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Appendices

Appendix 1

From the production function on the form:

$$q = Bt^{m}\ Lh^{\alpha}\ K^{\beta}\ e^{\mu}$$

The function transformed into the log-linear:

$$\ln(q) = C + m\ln(t) + \alpha\ln(Lh) + \beta\ln(K) + \mu$$

Where C=ln(B).

LS // Dependent Variable is LOGQ
Date: 06/17/99 Time: 15:03
Sample(adjusted): 1982 1997
Included observations: 16 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.173902	5.970331	0.196623	0.8474
LOGK	0.625436	0.323213	1.935058	0.0769
LOGLH	0.921554	0.508514	1.812250	0.0950
LOGT	0.198657	0.046319	4.288886	0.0011

R-squared	0.743876	Mean dependent var	13.20691
Adjusted R-squared	0.679845	S.D. dependent var	0.142596
S.E. of regression	0.080684	Akaike info criterion	-4.822105
Sum squared resid	0.078119	Schwarz criterion	-4.628958
Log likelihood	19.87382	F-statistic	11.61743
Durbin-Watson stat	1.807956	Prob(F-statistic)	0.000731

The technical progress' (Bt^{m}) effect is estimated to 176 percent for the period 1982 (t=1) to 1997 (t=17).

Appendix 2

From the production function on the form:

$$q = Be^{mt}\ Lh^{\alpha}\ K^{\beta}\ e^{\mu}$$

The function Transformed into the log-linear:

$$\ln(q) = C + mt + \alpha \ln(Lh) + \beta \ln(K) + \mu$$

LS // Dependent Variable is LOGQ
Date: 06/15/99 Time: 10:43
Sample(adjusted): 1982 1997
Included observations: 16 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.677849	4.639773	1.223734	0.2445
LOGLH	0.821755	0.285623	2.877065	0.0139
LOGK	0.120491	0.414783	0.290490	0.7764
T	0.050242	0.009025	5.566849	0.0001

R-squared	0.818916	Mean dependent var	13.20691
Adjusted R-squared	0.773645	S.D. dependent var	0.142596
S.E. of regression	0.067843	Akaike info criterion	-5.168805
Sum squared resid	0.055232	Schwarz criterion	-4.975658
Log likelihood	22.64742	F-statistic	18.08918
Durbin-Watson stat	1.676434	Prob(F-statistic)	0.000095

The technical progress' (Be^{mt}) effect is estimated to 232 percent for the period 1982 to 1997.

Appendix 3

From the production function on the form:

$$q = Be^{mt} Lh^{\alpha} K^{\beta} E^{\delta} e^{\mu}$$

The function Transformed into the log-linear:

$$\ln(q) = C + mt + \alpha \ln(Lh) + \beta \ln(K) + \delta \ln(E) + \mu$$

LS // Dependent Variable is LOGQ
Date: 06/15/99 Time: 12:09
Sample: 1991 1997
Included observations: 7

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-7.193405	17.50719	-0.410883	0.7210
LOGLH	0.102440	0.480108	0.213368	0.8508
LOGK	0.579969	1.144283	0.506841	0.6626
LOGE	1.115017	0.532471	2.094041	0.1713
T	0.008573	0.030117	0.284659	0.8027

R-squared	0.966232	Mean dependent var	13.28553
Adjusted R-squared	0.898697	S.D. dependent var	0.117870
S.E. of regression	0.037516	Akaike info criterion	-6.390189
Sum squared resid	0.002815	Schwarz criterion	-6.428825
Log likelihood	17.43309	F-statistic	14.30712
Durbin-Watson stat	2.211845	Prob(F-statistic)	0.066395

The technical progress' (Be^{mt}) effect is estimated to 1.2 percent for the period 1982 to 1997.

Appendix 4

The production function:

$$q = Bt^{m}\ Lh^{\alpha}\ K^{\beta}\ e^{\mu}$$

The restricted β=0 is tried $q = Bt^{m}\ Lh^{\alpha}\ e^{\mu}$

Wald Test:
Equation: EG_NY_LK

Null Hypothesis: C(2)=0			
F-statistic	3.744448	Probability	0.076902
Chi-square	3.744448	Probability	0.052983

Transformed into log-linear:

$$\ln(q) = C + m\ln(t) + \alpha\ln(Lh) + \mu$$

LS // Dependent Variable is LOGQ
Date: 08/19/99 Time: 11:58
Sample(adjusted): 1982 1997
Included observations: 16 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	11.79288	2.587988	4.556777	0.0005
LOGLH	0.153019	0.349481	0.437846	0.6687
LOGT	0.136751	0.036862	3.709768	0.0026

R-squared	0.663956	Mean dependent var	13.20691
Adjusted R-squared	0.612257	S.D. dependent var	0.142596
S.E. of regression	0.088793	Akaike info criterion	-4.675524
Sum squared resid	0.102496	Schwarz criterion	-4.530663
Log likelihood	17.70117	F-statistic	12.84269
Durbin-Watson stat	1.392212	Prob(F-statistic)	0.000835

The technical progress' (Bt^{m}) takes the wholes honor for the output growth and Lh turn insignificant.

Appendix 5

The production function:

$$q = Bt^{m}\ Lh^{\alpha}\ K^{\beta}\ e^{\mu}$$

The restricted $\alpha+\beta=1$ is tried: $q = Bt^{m}\ Lh^{\alpha}\ K^{1-\alpha}\ e^{\mu}$

Wald Test:
Equation: EG_NY_LK

Null Hypothesis:	**C(2)+C(3)=1**		
F-statistic	**0.482741**	**Probability**	**0.500415**
Chi-square	**0.482741**	**Probability**	**0.487183**

The hypothesis is not rejected (but not accepted either).

Appendix 6

Par-wise correlation among regressors (zero order correlation)

Correlation Matrix				
	LOGK	LOGLH	LOGQ	LOGT
LOGK	1.000000	-0.860228	-0.583382	-0.807060
LOGLH	-0.860228	1.000000	0.555161	0.615532
LOGQ	-0.583382	0.555161	1.000000	0.811788
LOGT	-0.807060	0.615532	0.811788	1.000000

Correlation matrix estimates: r_{12}=-0.86, r_{14}=-0.81, and r_{24}=0.62. Where (*1*=ln*(K); 2*=ln *(Lh); 3*=ln*(q); 4*=ln*(t)*)

Auxiliary regressions of the models variables:

For the form: ln*(t)*= *c* + ln*(Lh)* + ln*(K)*; $R^2_{\ln(t)} = 0.67$

LS // Dependent Variable is LOGT
Date: 06/28/99 Time: 19:43
Sample(adjusted): 1982 1997
Included observations: 16 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	59.85901	31.66061	1.890646	0.0812
LOGLH	-2.870516	2.938973	-0.976707	0.3465
LOGK	-4.819590	1.399559	-3.443650	0.0044

R-squared	0.675182	Mean dependent var	1.916991
Adjusted R-squared	0.625210	S.D. dependent var	0.789160
S.E. of regression	0.483124	Akaike info criterion	-1.287602
Sum squared resid	3.034319	Schwarz criterion	-1.142741
Log likelihood	-9.402202	F-statistic	13.51120
Durbin-Watson stat	0.440936	Prob(F-statistic)	0.000669

For the form: $\ln(Lh)=c+\ln(K)+\ln(t)$; $R^2_{\ln(Lh)}=0.76$

LS // Dependent Variable is LOGLH
Date: 06/28/99 Time: 19:42
Sample(adjusted): 1982 1997
Included observations: 16 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	11.31578	0.868163	13.03417	0.0000
LOGK	-0.496425	0.110089	-4.509317	0.0006
LOGT	-0.023816	0.024384	-0.976707	0.3465

R-squared	0.757767	Mean dependent var	7.527715
Adjusted R-squared	0.720501	S.D. dependent var	0.083239
S.E. of regression	0.044006	Akaike info criterion	-6.079485
Sum squared resid	0.025175	Schwarz criterion	-5.934625
Log likelihood	28.93287	F-statistic	20.33372
Durbin-Watson stat	1.173168	Prob(F-statistic)	0.000099

For the form: $\ln(K)=c+\ln(Lh)+\ln(t)$; $R^2_{\ln(K)}=0.86$

LS // Dependent Variable is LOGK
Date: 06/28/99 Time: 19:29
Sample(adjusted): 1982 1997
Included observations: 16 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	16.97853	2.017947	8.413766	0.0000
LOGLH	-1.228800	0.272502	-4.509317	0.0006
LOGT	-0.098980	0.028743	-3.443650	0.0044

R-squared	0.864028	Mean dependent var	7.538730
Adjusted R-squared	0.843109	S.D. dependent var	0.174795
S.E. of regression	0.069235	Akaike info criterion	-5.173124
Sum squared resid	0.062316	Schwarz criterion	-5.028264
Log likelihood	21.68198	F-statistic	41.30379
Durbin-Watson stat	1.024834	Prob(F-statistic)	0.000002

Appendix 7

Autocorrelation:

The auto- and partial correlogram is drawn for the model: $q = Bt^m\ Lh^\alpha\ K^\beta\ e^\mu$.

Date: 08/19/99 Time: 11:42
Sample: 1982 1997
Included observations: 16

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.014	0.014	0.0036	0.952
		2	-0.234	-0.234	1.1301	0.568
		3	-0.143	-0.144	1.5834	0.663
		4	-0.302	-0.386	3.7745	0.437

All autocorrelation and partial correlations are insignificant. The calculated Q-statistic does not exceed the critical Q-value. Hence, the hypothesis the all autocorrelation coefficients are zero is accepted.

Appendix 8

Heteroscedasticity test for the model: $q = Bt^{m}\ Lh^{\alpha}\ K^{\beta}\ e^{\mu}$.

White Heteroskedasticity Test:

F-statistic	0.722276	Probability	0.672600
Obs*R-squared	7.235076	Probability	0.511495

Test Equation:
LS // Dependent Variable is RESID^2
Date: 08/19/99 Time: 11:45
Sample: 1982 1997
Included observations: 16

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-39.98615	41.53044	-0.962816	0.3677
LOGK	4.871012	7.085213	0.687490	0.5139
LOGK^2	0.023855	0.273890	0.087096	0.9330
LOGK*LOGLH	-0.724215	0.502304	-1.441787	0.1926
LOGK*LOGT	0.109500	0.112714	0.971486	0.3637
LOGLH	5.720644	3.974153	1.439462	0.1932
LOGLH*LOGT	-0.120088	0.102059	-1.176650	0.2778
LOGT	0.027672	1.424434	0.019426	0.9850
LOGT^2	0.012608	0.013272	0.949973	0.3738

R-squared	0.452192	Mean dependent var	0.004882
Adjusted R-squared	-0.173874	S.D. dependent var	0.004834
S.E. of regression	0.005238	Akaike info criterion	-10.20544
Sum squared resid	0.000192	Schwarz criterion	-9.770863
Log likelihood	67.94054	F-statistic	0.722276
Durbin-Watson stat	3.127842	Prob(F-statistic)	0.672600

F-statistic is insignificant. Suggesting non of the assumptions are violated.

Appendix 9

The data for labour-hours, capital at cost, energy, and output ton on log-linear form:

obs	LOGK	LOGLH	LOGQ	LOGT
1982	7.765102	7.512282	13.02805	0.000000
1983	7.631432	7.481698	12.89922	0.693147
1984	7.692250	7.415079	13.04332	1.098612
1985	7.740882	7.418344	13.14412	1.386294
1986	7.777667	7.478276	13.19747	1.609438
1987	7.653191	7.516712	13.19561	1.791759
1988	7.630947	7.490007	13.27078	1.945910
1989	7.612633	7.448963	13.33586	2.079442
1990	7.567521	7.446877	13.19747	2.197225
1991	7.520300	7.506963	13.15773	2.302585
1992	7.387808	7.550402	13.17115	2.397895
1993	7.321056	7.647186	13.17496	2.484907
1994	7.281317	7.628733	13.35823	2.564949
1995	7.327715	7.609410	13.33909	2.639057
1996	7.345249	7.647219	13.33586	2.708050
1997	7.364610	7.645285	13.46169	2.772589
1998	7.389626	NA	13.38319	2.833213

	1977	1978	1979	1980	1981	1982	1983	1984
Index of the wholesale prices of industrial products(1990=100)						78.6	82.7	88.4
1985=100						85.5	90	96.2
Steel price index (1990=100)						75.1	79.6	87.0
-Price indices								
1985=100						79.4	84.1	92.0
Price indices						95.6	96.2	98.4
Hjaelpelinie						100.0	100.0	100.0
-Numbers not price index adjusted								
Revnue (mio DKK)	810.0	1,012.0	1,176.0	1,287.0	1,280.0	1,253.0	1,090.0	1,309.0
PPE at cost price (mio DKK) (Property, plan, and equipment)					1,230.0	1,438.4	1,468.5	1,468.5
PPE (mio DKK) (Property, plan, and equipment)				1,094.1	857.2	814.0	800.0	815.0
Year ended Investments in PPE*						28.8	32.1	68.4
Production equipment						23.1	25.0	65.6
Plant, Buildings, and property						5.7	7.1	2.8
sale of PPE							2.0	5.5
-Price index adjusted numbers								
Revnue (mio DKK) steel price index adjusted						1,668.0	1,370.0	1,503.9
Revnue (mio DKK) wholesale price index adjusted						1,594.5	1,317.7	1,480.4
Capital at cost (mio DKK)						*1,030.4*	*1,175.3*	*1,660.5*
Capital net deprciation (mio DKK)						1,035.8	967.1	921.7
Year ended Investments in PPE*						36.6	38.8	77.4
Production equipment						29.4	30.2	74.2
Plant, Buildings, and property						7.3	8.6	3.2
sale of PPE							2.4	6.2
Number of employed								
Labour workers					1,475	1,295	1,133	1,204
White collar workers					466	406	384	390
Total Average			2,724	2,496	1,941	1,701	1,517	1,594
Share of labour hours in total hours					76%	76%	75%	76%
Average working hours for the industry	1860	1860	1860	1848.8	1820	1820	1820	1820
Labour hours					*2,684,500*	*2,156,900*	*2,062,060*	*1,181,280*
White collar working hours					848,120	738,920	698,880	709,800
Total average working hours			5,066,640	4,609,613	3,532,620	3,095,820	2,760,940	2,901,080
Production output (1000 ton)								
Crude steel production	672	849	790	721	599	549	483	545
Output (1000 ton)	552	640	676	647	562	455	400	462
Output (ton)	*552,000*	*640,000*	*676,000*	*647,000*	*562,000*	*455,000*	*400,000*	*462,000*
Plates								
Long products								
Production mix (plates to long products)								
Energy per output ton (kWh/t)								
Plates (kWh/t)								
Long products (kWh/t)								
Energy consumption (MWh)								

1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
91.9	88.4	90.1	93.6	99.0	100.0	100.6	99.5	98.9	100.1	103.0
100	96.2	97	100.9	107	108.8					
94.6	95.3	91.0	94.6	101.7	100.0	94.1	91.5	92.5	98.0	106.4
100.0	100.7	96.2	100.0	107.5	105.7					
102.9	107.7	101.0	101.1	102.7	100.0	93.5	92.0	93.5	97.9	103.3
100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1,503.0	1,412.0	1,272.0	1,573.0	1,880.0	1,629.0	1,398.0	1,261.0	1,146.0	1,435.0	1,572.0
1,531.5	1,564.3	1,656.5	1,675.5	1,700.9	1,714.5	1,831.6	1,892.0	2,071.7	2,058.5	2,077.6
804.0	843.0	808.0	777.0	496.0	550.0	552.0	661.0	610.0	577.0	616.0
42.8	94.5	24.8	31.8	22.9	120.4	63.9	184.6	25.8	49.3	111.0
36.1	85.5	19.2	30.4	20.2	87.7	48.7	181.5	24.9	39.2	90.8
6.7	9.0	5.6	1.4	2.7	32.7	15.2	3.1	0.9	10.1	20.2
10.3	2.2	5.9	6.3	9.3	3.3	4.3	4.9	39.1	30.2	8.0
1,588.7	1,482.1	1,397.6	1,662.7	1,848.5	1,629.0	1,485.7	1,378.1	1,238.9	1,464.3	1,477.4
1,635.3	1,596.9	1,411.8	1,680.6	1,899.0	1,629.0	1,389.7	1,267.3	1,158.7	1,433.6	1,526.2
1,665.2	*1,769.2*	*1,838.5*	*1,790.1*	*1,718.1*	*1,714.5*	*1,820.7*	*1,901.5*	*2,094.7*	*2,056.4*	*2,017.1*
874.8	953.4	896.8	830.1	501.0	550.0	548.7	664.3	616.8	576.4	598.1
46.6	106.9	27.5	34.0	23.1	120.4	63.5	185.5	26.1	49.3	107.8
39.3	96.7	21.3	32.5	20.4	87.7	48.4	182.4	25.2	39.2	88.2
7.3	10.2	6.2	1.5	2.7	32.7	15.1	3.1	0.9	10.1	19.6
11.2	2.5	6.5	6.7	9.4	3.3	4.3	4.9	39.5	30.2	7.8
1,264	1,345	1,203	1,192	1,186	1,149	1,096	960	898	863	904
399	416	396	361	347	341	339	332	274	212	219
1,663	1,761	1,599	1,553	1,533	1,490	1,435	1,292	1,172	1,075	1,123
76%	76%	75%	77%	77%	77%	76%	74%	77%	80%	80%
1820	1774.5	1751.75	1729	1706.25	1683.5	1683.5	1683.5	1683.5	1683.5	1683.5
2,308,480	*2,288,703*	*2,107,355*	*2,060,900*	*2,023,612*	*1,934,342*	*1,845,116*	*1,618,160*	*1,511,782*	*1,462,861*	*1,521,884*
726,180	738,192	693,693	624,169	592,069	574,074	570,707	558,922	461,279	356,902	368,687
3,026,660	3,124,895	2,801,048	2,685,137	2,615,681	2,508,415	2,415,823	2,175,082	1,973,062	1,809,763	1,890,571
528	632	606	650	625	610	633	591	603	723	648
511	539	538	580	619	539	518	525	527	633	621
511,000	*519,000*	*538,000*	*580,000*	*619,000*	*539,000*	*518,000*	*525,000*	*527,000*	*633,000*	*621,000*
341	362	372	392	434	362	348	368	320	378	397
170	177	166	188	185	177	170	157	207	248	216
2.0	2.0	2.2	2.1	2.3	2.0	2.0	2.3	1.5	1.5	1.8
						1,528	1,487	1,412	1,390	1,415
						1,653.0	1,585.0	1,570.0	1,537.0	1,541.0
						1,272.0	1,257.0	1,167.0	1,166.0	1,183.0
						791,484	*700,634*	*743,969*	*878,884*	*870,824*

1996	1997	1998	1999
104.1	106.1		
101.2			
97.2			
100.0			
1,505.0	1,709.0	1,700.0	
2,180.7	2,218.3	2,361.6	2,465.7
585.0	650.0	662.0	
43.8	159.7	108.4	
32.4	111.9	98.0	
11.4	47.8	10.4	
6.2	16.3	4.3	
1,487.2			
1,445.7	1,610.7		
2,094.8	*2,080.8*		
562.0	612.6		
42.1	150.5		
31.1	105.5		
11.0	45.1		
6.0	15.4		
920	938	966	
206	190	191	
1,126	1,128	1,157	
82%	83%	83%	
1683.5	1683.5	1676.1	1669.7
1,548,820	*1,579,123*	*1,618,112*	
346,801	319,865	320,135	
1,895,621	1,898,988	1,939,248	
739	787	800	
619	702	649	
619,000	*702,000*	*649,000*	
403	487	424	
218	232	211	
1.8	2.1	2.0	
1,408	1,283	1,337	
1,537.0	1,390.0	1,450.0	
1,170.0	1,090.0	1,110.0	
871,865	*947,826*	*867,728*	

Curriculum Vitae

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