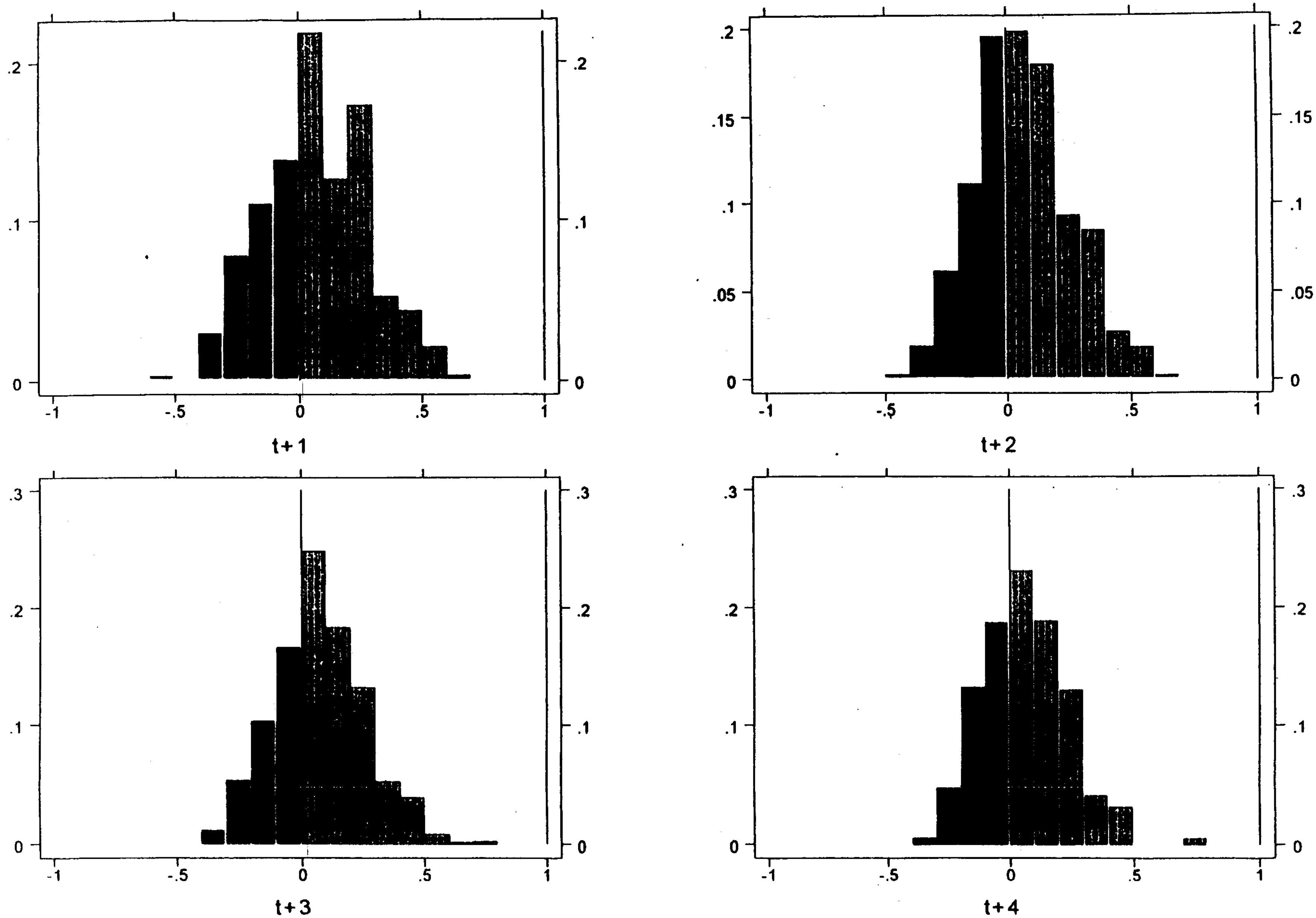


U.N.: Correlation between TFP and Investment

CORRELATIONS ARE WITHIN SECTORS FOR EACH COUNTRY

Kuznets Lecture II -62

% Δ TFP PREDICTING % Δ L TWO [illegible]



U.N.: Correlation between TFP and Labor

CORRELATIONS ARE WITHIN SECTORS FOR EACH COUNTRY

PREDICTING CHANGES IN RATES OF RETURN IN KOREA AND JAPAN

(ΔTFP_t PREDICTING $\left[\rho^*_{t+j} - \frac{(\rho^*_{t-1} + \rho^*_t)}{2}\right]$)

	Number of Positive Correlations (Sign Test)			
	t+1	t+2	t+3	t+4
59 Industries 3-digit Korea	54	40	35	38
	(6.4)**	(2.7)**	(1.4)	(2.2)*
139 Industries 4-digit Korea	119	103	81	74
	(8.4)**	(5.7)**	(2.0)	(0.8)
139 Firms Korea	111	87	79	77
	(7.0)**	(3.0)**	(1.6)	(1.3)
167 Firms Japan	151	151	108	97
	(10.4)**	(10.4)**	(3.8)**	(2.1)*

1) The value of sign test is $Z=(x-np)/(npq)^{1/2}$, where x is the number of positive correlations, n is the total number of observations (firms or industries), and p = q = ½.
2) Korea industries: 1976-96, Korea Firms: 1986-96, Japan Firms: 1977-1996

* significant at the 0.05 level.
** significant at the 0.01 level.

- Our final table presents data from Korea and Japan. Here we once again take ΔTFP_t as the predictor and $\left[\rho^*_{t+j} - \frac{(\rho^*_{t-1} + \rho^*_t)}{2}\right]$ as our "predictand".

- The data sets refer:

  a) To 59 3-digit industries in Korea

  b) To 139 4-digit industries in Korea

  c) To 139 listed firms in Korea

  d) To 167 listed firms in Japan

Kuznets lecture II (65)

PREDICTING CHANGES IN RATES OF RETURN IN KOREA AND JAPAN

(ΔTFP_t PREDICTING $\left[\rho^*_{t+j} - \frac{(\rho^*_{t-1} + \rho^*_t)}{2}\right]$)

	Number of Positive Correlations (Sign Test)			
	t+1	t+2	t+3	t+4
59 Industries 3-digit Korea	54 (6.4)**	40 (2.7)**	35 (1.4)	38 (2.2)*
139 Industries 4-digit Korea	119 (8.4)**	103 (5.7)**	81 (2.0)	74 (0.8)
139 Firms Korea	111 (7.0)**	87 (3.0)**	79 (1.6)	77 (1.3)
167 Firms Japan	151 (10.4)**	151 (10.4)**	108 (3.8)**	97 (2.1)*

1) The value of sign test is $Z=(x-np)/(npq)^{1/2}$, where x is the number of positive correlations, n is the total number of observations (firms or industries), and $p = q = ½$.
2) Korea industries: 1976-96, Korea Firms: 1986-96, Japan Firms: 1977-1996

* significant at the 0.05 level.
** significant at the 0.01 level.