Take Home Exam Economics 410: Economic Development: Fall 2018

1. (40) Consider the following representation of real output per worker:

$$y_{it} = A_{it} k_{it}^{.33} h_{it}^{.67}$$

where A_{it} is the technology level used by country i in year t, k_{it} is the real physical capital per worker in country i in year t, and h_{it} is the human capital per worker in country i in year t. We can take the natural logs of both sides of this equation and produce:

$$lny_{it} = lnA_{it} + .33lnk_{it} + .67lnh_{it}$$

Where human capital is defined via the Mincer relationship depending on years of schooling, *E*, and experience, *x*:

$$lnh_{it} = .10E_{it} + .0495x_{it} - .0007x_{it}^{2}$$

Finally we can look at the last year of observation, typically 2010, and the first year that we observe these items for a country, t_0. We can subtract the first year observation from the last year observation and divide by the number of years separating the two observations to produce growth rates per year:

$$\frac{lny_{iT} - lny_{it_0}}{T - t_0} = \frac{lnA_{iT} - lnA_{it_0}}{T - t_0} + .33\frac{lnk_{iT} - lnk_{it_0}}{T - t_0} + .67\frac{lnh_{iT} - lnh_{it_0}}{T - t_0}$$

This is commonly written in terms of annualized growth rates of variable say z, as g_z. Thus we can rewrite the above equation as:

$$g_y = g_A + .33g_k + .67g_h$$

Look at the Table below, and fill in the missing entries using the equations above to help.

Region	g_y	g_A	g_k	g_h	$\frac{g_A}{g_y}$	$1 - \frac{g_A}{g_y}$
World	1.24		1.19	0.49		
Western Countries	1.42	0.60	1.43			
Southern Europe	1.46	0.54		0.57		
Central & Eastern Europe	1.37	0.39		0.77		
Newly Industrialized Countries	1.83		0.57	1.06		
Asia		0.50	1.10	0.43		
Sub-Saharan Africa		0.49	0.73	0.49		
Latin America		0.49	1.15	0.50		
Middle East	1.16	0.48	1.10			

North Africa	1.21	0.49	1.18			

2. (40) An alternative way of asking if the model of real output per worker determination helps to explain income differences across countries is to ask how much of the variation of output growth rates is explained by variation in growth rates of the two inputs, physical capital and human capital.

Thus we can do what is called a variance decomposition of the growth equation above. First it is helpful to do a change of variables. We define the growth rate of inputs as the following:

$$g_x = .33g_k + .67g_h$$

Now notice that the growth rate equation above can be rewritten as:

$$g_y = g_A + g_x$$

Now we can apply the variance operator and recall from statistics that:

$$var_{g_y} = var_{g_A} + var_{g_x} + 2cov_{g_A,g_x}$$

In words, the variance of the growth rate of output per worker is equal to the sum of the variance of the growth rate of TFP, the variance of the growth rate of inputs and 2 times the covariance of growth rate of TFP and the growth rate of inputs.

One method of analyzing this equation is to "assign" one covariance term to each of the first two terms, and then divide both sides of the equation by the variance of the growth rate of real output per worker to produce:

$$1 = \frac{var_{g_A} + cov_{g_A,g_x}}{var_{g_y}} + \frac{var_{g_x} + cov_{g_A,g_x}}{var_{g_y}}$$

a. (5) Comment on this "egalitarian" approach. The first term is sometimes referred to as the share of the variance of the growth rate of output per worker explained by TFP and the second term is sometimes referred to as the share of the variance of the growth rate of output per worker explained by inputs.

b. (5) An alternative to this approach is to consider why the growth rate of TFP is correlated (has non zero covariance) with the growth rate of inputs. Some theories argue that TFP induces the accumulation of factors, that is if TFP improves, then it makes both physical capital and human capital more productive, and hence induces society to accumulate more of each. Under this approach there are two standard theories that are consistent with this analysis. List those here and the original creators of these theories.

c. (5) Write the equation from class that produces this variance decomposition. Use the notation that σ_{g_i} is the standard deviation of the growth rate of i (where i can be TFP or inputs), and $\rho_{g_A g_x}$ is the correlation of the growth rate of TFP and the growth rate of inputs.

d. (5) Alternative theories posit that accumulation of inputs induces growth in TFP. List the two theories that produce this relationship and the creators of the theories.

e. (5) Write out the equation that shows this causality of growth using the same notation as in c.

f. (5) Now take the share of the variance of the growth rate of real output per worker that is explained by inputs in both c. and e., and average them. Then 1 – that share is the average share explained by TFP. Let's call this the "theory" assignment. The Table below shows the share explained by inputs and TFP for both the "egalitarian" assignment and the "theory" assignment. These are contained the Table below

Region	Egalitarian input share	Egalitarian TFP share	Theory input share	Theory TFP share
World	.455	.545	.458	.542
Western Countries	.344	.656	.408	.592
Southern Europe	.368	.632	.496	.504
Central & Eastern Europe	.554	.446	.548	.442
Newly Industrialized Countries	.097	.903	.171	.829
Asia	.475	.525	.478	.522
Sub-Saharan Africa	.417	.583	.447	.553
Latin America	.408	.592	.439	.561
Middle East	.719	.281	.666	.334
North Africa	1.145	-.145	.761	.239

How different are the two results? Consider that economists would hope that inputs would explain greater than 50% of the variation in long run growth rates. Would you say either of the results constitute success for input explanations?

g. (5) Now suppose that human capital accumulates across generations and potentially across borders. Suppose that human capital of children in a typical country i is produced by their schooling and the human capital of their parents, and the knowledge available in the world. Formally this can be written as:

$$h_{it+1} = A\overline{h}_t^{\rho} h_{it}^{\beta-.10\rho} exp(.10E_{it+1} + .0495e_{it+1} - .0007e_{it+1}^2)$$

where the term on the left hand side of the equation is the human capital of children when they work, $\overline{h}_t$ is the state of the art of knowledge, h_{it} is the human capital of their parents, E_{it+1} is the years of schooling of the child, and e_{it} is the average years of work experience of the child. The value of $\beta = .375$. Finally assume that the strength of the "spillover" is given by:

$$\rho = min\{.35, \frac{E_{it+1}}{30}\}$$

Comment on the importance of schooling in producing human capital for the children, directly (in the exponential term), and indirectly in the spillover term. What schooling amount produces the maximum ability to use the state of the art knowledge in the world?

h. (5) The Table below contains the share of growth accounted for by inputs and TFP, columns 2 and 3, and the share of the variance of growth of real output per worker using both the "egalitarian" and the "theory" approaches from above.

Region	Input growth share	TFP growth share	Egalitarian input share	Egalitarian TFP share	Theory input share	Theory TFP share
World	.842	.158	.950	.050	.947	.053
Western Countries	.847	.153	.966	.034	.963	.037
Southern Europe	.897	.103	.959	.041	.959	.041
Central & Eastern Europe	.866	.134	.965	.035	.936	.064
Newly Industrialized Countries	.903	.097	1.024	-.024	.959	.041
Asia	.861	.139	.945	.055	.936	.064
Sub-Saharan Africa	.663	.337	.918	.082	.901	.099
Latin America	.722	.278	.935	.065	.935	.065
Middle East	.829	.171	.968	.032	.952	.048
North Africa	.926	.074	1.054	-.054	.920	.080

Does this new human capital definition do a better job to explain long run growth and the variation of long run growth across countries compared with the Mincer human capital definition from part a?

3. (40) Now look at the U.S. states. The following Table contains the growth rate of real output per worker, real physical capital per worker, human capital per worker and TFP for the states of the US for two different time periods.

Table 1

Region	Time period	g_y	g_A	g_k	g_h	Input share	TFP share
US states	1840-2000	1.54	0.56	1.35	0.80		
US states	1900-2000	1.92	0.75	1.75	0.87		
North	1840-2000	1.63	0.64	1.43	0.77		
South	1840-2000	1.93	0.79	1.79	0.82		
West	1840-2000	0.77	0.05	0.54	0.80		
North	1900-2000	1.67	0.62	1.58	0.80		
South	1900-2000	2.41	1.03	2.23	0.96		
West	1900-2000	1.62	0.59	1.34	0.88		

a. (5) Compute the share of growth explained by inputs and TFP. How well does the economic model explain growth as a function of input accumulation?

Now consider the fertility rates of whites and blacks by census division. Also the schooling of the cohorts by race by census divisions.

Table 2: Children Ever Born: By Census Division and Race

Year	NE	MidAtl	SoAtl	ESC	WSC	Mtn	Pac	WNC	ENC	USA
white										
1800	7.36	8.37	7.56	9.10	-	-	-	-	10.5	7.89
1840	5.06	6.05	6.37	7.07	6.57	-	-	7.61	7.19	6.33
1880	3.63	4.40	5.35	5.26	6.07	4.65	4.41	4.64	4.29	4.63
1920	2.52	2.76	3.64	3.83	4.09	3.66	2.50	3.28	2.88	3.12
1940	2.06	2.03	2.71	3.04	2.82	2.69	1.81	2.36	2.21	2.33
1950	1.93	1.83	2.29	2.60	2.34	2.49	1.83	2.22	2.04	2.09
1960	2.32	2.16	2.41	2.69	2.61	2.84	2.33	2.67	2.48	2.44
1970	2.89	2.66	2.70	2.82	2.98	3.24	2.85	3.20	3.05	2.90
1980	2.53	2.42	2.40	2.55	2.64	2.78	2.41	2.75	2.68	2.55
1990	1.74	1.79	1.77	1.94	2.01	2.08	1.76	2.06	1.97	1.88
2000	1.90	1.99	1.78	1.91	2.14	2.19	2.09	2.09	2.07	2.01
Black										
1840	5.22	5.89	7.66	6.91	4.71	-	-	8.71	7.69	7.15
1880	3.94	4.17	6.98	6.19	6.61	3.25	2.69	5.34	4.80	6.47
1920	2.86	2.71	4.39	4.15	4.38	1.83	2.72	2.65	2.86	4.08
1940	2.07	1.88	3.17	2.98	2.87	2.70	2.43	1.88	1.91	2.79
1950	1.77	1.58	2.77	3.01	2.73	2.97	1.87	2.08	1.75	2.48
1960	2.26	2.04	3.20	3.74	3.46	3.42	2.36	2.66	2.38	2.95
1970	3.09	2.80	3.73	4.32	4.03	3.69	3.16	3.63	3.32	3.55
1980	2.92	2.76	3.26	3.80	3.58	3.16	2.86	3.34	3.16	3.22
1990	2.19	2.10	2.23	2.52	2.45	2.21	2.03	2.35	2.27	2.26
2000	1.92	2.26	2.14	2.22	2.36	2.33	1.98	2.46	2.16	2.20

Table 3: Years of Schooling by Birth Cohort: By Census Division and Race

Year	NE	MidAtl	SoAtl	ESC	WSC	Mtn	Pac	WNC	ENC	USA
white										
1840	4.41	3.71	1.51	1.30	0.94	-	-	1.42	2.84	2.90
1880	7.54	6.53	6.18	6.14	5.56	4.83	5.75	6.61	6.61	6.49
1920	9.90	9.52	8.67	8.35	8.71	9.64	10.5	9.86	9.84	9.50
1940	11.5	11.4	10.7	9.77	10.6	11.4	12.2	11.0	11.1	11.1
1950	11.7	11.6	11.1	10.3	11.0	11.9	12.5	11.4	11.3	11.4
1960	12.5	12.2	12.2	11.5	11.9	12.6	12.6	12.3	12.0	12.2
1970	14.2	13.9	14.4	13.4	14.2	14.6	14.6	13.9	13.5	14.0
1980	14.5	14.5	14.9	14.1	14.5	15.2	14.8	14.9	14.5	14.6
1990	13.2	13.3	14.1	13.7	13.4	14.6	13.5	14.3	13.9	13.7
2000	14.9	14.9	15.0	14.9	14.7	15.0	14.8	14.9	14.9	14.9
Black										
1840	0.29	0.18	0.02	0.00	0.10	-	-	0.03	0.16	0.03
1880	5.14	4.93	2.79	3.10	1.90	1.50	4.13	5.02	5.00	2.94
1920	9.21	8.33	6.09	6.15	6.32	9.02	10.3	9.17	8.93	6.55
1940	11.0	10.2	7.75	7.23	8.10	10.2	12.3	9.95	10.1	8.27
1950	11.2	10.5	8.60	8.17	8.90	11.0	12.2	10.3	10.4	9.22
1960	12.9	12.9	12.1	11.6	12.1	13.6	13.6	12.3	12.5	12.4
1970	12.9	12.9	12.1	11.6	12.1	13.6	13.6	12.3	12.5	12.4
1980	13.0	12.8	12.9	12.4	12.7	14.2	13.6	13.0	12.9	12.9
1990	12.2	12.2	13.1	12.3	12.6	13.4	12.7	12.9	12.5	12.6
2000	14.3	14.2	14.4	14.3	14.2	14.6	14.2	14.4	14.2	14.3

b. (5) Using the previous 2 tables, what is the relationship between the fertility of moms and the subsequent years of schooling attained by their children?

c. (10) Comparing the long term results, with those over the 1950-1970 period, do you find discrepancies with the connection?

Table 4: Probability of Dying before 45 by Birth Cohort: Census Division and Race

Year	NE	MidAtl	SoAtl	ESC	WSC	Mtn	Pac	WNC	ENC	USA
white										
1800	.613	.643	.562	.508	-	-	-	-	.573	.599
1840	.607	.644	.560	.501	.451	-	-	.539	.565	.585
1880	.573	.592	.519	.450	.520	.567	.489	.458	.508	.524
1920	.300	.308	.282	.261	.274	.338	.288	.246	.289	.287
1940	.131	.137	.156	.164	.169	.185	.146	.126	.137	.145
1950	.080	.083	.095	.105	.103	.111	.092	.084	.088	.091
1960	.070	.066	.080	.085	.081	.089	.077	.073	.074	.075
1970	.065	.068	.077	.084	.079	.082	.074	.070	.071	.073
1980	.050	.054	.060	.063	.065	.062	.059	.052	.055	.057
1990	.042	.051	.052	.055	.056	.052	.055	.044	.046	.050
2000	.037	.043	.041	.049	.047	.049	.039	.042	.045	.043
Black										
1800	.813	.883	.830	.778	-	-	-	-	.837	.830
1840	.811	.885	.832	.760	.709	-	-	.851	.845	.804
1880	.735	.791	.727	.654	.656	.687	.619	.748	.754	.697
1920	.535	.554	.485	.462	.443	.575	.457	.530	.568	.481
1940	.269	.303	.340	.317	.297	.359	.255	.312	.309	.319
1950	.169	.197	.210	.203	.187	.224	.162	.213	.204	.201
1960	.141	.152	.177	.156	.155	.172	.114	.161	.140	.157
1970	.132	.159	.170	.167	.152	.150	.112	.164	.155	.158
1980	.094	.112	.112	.113	.114	.117	.109	.119	.116	.113
1990	.099	.132	.110	.104	.105	.088	.109	.105	.117	.113
2000	.065	.089	.091	.103	.088	.097	.062	.107	.103	.091

d. (5) Using the above Table, formulate a theory of the preferences of prospective parents on the number of children they have as it relates the probability of the child's generation dying before attaining the age of 45.

Table 5: Human Capital by Birth Cohort: Census Division and Race

Year	NE	MidAtl	SoAtl	ESC	WSC	Mtn	Pac	WNC	ENC	USA
white										
1840	8.28	8.67	3.66	3.96	4.45	-	-	4.21	6.37	6.60
1880	15.8	15.6	6.87	7.81	8.22	8.28	10.5	8.87	11.9	11.6
1920	32.5	31.2	20.4	21.7	20.7	20.6	25.4	23.6	27.7	26.3
1940	46.3	45.0	34.3	35.3	35.2	35.0	41.0	38.7	42.2	40.4
1950	53.4	52.5	43.5	43.3	44.2	44.5	48.8	47.0	49.8	48.4
1960	66.0	65.0	56.2	55.9	57.3	57.0	62.1	60.1	62.9	61.2
1970	75.2	74.4	67.4	67.0	68.3	68.7	71.4	70.6	72.5	71.2
1980	94.4	93.5	87.1	86.4	87.9	88.2	91.5	90.0	91.8	90.4
1990	108	107	102	101	103	103	105	104	105	104
2000	134	134	130	129	130	131	132	132	133	132
Black										
1840	1.38	0.82	0.10	0.12	0.22	-	-	0.23	0.44	0.16
1880	2.71	1.54	0.13	0.09	0.32	0.71	1.68	0.55	0.92	0.24
1920	12.2	8.25	1.06	0.75	1.70	2.62	7.80	4.73	6.24	2.00
1940	26.1	19.6	3.98	2.88	5.50	9.20	23.0	14.3	16.8	7.30
1950	37.0	31.0	7.70	5.45	9.68	17.1	32.9	22.3	26.4	14.3
1960	49.4	41.2	13.7	10.2	16.6	26.3	46.1	33.8	37.5	24.1
1970	62.1	56.5	25.2	20.4	28.9	43.5	58.6	47.1	52.3	39.0
1980	80.7	73.7	40.3	35.6	46.6	59.3	77.9	66.6	70.2	55.8
1990	97.2	92.6	59.2	55.0	66.1	81.2	93.8	84.7	89.0	74.7
2000	123	118	85.9	81.6	94.2	105	121	113	115	101

e. (5) The above Table contains the intergenerational human capital of the birth cohorts given in Table 2. Write out an accumulation technology of human capital that is consistent with this Table.

Table 6: Growth Accounting by Region

Variable	NE	Mid-Atl	So Atl	ESC	WSC	Mtn	Pac	WNC	ENC	USA
g_y	1.56	1.66	2.05	1.79	1.77	1.44	1.10	1.53	1.57	1.61
g_k	1.46	1.49	1.95		1.51	1.28	0.66		1.33	1.42
g_h		0.76		0.79	0.84		0.84	0.85	0.77	
g_x	0.96		1.19	1.08		0.97		1.01	0.95	1.01
g_{tfp}	0.60	0.66	0.86	0.71	0.71	0.47	0.32	0.52		0.60
$share_x$					60%					
g_{hcnew}	1.39	1.33		1.89	2.11	1.79	1.26	1.82	1.51	1.70
g_{xnew}	1.41		1.98	1.82		1.62		1.65		
g_{tfpnew}		0.28	0.07		-.14		0.04		0.12	0.00
$share_{xnew}$					108%				92%	

f. (10) Fill in the missing cell entries in the above Table. In terms of explaining a fraction of the observed growth per worker, does the new human capital model do a better job than the first one?

4. (40) The following parts are short answer questions from *Victory of Reason: How Christianity Led to Freedom, Capitalism, and Western Success* by Rodney Stark.

   a. (5) Name 4 city-states that thrived after the fall of the Roman Empire. Give the main businesses in each city that became notably successful. What does Stark credit as a unifying explanation for these 4 city states ability to prosper?

b. (5) What region of Italy failed to prosper, and what was the principle reason given by Stark for this failure?

c. (5) What was the name of the first *SuperCompany*? Where were its locations? What was its industry, and why did it fail?

d. (10) Name the dominant capitalist cities in Northern Europe mentioned in Stark's book. What was the industry that propelled these cities to economic prosperity?

e. (5) Where did the commercial center move to and why?

f. (5) Briefly describe the rise of English capitalism. From what primary product to higher valued product did the English ascend? Where did the firms locate and when did this occur? What power sources were important?

g. (5) What was the principle reason for the anticapitalism of Spain and France?