

Evolution Scenarios at the Romanian Economy Level, Using the R.M. Solow Adjusted Model

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***Abstract.** Besides the models of M. Keynes, R.F. Harrod, E. Domar, D. Romer, Ramsey-Cass-Koopmans model etc., the R.M. Solow model is part of the category which characterizes the economic growth.*

The paper proposes the presentation of the R.M. Solow adjusted model with specific simulation characteristics and economic growth scenario.

Considering these aspects, there are presented the values obtained at the economy level, behind the simulations, about the ratio Capital on the output volume, Output volume on employee, equal with the current labour efficiency, as well as the Labour efficiency value.

Key words: *reprezentive consumer; reprezentive firm; macroeconomic model; macroeconomic equilibrium; evolution scenarios; simulation; labour efficiency.*

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JEL Codes: C15, O11.

REL Codes: 8E, 10B.

1. Presentation of the R.M. Solow adjusted model, with specific simulation characteristics

It is well-known that any economic growth is accompanied by a continuous modification of the life and work conditions and, on the other hand, it releases changes due to which the communities adapt themselves to the changeable exigency of the production, in general.

In consequence, the analysis of the economic growth must explain the social conversion and the progress steps registered by the production technologies.

Besides the hypothesis from the R.M. Solow adjusted model⁽¹⁾, in the next simulations we will use a number of practical ones⁽²⁾, for allowing the running of a consistent model, such as:

- the analysis is made at a given moment (year), with straight mention at 20 past periods, and the forecast will have, also, 20 future periods;
- the model parameters will be:
 - s - rate of savings (ratio savings volume on each employee);
 - r_1 - annual growth rhythm of the employment;
 - r_2 - annual growth rhythm of the technical progress attached to the labour force;
 - ρ - annual depreciation rate of the capital;
 - γ_2 - attached power to the production function (output elasticity considering the labour factor);

Observations: 1. The same parameters noted with the sign *prime* will signify the values after the shock;

2. Because the simulations are made on the discreet case, the indicators will have the same characteristic – the time will be index (discreet value) and not one infinitesimal.

- it is assumed that in the year zero take place a shock, demonstrated through the modification of at least one parameter: s , r_1 , r_2 , ρ and/or γ_2 ;

From the econometric analysis were deduced the following values of the R.M. Solow model:

Initial values of the model parameters

Table 1	
$s = 0,275$	$\rho = 0,04$
$r_1 = 0,002$	$\gamma_2 = 0,8$
$r_2 = 0,05$	

- Values obtained at the economy level, at equilibrium:

$\frac{K_t}{Q_t} = \frac{s}{r_1 + r_2 + \rho}$ representing the ratio capital on output volume;

$\frac{Q_t}{L_t} = \left(\frac{s}{r_1 + r_2 + \rho} \right)^{\frac{1-\gamma_2}{\gamma_2}}$ representing the ratio output volume on employee, equal with the current labour efficiency E (labour efficiency or productivity in year zero);

$\left(\frac{60000 \cdot \frac{K_0}{Q_0}}{Q_0} \right)^{\frac{1-\gamma_2}{\gamma_2}}$ representing labour efficiency value, E , in year zero;

Furthermore, the calculation of the economic growth considering the R.M. Solow adjusted model contains the results organization in the table 2.

Economic growth calculated with Solow model

Table 2

Years before and after the shock (t)	Labour efficiency, E	Ratio capital on output volume, K/Q	Ratio output volume on employee, equal with the current labour efficiency, E	Labour productivity (ratio output on employee)
-20	$E_t = \frac{E_0}{(1+r_2)^{-t}}$	$\left(\frac{K}{Q}\right)_{-20} = \frac{s}{r_1+r_2+\rho}$	$\left(\frac{Q}{L}\right)_{-20} = \left(\frac{K}{Q}\right)_{-20} = \frac{s}{r_1+r_2+\rho}$	$\left(\frac{\tilde{Q}}{L}\right)_t = \left(E_t \left(\frac{K}{Q}\right)_t\right)^{\frac{1-\gamma_2}{\gamma_2}}$
-19				
-18				
...				
-3				
-2	$t = \overline{-20,-1}$	$\left(\frac{K}{Q}\right)_t = \left(\frac{K}{Q}\right)_{t-1}$	$\left(\frac{Q}{L}\right)_t = \left(\frac{Q}{L}\right)_{t-1}$	$t = \overline{-20,-1}$
-1		$t = \overline{-19,-1}$	$t = \overline{-19,-1}$	
0	$E_0 = \left(\frac{60000}{\frac{K_0}{Q_0}}\right)^{\frac{1-\gamma_2}{\gamma_2}}$	$\left(\frac{K}{Q}\right)_0 = \left(\frac{K}{Q}\right)_{-1}$	$\left(\frac{Q}{L}\right)_0 = \frac{s'}{r'_1+r'_2+\rho'}$	$\left(\frac{\tilde{Q}}{L}\right)_0 = \left(E_0 \left(\frac{K}{Q}\right)_0\right)^{\frac{1-\gamma_2}{\gamma_2}}$
1	$E_t = E_0(1+r'_2)^t$	$\left(\frac{K}{Q}\right)_t = \left(\frac{K}{L}\right)_t, t = \overline{1,20}$	$\left(\frac{Q}{L}\right)_t = \left(\frac{Q}{L}\right)_{t-1}$	$\left(\frac{\tilde{Q}}{L}\right)_t = k_t^{1-\gamma_2} E_t^{\gamma_2}$
2				
3				
...				
18				
19		$t = \overline{1,20}$	$t = \overline{1,20}$	
20				

Years before and after the shock (t)	Technical endowment of the labour, k	Ratio output volume on employee, considering the current labour efficiency, E	Ratio output on employee, before and after the shock
-20	$k_t = \frac{\left(\frac{K}{Q}\right)_t}{\left(\frac{\tilde{Q}}{L}\right)_t}, t = \overline{-19,-1}$	$\left(\frac{\tilde{Q}}{L}\right)_t = \left(E_t \left(\frac{Q}{L}\right)_t\right)^{\frac{1-\gamma_2}{\gamma_2}}$	$\left(\frac{\tilde{\tilde{Q}}}{L}\right)_t = \left(\frac{\tilde{Q}}{L}\right)_t$
-19			
-18			
...			
-3			
-2		$t = \overline{-20,-1}$	$t = \overline{-20,-1}$
-1			
0	$k_0 = \frac{\left(\frac{K}{Q}\right)_0}{\left(\frac{\tilde{Q}}{L}\right)_0}$	$\left(\frac{\tilde{Q}}{L}\right)_0 = \left(E_0 \left(\frac{Q}{L}\right)_0\right)^{\frac{1-\gamma_2}{\gamma_2}}$	$\left(\frac{\tilde{\tilde{Q}}}{L}\right)_0 = \left(E_0 \left(\frac{K}{Q}\right)_0\right)^{\frac{1-\gamma_2}{\gamma_2}}$
1	$k_t = k_{t-1}(1-r'_1-\rho') + \left(\frac{\tilde{Q}}{L}\right)_{t-1} s'$	$\left(\frac{\tilde{Q}}{L}\right)_t = \left(E_t \left(\frac{Q}{L}\right)_t\right)^{\frac{1-\gamma_2}{\gamma_2}}$	$\left(\frac{\tilde{\tilde{Q}}}{L}\right)_t = \frac{\left(\frac{\tilde{\tilde{Q}}}{L}\right)_{t-1}^2}{\left(\frac{\tilde{\tilde{Q}}}{L}\right)_{t-2}}, t = \overline{1,20}$
2			
3			
...			
18			
19	$t = \overline{1,20}$	$t = \overline{1,20}$	
20			

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2. Characterization of the economic growth scenario

Scenario 1. It has the following characteristics:

Models parameters	Initial values (%)	Shock (%)	After shock values (%)
s, rate of savings	27.50	12.00	39.50
ro, annual rate of the capital depreciation	5.00	0.00	5.00
r1, annual growth rhythm of the employment	2.00	0.00	2.00
r2, annual growth rhythm of the technical progress attached to the labour force	5.00	0.00	5.00
Gama 2: attached power to the production function (output elasticity considering the labour factor)	0.5		No changes in time
Values obtained at the economy level			
Ratio capital on output volume, K/Q:	2.29166667		3.29166667
Ratio output volume on employee, equal with the current labour efficiency, E:	2.29166667		3.29166667
Value of the labour efficiency (E) at the zero moment (year):	26.182		26.182

The results are presented in Appendix 1.

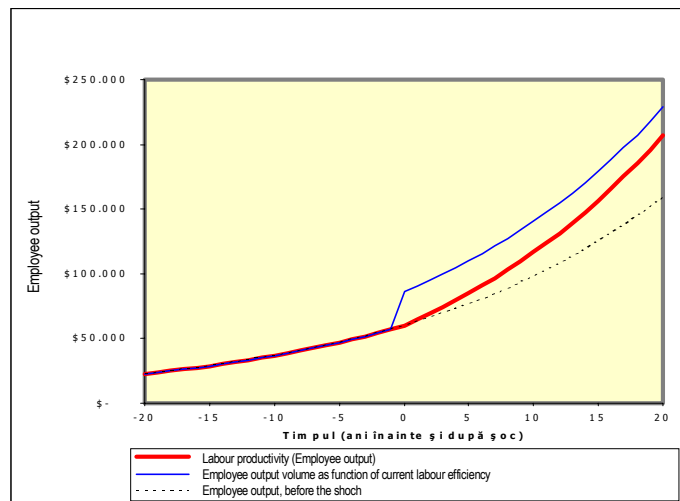


Figure 1. Adjusted increasing Solow model: employee output

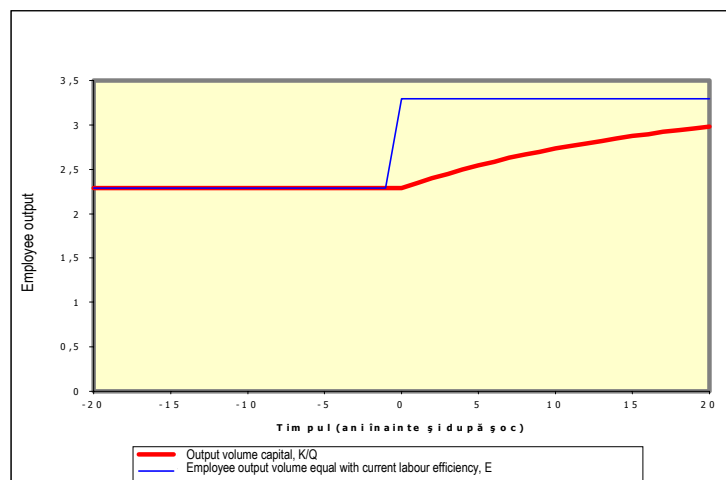


Figure 2. Adjusted increasing Solow model capital-output ratio

Scenario 2. It has the following characteristics:

Models parameters	Initial values (%)	Shock (%)	After shock values (%)
s, rate of savings	20.00	700	27.00
ro, annual rate of the capital depreciation	5.00	0.00	5.00
r1, annual growth rhythm of the employment	2.00	0.00	2.00
r2, annual growth rhythm of the technical progress attached to the labour force	5.00	0.00	5.00
Gama 2: attached power to the production function (output elasticity considering the labour factor)	0.5		No changes in time
Values obtained at the economy level			
Ratio capital on output volume, K/Q:	1.6666667		2.25
Ratio output volume on employee, equal with the current labour efficiency, E:	1.6666667		2.25
Value of the labour efficiency (E) at the zero moment (year):	36.00		36.000

The results are presented in Appendix 2.

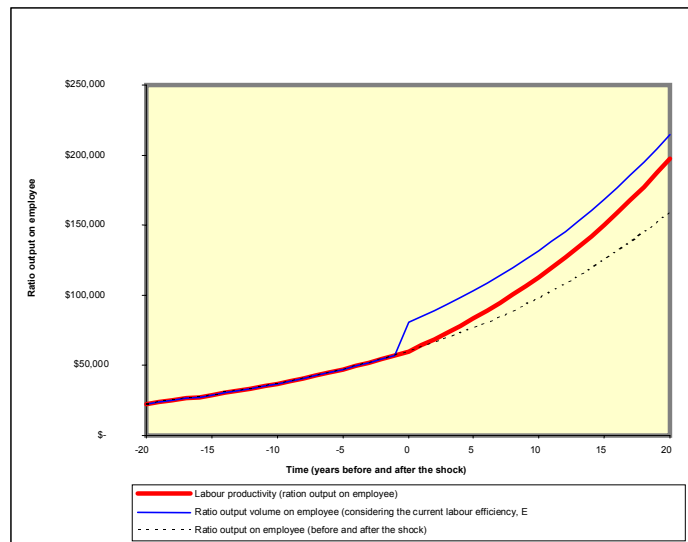


Figure 3. The R.M. Solow adjusted growth model: output on employee

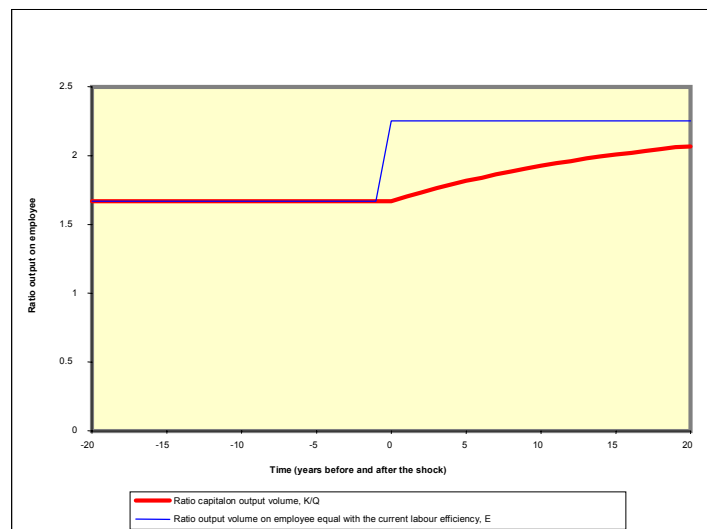


Figure 4. R.M. Solow adjusted growth model: ratio capital-output

Notes

- (1) See Roșca Gh. I., Stancu S., Modelul lui R.M. Solow ajustat de creștere economică, *Revista Economie-teorie și practică*, Nr. 5(510), pag. 3, București, 2007
- (2) This simulations considered Brad Delong analysis on the same Solow model.

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<http://www.bvb.ro>
<http://www.rasd.ro>

Appendix 1

Years before and after the shock	Labour efficiency, E	Ratio capital on output volume, K/Q	Ratio output volume on employee, equal to the current labour efficiency, E	Technical endowment of the labour, k	Labour productivity (ratio output on employee)	Ratio output volume on employee, considering the current labour efficiency, E	Ratio output on employee before and after the shock
-20	9.868	2,29166667	2,291666667	51.822	22.613	22.613	22.613
-19	10.361	2,29166667	2,291666667	54.413	23.744	23.744	23.744
-18	10.879	2,29166667	2,291666667	57.134	24.931	24.931	24.931
-17	11.423	2,29166667	2,291666667	59.991	26.178	26.178	26.178
-16	11.994	2,29166667	2,291666667	62.990	27.487	27.487	27.487
-15	12.594	2,29166667	2,291666667	66.140	28.861	28.861	28.861
-14	13.224	2,29166667	2,291666667	69.447	30.304	30.304	30.304
-13	13.885	2,29166667	2,291666667	72.919	31.819	31.819	31.819
-12	14.579	2,29166667	2,291666667	76.565	33.410	33.410	33.410
-11	15.308	2,29166667	2,291666667	80.393	35.081	35.081	35.081
-10	16.073	2,29166667	2,291666667	84.413	36.835	36.835	36.835
-9	16.877	2,29166667	2,291666667	88.634	38.677	38.677	38.677
-8	17.721	2,29166667	2,291666667	93.065	40.610	40.610	40.610
-7	18.607	2,29166667	2,291666667	97.719	42.641	42.641	42.641
-6	19.537	2,29166667	2,291666667	102.605	44.773	44.773	44.773
-5	20.514	2,29166667	2,291666667	107.735	47.012	47.012	47.012
-4	21.540	2,29166667	2,291666667	113.122	49.362	49.362	49.362
-3	22.617	2,29166667	2,291666667	118.778	51.830	51.830	51.830
-2	23.748	2,29166667	2,291666667	124.717	54.422	54.422	54.422
-1	24.935	2,29166667	2,291666667	130.952	57.143	57.143	57.143
0	26.182	2,29166667	3,291666667	137.500	60.000	86.182	60.000
1	27.491	2,348	3,291666667	151.575	64.552	90.491	63.000
2	28.865	2,401	3,291666667	166.463	69.318	95.015	66.150
3	30.309	2,452	3,291666667	182.191	74.310	99.766	69.458
4	31.824	2,499	3,291666667	198.790	79.538	104.755	72.930
5	33.415	2,544	3,291666667	216.292	85.015	109.992	76.577
6	35.086	2,587	3,291666667	234.733	90.752	115.492	80.406
7	36.840	2,627	3,291666667	254.148	96.762	121.266	84.426
8	38.682	2,664	3,291666667	274.579	103.060	127.330	88.647
9	40.617	2,700	3,291666667	296.067	109.660	133.696	93.080
10	42.647	2,733	3,291666667	318.658	116.576	140.381	97.734
11	44.780	2,765	3,291666667	342.400	123.825	147.400	102.620
12	47.019	2,795	3,291666667	367.342	131.423	154.770	107.751
13	49.370	2,823	3,291666667	393.541	139.388	162.509	113.139
14	51.838	2,850	3,291666667	421.051	147.738	170.634	118.796
15	54.430	2,875	3,291666667	449.934	156.493	179.166	124.736
16	57.152	2,899	3,291666667	480.253	165.672	188.124	130.972
17	60.009	2,921	3,291666667	512.076	175.298	197.530	137.521
18	63.010	2,942	3,291666667	545.473	185.392	207.407	144.397
19	66.160	2,962	3,291666667	580.520	195.978	217.777	151.617
20	69.468	2,981	3,291666667	617.295	207.080	228.666	159.198

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Years before and after the shock	Labour efficiency, E	Ratio capital on output volume, K/Q	Ratio output volume on employee, equal to the current labour efficiency, E	Technical endowment of the labour, k	Labour productivity (ratio output on employee)	Ratio output volume on employee, considering the current labour efficiency, E	Ratio output on employee before and after the shock
-20	13,568	1.66666667	1.66666667	37,689	22,613	22,613	22,613
-19	14,246	1.66666667	1.66666667	39,573	23,744	23,744	23,744
-18	14,959	1.66666667	1.66666667	41,552	24,931	24,931	24,931
-17	15,707	1.66666667	1.66666667	43,630	26,178	26,178	26,178
-16	16,492	1.66666667	1.66666667	45,811	27,487	27,487	27,487
-15	17,317	1.66666667	1.66666667	48,102	28,861	28,861	28,861
-14	18,182	1.66666667	1.66666667	50,507	30,304	30,304	30,304
-13	19,092	1.66666667	1.66666667	53,032	31,819	31,819	31,819
-12	20,046	1.66666667	1.66666667	55,684	33,410	33,410	33,410
-11	21,048	1.66666667	1.66666667	58,468	35,081	35,081	35,081
-10	22,101	1.66666667	1.66666667	61,391	36,835	36,835	36,835
-9	23,206	1.66666667	1.66666667	64,461	38,677	38,677	38,677
-8	24,366	1.66666667	1.66666667	67,684	40,610	40,610	40,610
-7	25,585	1.66666667	1.66666667	71,068	42,641	42,641	42,641
-6	26,864	1.66666667	1.66666667	74,622	44,773	44,773	44,773
-5	28,207	1.66666667	1.66666667	78,353	47,012	47,012	47,012
-4	29,617	1.66666667	1.66666667	82,270	49,362	49,362	49,362
-3	31,098	1.66666667	1.66666667	86,384	51,830	51,830	51,830
-2	32,653	1.66666667	1.66666667	90,703	54,422	54,422	54,422
-1	34,286	1.66666667	1.66666667	95,238	57,143	57,143	57,143
0	36,000	1.66666667	2.25	100,000	60,000	81,000	60,000
1	37,800	1.700	2.25	109,200	64,248	85,050	63,000
2	39,690	1.731	2.25	118,903	68,697	89,303	66,150
3	41,675	1.760	2.25	129,128	73,358	93,768	69,458
4	43,758	1.788	2.25	139,895	78,240	98,456	72,930
5	45,946	1.814	2.25	151,228	83,357	103,379	76,577
6	48,243	1.839	2.25	163,148	88,718	108,548	80,406
7	50,656	1.862	2.25	175,681	94,336	113,975	84,426
8	53,188	1.884	2.25	188,854	100,224	119,674	88,647
9	55,848	1.905	2.25	202,695	106,396	125,658	93,080
10	58,640	1.925	2.25	217,233	112,865	131,940	97,734
11	61,572	1.943	2.25	232,501	119,648	138,537	102,620
12	64,651	1.961	2.25	248,530	126,758	145,464	107,751
13	67,883	1.977	2.25	265,358	134,214	152,738	113,139
14	71,278	1.993	2.25	283,021	142,032	160,374	118,796
15	74,841	2.007	2.25	301,558	150,230	168,393	124,736
16	78,583	2.021	2.25	321,011	158,827	176,813	130,972
17	82,513	2.034	2.25	341,424	167,844	185,653	137,521
18	86,638	2.046	2.25	362,842	177,302	194,936	144,397
19	90,970	2.058	2.25	385,315	187,222	204,683	151,617
20	95,519	2.069	2.25	408,893	197,628	214,917	159,198